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**SOFTWARE TO ANALYSE BUSINESS PROFITABILITY**

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# **Introduction**

As the current financial period is marked by a dynamic market and technology continues to evolve rapidly, sustainable profitability is imperative for a business in order to remain relevant and competitive. It provides valuable knowledge to positively impact the financial health and offers crucial information needed to evaluate the present state of the business. Profitability metrics can modify actual competitive standing by identifying areas for improvement and setting realistic performance goals. This concept is closely linked to cash flow and effective profitability analysis, aiding financial management and providing a comprehensive understanding on the timing of cash inflows and outflows essential for maintaining liquidity and meeting short-term financial obligations. Continuous profitability analysis isn't merely about assessing past financial performance; it's a forward-looking tool guiding management to better strategic decisions, enhancing operational efficiency. This thesis aims to offer insights into which sectors of a business need to make changes to allocate resources more efficiently, using specific software relevant to the industry in which the business is operating. Designed as a tool for profitability analysis, the software will encompass key functionalities required for making informed decisions. It will enable users to benchmark against current market trends dynamically, providing a comprehensive view of the financial situation. Additionally, it will offer options to calculate and analyze different rates of returns and financial ratios, starting from raw data gathered over the years in a database. Understanding plain data can be challenging, so the software will present analysis results as graphs on the main dashboard or, if needed, integrate with Live Charts for a simpler overview. Another key focus of the application is real-time market data fetched through the Alpha Vantage API, despite its limitations due to the free version, it will still provide valuable insights, allowing users to compare with peers effectively. Lastly, the software will emphasize user-friendliness, offering intuitive design and customizable dashboards. It will prioritize security, implementing robust encryption and access control measures. Regular updates will ensure compliance with industry standards and regulatory requirements, empowering businesses to drive sustainable growth.

# **Concept of profitability**

Profitability as a general concept is defined as the ratio between a business’ revenues and its expenses, at a microeconomic level it signifies a type of efficiency achieved alongside production factors. In short, it is a measure of a company’s ability to generate profit. This indicator should be split in two ratios, mainly, gross profit margin and net profit margin as stated by Daiva Tamulevičienė in his article “The scientists of economic theory usually suggest to calculate two profitability ratios: gross profit margin and net profit margin. It is appropriate to name these ratios as gross and net profitability of sales because they are calculated by respectively dividing gross and net profit from sales revenue”.   
Although this represents the most common calculations, profitability can be more comprehensive by adding other ratios into account when developing a profitability analysis, thus starting from these key ratios will provide the necessary ground for a complex analysis. “In many works of foreign authors (Gibson, 1992, 2012; Stickney, 1993; Fridson and Alvarez, 2011; Maynard, 2013; Plenborg and Petersen, 2011; Stickney, Brown and Wahlen, 2006 and others), two terms are used to describe profitability: "profitability" and "return". The term "profitability" is used when analysing sales profitability ratios, whereas "return" describes assets and equity profitability”

The cited paragraph suggests that here is a fine line between profitability and return ratios regarding profitability, each having specific metrics leading to the business final goal of assessing current financial health. Additionally, profitability as a standalone concept does not revolve only around the income statement or the balance sheet individually which represent some sources of gathering data. In order to fully grasp the view on overall profitability there has to be resources allocated for industry benchmarks, qualitative factors or other various financial statements.

When relating to the income statement, profitability by itself can be categorized by nature and function as it represents different segments. Categorization by nature falls into a common list of categories such as: operating revenue, non-operating revenue, operating expenses, etc. and it provides clarity in financial reporting by offering an easy way to distinguish between revenues and expenses. On the other hand, categorization by function is represented by categories like: cost of goods sold, general administrative expenses, research and development, etc. and it allows for a granular analysis of different aspects. The size of the business has a significant role when choosing what area of activity to analyze, for example, as a small business the common pick for it is by nature of the expenses as they are disclosed only according to the categories they are spent on. On the contrary, for a medium-sized / large-sized business it is more often seen by function of the expenses as it is more detailed and it allows for the calculation of gross profit and operating profit which will give a more comprehensive understanding over the financial statements.

## **Financial metrics and ratios**

According to [investopedia.com](https://www.investopedia.com/terms/m/metrics.asp) metrics are “…measures of [quantitative assessment](https://www.investopedia.com/articles/investing/041114/simple-overview-quantitative-analysis.asp) commonly used for assessing, comparing, and tracking performance or production. Generally, a group of metrics will typically be used to build a dashboard that management or analysts review on a regular basis to maintain performance assessments, opinions, and business strategies.” (Julie Young, 2022), in other words, a metric can be quantified in order to measure a specific status of the business. Ratios on the other hand are derived from metrics and are used to assess the relationship between different components of the business. As previously stated, profitability can be expressed as a ratio but it is not a universal ratio, hence it can also be measured by Return on Assets (ROA), Return on Equity (ROE), Asset Turnover Ratio, Working Capital Turnover Ratio, etc. all of which can be gathered solely from the balance sheet, despite of profitability ratios being a mix of both balance sheet and income statement. Those indicators can be used according to the degree of relevance for the financial department and based on the specific goals set by the management.

When choosing an indicator, having a good idea about what is going to be measured can help the process further by avoiding possible issues. Some considerations can shape the selection and analysis of the core metrics, such as: “Any single core metric must be generally applicable everywhere at all times, because core metrics are intended to show progress across the entire theater[[1]](#footnote-1). However, finding a metric that meets this requirement has proven to be very difficult, if not impossible.” or “It is not clear how individual core metrics should be tied to end states or how they might show progress toward those end states (or, to use a more common term, objectives). Doctrine provides insufficient guidance as to how metrics should show progress in assessment reports.” (ISAF Afghan Assessment Group, 2009) The quotes provided show that finding one metric that works well in all circumstances is really hard, almost like finding a single number which can accurately reflect all the business financial conditions. Also, it is quite difficult to link single metrics to bigger objectives as a business cannot always fully understand the connections between individual metrics and specific goals. To further develop a way of measurement for profit, financial ratios can be classified into five key ratios: Liquidity, Profitability, Solvency, Efficiency and Valuation; each one serving for different purposes but mixed together they can offer a broader understanding of the business actual financial situation. Although it may depend on the specific activity that the business is operating in, ratios may vary in order to cover specific necessities of the business. Considering two key ratios, namely efficiency ratios and valuation ratios, which can be derived from profitability ratio, when combined, the resulting output will be an overview of the financial data in terms of profitability.

## **Financial analysis and forecasting**

Through rigorous examination of financial statements, ratio analysis and trend analysis, experts have worked to understand what influences financial performance and find strengths and areas to improve. In the journal of Education [Finance](https://www.jstor.org/stable/40703586?read-now=1&seq=6#page_scan_tab_contents) it is specified that “It should be recognized that financial reporting is only one source of information available to decision makers. Analysis which relies solely on such a data base is limited. Social, economic, and political information from other sources is often required to produce relevant and reliable evaluations and decisions”. While financial reports provide valuable data, they may not capture the entire context or other implications of economic decisions, hence the need of a more detailed analysis using diverse techniques such as: “Financial Statement Analysis”, “Ratio Analysis”, “Trend Analysis”, “Comparative Analysis”, “Forecasting Techniques” and so forth. As the software analysis will be done by using ratio analysis, despite its complexity, it is important to recognize its limitations presented by Charles J. Woelfel (1987), in his work where he stated:” Ratio analysis has limitations which must be kept in mind when the process is being undertaken. Major limitations of ratio analysis.”. Although the information is specific to the education sector, there are limitations which are relevant for this thesis:

1. Ratios reflect average conditions that represent past conditions and circumstances
2. Ratios typically do not reflect price-level effects, the impact of inflation or deflation or current market value
3. Ratios are constrained by the limitations of the financial statement data upon which they are based

As there are multiple financial ratios, William H. Beaver specifies that “The usefulness of ratios can only be tested with regard to some particular purpose” initially, a metric has to be considerate in order to give purpose to ratios being utilized. As profitability can also be negative, on a long term it will lead to business failure so this creates the need of profitability analysis in order to avoid this unwanted event. In the same manner, integrating specific forecasting techniques with ratio analysis can extend the perspective on the financial statements. “Forecasting plays an important role in every major functional area of business management. In the area of marketing however, forecasting is doubly important; not only does it have a central role in marketing itself, but marketing-developed forecasts play a key role in the planning of production, finance, and other areas of corporate activity.” (Forecasting: Issues & Challenges for Marketing Management) the study is related to forecasting techniques; time series analysis is a good approach as it is examining historical data in order to identify trends and patterns which can be extrapolated later on to forecast values set of observations arranged chronologically is called a time series (An approach to Time series analysis).

Econometric models often utilize statistical techniques to analyze the relationships between various economic events or variables to make predictions based on these respective relationships. Creating a link between time series analysis and profitability, a significative insight on the business current pattern can be observed, revealing the company’s financial performance over time. Also, the analysis could be further refined with econometric models that will seek to quantify in a better way the existing relationships between profitability and other economic variables such as interest rates or macroeconomic indicators.

## **Factors affecting profitability**

Profitability, a vital measure of business efficiency, is influenced by various internal and external factors. Research consistently shows that firm size, asset management, and industry characteristics notably impact a company’s financial performance. Larger firms often benefit from economies of scale, allowing them to operate more efficiently and generate higher profits. However, some studies indicate that smaller firms, due to their agility and innovative capabilities, can also achieve high profitability levels by adapting quickly to market changes and customer demands (Margaretha and Supartika, 2016). Furthermore, financial management practices, including effective credit and asset management, directly influence profitability. Banks, for example, see profitability affected by their asset and equity management, with successful ones demonstrating adept control over factors like credit facilities and deposit growth (Al-abedallat, 2017). These institutions must balance risk and return effectively, particularly in competitive and rapidly changing markets, to maintain and enhance their profitability. Thus, strategic financial management and operational efficiency are fundamental for any firm aiming to improve its profitability in a sustainable manner.

The factors affecting the profitability of businesses are diverse, ranging from firm size to chain affiliation. For instance, the study by Alarussi and Alhaderi (2018) explored the determinants of profitability for companies listed in Malaysia, identifying five critical factors which were: firm size, working capital, company efficiency, liquidity, and leverage. Their findings showed that larger companies, those with well-managed assets, and those maintaining sufficient working capital tend to be more profitable. They measured firm size by total sales and efficiency by the asset’s turnover ratio. Conversely, they found that higher debt equity and leverage ratios negatively impacted profitability. Interestingly, liquidity, as indicated by the current ratio, had no significant effect on profitability. Therefore, it appears that larger firms with efficient asset management and solid working capital are more likely to be profitable, whereas high leverage can be detrimental. But in the study of Menicucci (2017), he took a different perspective by focusing on the Italian hospitality industry. By analyzing data from 2,366 Italian hotels between 2008 and 2016, Menicucci identified key factors affecting profitability, including firm size, internationalization, location, having accommodation as the primary activity, and chain affiliation, all of which positively influenced profitability. Additionally, Menicucci put accent on the negative impact of the financial crisis on profitability by highlighting the significance of external economic conditions. These insights are particularly valuable for diverse industries such as: hotel investors, owners, managers, and policymakers in developed countries like Italy, aiming to enhance hotel profitability.

Every time a profitability analysis is conducted, factors such as scale, scope, stability, etc. are taken into account and because of the common shared theme of economic impact, studies from different industries can relate together. In the insurance industry, large firms manage risks more efficiently due to their substantial resources. This concept parallels the agriculture sector, where operations that benefit from economies of scale achieve higher profitability, and diversified systems are designed to enhance stability and economic viability. Just as one industry is heavily influenced by regulatory environments and market dynamics, diversified farming systems are also impacted by market conditions and policies which can either support or alter the economic viability. [Economic Factors Affecting Diversified Farming Systems on JSTOR](https://www.jstor.org/stable/26269286?searchText=Factors+influencing+profitability&searchUri=%2Faction%2FdoBasicSearch%3FQuery%3DFactors%2Binfluencing%2Bprofitability%26so%3Drel%26efqs%3DeyJjdHkiOlsiYW05MWNtNWhiQT09Il19&ab_segments=0%2Fbasic_search_gsv2%2Fcontrol&refreqid=fastly-default%3Aabf0a1c3a48707b83b3e887daa9131d3). The study that was conducted to present the relevancy of effects of firm size and risk was done by utilizing data from the top 400 firms sorted by asset size, reveals that large insurers manage risks effectively due to their extensive resources and broader market reach. Conversely, small insurers face greater vulnerability, primarily due to limited diversification and regional constraints. These findings underscore the necessity for adopting size-specific strategic approaches and tailored regulatory measures to enhance profitability and mitigate risks in the insurance sector. This differentiation in strategic needs highlights the critical role of firm size in shaping profitability factors within the industry. [The Effects of Firm Size on Risk and Profitability of the Property and Casualty Insurance Industry on JSTOR](https://www.jstor.org/stable/41946132?read-now=1&seq=6#page_scan_tab_contents).

# **Method of analysis**

Decomposing the analysis of profitability is one of the key methods used to assess performance under the framework of operating profitability, into three main drivers: the profit margin, the asset turnover, and a funding ratio measuring the percentage of operating assets funded by capital. This approach emphasizes the distinction between operational activities and those pertaining to financing, giving a better picture of the fiscal fitness of an organization (Nissim, 2022).

The Dupont analysis is more common, combining the methods for factor analysis and comparative analysis to examine the overall profitability of an enterprise. This method provides an overall rating because it considers major profitability parameters like return on assets and return on equity. Through this technique, firms can reveal where they are good with their financial statements and where they are lagging, and in turn, could take measures accordingly for better performance (Li, 2021). Profit can be maximized while optimizing productive capacity, forecasting demand elasticity for pricing strategies, and controlling resource usage. For example, industry-specific profitability analysis (based on payment class) enables a hospital to determine how much revenue it earns over its expenses (Cleverley, 1978).

Profitability analysis is valuable in making strategic marketing decisions and every scientific research adds to the bigger image of how profitability analysis is tailored and how its application varies across industries. These approaches have resulted in more detailed knowledge on customer relationship-based information on product manufacturing, environmental sustainability, energy management, and growing profitability and economic sustainability strategies.

## **DuPont Analysis**

The DuPont formula is another profitability analysis tool developed by the DuPont Corporation in the 1920s. ROE has three components: profit margin, asset turnover, and financial leverage, thus granting an exhaustive picture of the company's profitability. Profit margin is represented as the ratio between net income and sales, and shows the amount of profit a company makes with every dollar of sales. Higher profit margin indicates better control over costs and effective pricing. Asset turnover is the ratio of sales to total assets and, consequently, measures the company's efficiency in turning its assets into sales. Better control over assets ensures more sales are generated with the same asset amount. Financial leverage is the ratio of total assets to shareholders' equity, showing how much of the company's total assets are financed by equity. Higher financial leverage indicates greater reliance on debt, which can magnify returns and risks.

With the DuPont formula, analysts are able to dig into the aspect in which a company is doing well or in which it is faltering. For example, a company can have a high ROE but a low margin, which would suggest that cost reduction strategies may be of great benefit. Another firm could have low asset turnover, which indicates that it should optimize asset utilization or divest of underperforming assets. Studies have established the effectiveness of the DuPont formula in various industries. For example, Doorasamy (2016) applied the DuPont analysis to the food industry to shed light on the incremental insights due to profit margin changes for betterment of financial performance. Again, Sheela and Karthikeyan (2012) have used the formula in the profitability analysis of pharmaceutical companies in India to establish the drivers of financial performance. DuPont formula is the one that can break ROE into the controllable parts, and for this reason, it is a remarkable tool for strategic decision-making. After all, if a company knows its profit margin, asset turnover, and financial leverage, the company can then better strategize ways to lift profitability and bring sustainable long-term growth.

Integration of DuPont formula into profitability analysis software can contribute greatly to decision-making in strategic planning. This software, therefore, can easily exploit the three different components of the DuPont analysis to have a proper overview of the health of a firm.   
For example, if the software detects low profit margins, it may provide suggestions around cost-cutting or price point. If the asset turnover is low, it may suggest improved asset use or the divestment of non-performing assets. It can also monitor changes over time, allowing the companies to track the impact of implemented strategies on their profitability. To further aid in the process understanding, we will use the following example:

**Table 1.**

*Data collected from company XYZ Corp. for the year 2023.*

|  |  |  |  |
| --- | --- | --- | --- |
| Net Income | Revenue from sales | Total Assets | Total Equity |
| 120,000 | 800,000 | 500,000 | 200,000 |

Proceeding with the calculation of relevant metrics according to the DuPont analysis, hence the need for Profit Margin, Asset Turnover, Equity Multiplier and Return on Equity.

Therefore, ROE = 0.15 x 1.6 x 2.5 = 0.60 (60%).

Based on this result, interpretations can be made about XYZ Corp. financial situation. Because of the high return on equity, can say about XYZ Corp. that it is driven by a combination of a strong profit margin, efficient use of assets and significant financial leverage. Looking at the values obtained, it can be stated that the company effectively converts sales into actual profit leading the business to be highly profitable.

## **Financial ratio analysis**

Profitability ratios are essential as they help determine how well a company generates earnings relative to its expenses and other cost items. They include the Net Profit Margin, Return on Assets, and Return on Equity ratio. The Net Profit Margin helps assess the pricing strategy and efficiency of controlling costs as it shows what amount of each dollar of sales is profit. ROA helps determine how well a company uses its assets to generate profits, while ROE helps assess the return on shareholders’ income. In the case of Nigeria’s pharmaceutical companies, financial ratio analysis has been used for the determination of profitability. Innocent et al. in 2013 conducted a study for a period that also indicated financial ratios significantly influence profitability outcomes. The study also showed the importance of using financial ratios in making strategic decisions. In other industries, such as banking across Africa, the study by Ahmed and Teru in 2017 provided meaningful information for profitability prediction. The study indicated that both ratios, ROA and ROE, were statistically significant for predicting bank profitability. The information was essential for bank investors and regulators on the variables influencing profitability. Pratama et al. in 2022 used the profitability ratios to propose a strategy on how to operate in the industry. This indicates how financial performance correlates with business objectives to enhance profitability and improve competitiveness.

Another study conducted by Turhan and Aydemir (2021) reveals the significance of technology in financial ratio analysis, particularly within the information and technology sector. The study employed various multi-criteria decision-making approaches to evaluate the financial performance of companies listed on the BIST Information and Technology Index. Using tools like the Analytical Hierarchy Process and Grey Relational Analysis, the research highlighted how technology can improve the precision and promptness of financial reports. Such precision is crucial for companies to assess their financial health and strategic positioning, enabling them to adapt and succeed in the rapidly evolving technological landscape.

## **Cost-volume-profit**

Cost-volume-profit analysis works as an excellent tool used to understand the relationships between cost, volume, and profit in a business setting. It supports decision-making processes aimed at improving the level of profitability. There are several cases noted by different scholars demonstrating the utility of CVP analysis in various business areas. For instance, E. Lulaj and E. Iseni (2018) stressed the significance of using this tool in planning and decision supports in a business setting. The researcher demonstrated how CVP analysis links cost management with the level of profitability, thus informing future business planning. It allows businesses and managers to understand the impact of change in cost and volume on profit, therefore, a better process of decision-making.

According to a study by Bușan and Dina (2009), managers utilize CVP analysis to evaluate how different scenarios—such as changes in sales volume or pricing strategies—impact profitability. This analysis provides a clear understanding of the fixed and variable costs associated with production, helping in the optimization of pricing and production strategies (Bușan & Dina, 2009).

Dickinson (1974) explores the introduction of uncertainty into CVP analysis, highlighting the importance of considering variations in demand, prices, and costs. This approach allows for a more realistic and flexible analysis, accommodating the unpredictable nature of market conditions. By incorporating statistical methods, businesses can better estimate potential outcomes and make informed decisions under uncertainty. Although the highly use of CVP in different areas of activity, this process of analyzing a business after a certain relationship between specific ratios, it is strongly linked to Break-Even analysis ([Integrating Standard Cost-Volume-Profit and Degree of Operating Leverage with Accounting Variance Analysis on JSTOR](https://www.jstor.org/stable/23608650?read-now=1#page_scan_tab_contents).

Before proceeding with the main theme of cost-volume-profit analysis, a short insight on Break-Even analysis it is presented by Haim Levy and Robert Brooks as being “widely employed to measure firm risk” ([Financial Break-Even Analysis and the Value of the Firm on JSTOR](https://www.jstor.org/stable/3664841?read-now=1&seq=2#page_scan_tab_contents) )Despite the direct link between BE and CVP, because a profitability analysis does usually require a variety of metrics such as ROE, ROA, Profit Margin, etc., BEA focuses solely on the break-even point without providing any comprehensive metrics that offer insights into the overall profitability. Also, it does not take into account the financial structure of the company, therefore this kind of procedure will not provide significant insight on the final report of business status.

## **Trend analysis**

Trend analysis is a critical approach within profitability analysis because it allows enterprises to relate their financial performance across distinct time intervals. In most cases, the historic data indicates the ability to identify patterns, forecast future performance as well as make informed strategic decisions. It is fundamental in the evaluation of the level of sustainability of profit and general financial health of an organization. In the telecommunication industry in Ghana, profitability was analyzed using trend analysis across a time span of four years. The study by Koi-Akrofi (2013) showed that profitability ratio parameters which include the Net Profit Margin (NPM) and Return on Assets (ROA) have a correlation. The approach allowed the identification of significant insights into the financial stability and efficiency of companies in the telecom industry across the analyzed period. Similarly, across manufacturing firms in Sri Lanka, a study was done by Gnanasooriyar (2014) that used trend analysis in the assessment of profitability. The study indicated fluctuations in profitability and fluctuations in equity which produced a detailed view of the firm's financial performance. Empirically, the study emphasized the need to understand industry-specific trends as it enhances financial decision-making. In Serbia, Vesic and Petronijevic (2018) conducted an analysis of the profitability trends of major banks for the period 2010–2017. Not only did it exhibit the profitability ratio, but it also showed an all-around view of the banking sector's financial health. This aspect was instrumental in the comprehension of growth periods and decline. As such, more effective strategic planning towards profitability in the coming period was realizable. Trend analysis could be applied to specific industries, as was evidenced by Velmathi (2015) in the analysis of Britannia Industries Ltd. From the evaluation of profitability using ratios and correlation analysis, the paper informed much about the financial status and the operational efficiency of the company. Also, Popat (2012) did the comparative study of selected steel industries, establishing that the profitability trends were different among the main players such as Tata Steel, JSW, and SAIL. This helped in understanding the competitive landscape and areas that needed more insight. The need for profitability trend analysis has also been carried to the new research areas, for instance, in demand-side flexibility for the electricity systems. Forero-Quintero and Villafáfila-Robles (2022) analyze the profitability of these systems in a manner so that the trend analysis will be done for the innovative sectors in order to provide an estimate of the financial viability and resource allocation. Consequently, in a summary, trend analysis forms the backbone of profitability analysis for all these and other companies. It enables business entities to keep track of how they are performing, to forecast future outcomes, and to develop strategy from historical data. The ability of a business to identify trends and patterns will have the potential to secure long-term profitability and therefore financial stability.

To make the process of trend analysis efficient in gathering data as accurately as possible, the use of real-time market data in this context can be realized. This entire activity would be affected through the various APIs that are available online. Real-time data collection via the use of APIs has been studied in various areas. The ability to collect data in real-time through APIs has changed many aspects of industry where users can integrate data streams and analyze seamlessly. A prominent example exists in neonatal intensive care units (NICUs), which use an adaptive streaming API to ingest physiological data from bedside monitors. It is a system that processes data on the fly and is built on a pay-per-use model with no breaks, disruption, or manual intervention, which enhances patient care and research capacity (Inibhunu et al., 2019).

A real-time streaming API design using Apache Storm also demonstrates high throughput capabilities in processing big data with low latency. This method is based on the high requirement for any real-time processing solution to handle large-scale data streams and evolve into truly real-time processing. This system uses Apache Storm to provide a fault-tolerant, scalable, and efficient data processing solution, which is essential for real-time analytics (Munshi et al., 2019).

# **Software system for profitability analysis**

This software is designed to provide a comprehensive tool for businesses to assess their current financial situation through the use of profitability ratios which can be later used for a comparison with its peers. The comparation with companies operating in the same industry it is possible through a free API which makes possible external data retrieval for specific companies based on a business symbol and the database of the software which represents internal data. Because it is a software that provides necessary tools for a business to help managers make an informed decision, interpret and visualize the data obtained it incorporates a decision support system.

A decision support system (DSS) is a computer program application used to improve a company's decision-making capabilities. It analyzes large amounts of data and presents an organization with the best possible options available. This is very important and forms a vital aspect of any modern business environment that is significantly enriched, competitive, and rapidly changing. The systems are aimed at helping any organization develop a competitive advantage by improving; therefore, providing the ability to make informed decisions which will ensure profitability growth.

## **Data analytics for decision support**

This kind of process leverages advanced data mining techniques as specified in “Intelligent financial decision support system based on big data” (Danna Tong and Guixian Tian, 2023). As an example of this system’s implementation, it significantly improved operational efficiency and decision accuracy while also making possible to monitor the industry in real-time which helped in generating detailed financial reports and visual representations of key financial metrics.

As a general rule, when using a decision support system in any context, key focus is going to be on available data that can be acquired in order to further sustain any kind of analytical process. This being said, in the context of a software which analyzes profitability, implementing a system driven by data can provide valuable information for management as its primary role it is represented by data reports and analysis.

Data-driven decision support systems are integral to contemporary management practice because they have the ability to transform business data into business intelligence. One such system is detailed in "Understanding Data-Driven Decision Support Systems" (D.Power, 2008). The importance is exemplified through their support for Business Intelligence (BI) and performance monitoring, allowing managers and IT professionals to analyze large amounts of data effectively. It does incorporate a range of components like models, databases, and analytical tools that support the decision-making process.

These systems facilitate effective use of data mining and data warehousing, enabling real-time data analysis and strategic decisions. The article lists numerous development packages and criteria for evaluating DSS development software, stating that the choice of software impacts the system's features and capabilities (Power, 2008). They are crucial when looking to use data as an asset for better decision-making and to create an edge over the competition.

As seen previously, decision support systems are computerized tools designed to assist decision making processes across various industries. As these systems utilize a combination of data sources and modeling techniques, they typically comprise components like:

1. Database
2. Model base
   1. “The model base has the models used to perform optimization, simulation, or other algorithms for advanced calculations and analysis”
3. Knowledge base
   1. “For example, the knowledge base may contain how many employees in an organization’s database have worked within the organization for over ten years”
4. Graphical User Interface (GUI)

The integration of sophisticated models and user-friendly interfaces can make this kind of systems valuable for enhancing decisions making efficiency and effectiveness (Ioana Andreea Stefan, F.G. Filip, 2011).

Therefore, in the current context of profitability analysis, using a specific DSS model can help manage important problems that may arise in the financial year. What this research aims to provide is a tool designed to analyze profitability by leveraging data from Income Statement and Balance Sheet to accurately calculate specific financial ratios to assess the financial health of the business with insights from real-time market data from other businesses in the same industries. Features that can be considered significant are as follows:

1. Financial Analysis
   1. Uses data from financial statements to compute key ratios such as ROA, ROE, Contribution Margin, Current Ratio, etc.
2. Market Benchmarking
   1. Incorporates real-time data from the market to benchmark the business's performance against industry peers.
3. Visualization and Reporting
   1. Provides a dashboard for visualizing financial data and trends, and allows users to generate comprehensive reports.

## **Software infrastructure**

“Software infrastructure is the backbone of any digital system, providing the essential framework and components that support the development, deployment, and operation of software applications. It encompasses a wide range of tools, services, and technologies that enable the seamless functioning of software in various environments.” (SoleIT, 2024). Therefore, this software was developed in the Visual Studio environment provided by Microsoft on a desktop with Windows as main operating system with heavy reliance on .NET Framework, providing in the end a Windows-based desktop application.

### **Implementation technologies**

This software was created with the use of Windows Presentation Foundation which is a UI framework that is independent of resolution and utilizes a vector-based rendering engine so it can provide a modern graphic software. It offers a broad range of features, including data binding, layout management, 2D and 3D graphics, custom styles; everything is part of the .NET ecosystem and WPF enables the development of applications that can seamlessly integrate with other .NET API components (Microsoft team, 2023).

Starter technologies used along WPF, were Visual Basic.NET with XAML (Extensible Application Markup Language), a declarative markup language, which provides an easy way to build Windows-based desktop applications with a modern look and a lot of options for personal customization therefore enhancing overall aspect of the software.

As main reasons for why VB.NET was used:

1. Relatively simple syntax and straightforward
2. Legacy support
   1. Although technology presented improvements this does not directly implies the fact that every old technology used was replaced. Therefore, there are still outdated systems which cannot use newer technologies and could make a use of this software.
3. Rapid Application Development (the concept of RAD is possible because of the extensive library with pre-built controls that are integrated into the IDE used.)

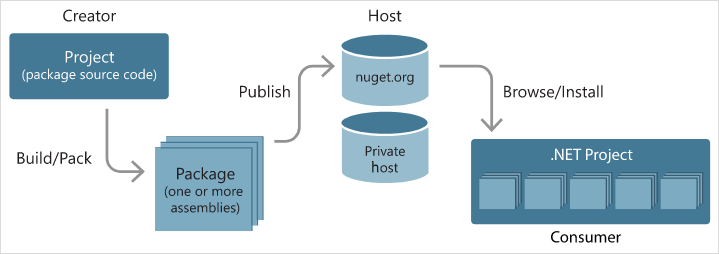
To provide a complete front-end development, XAML came in aid with possibilities to extend the amount of personalization by using custom styles and developing layouts based on the actual necessities of the application. Moreover, it allows to write the entire code for the interface so there will be a better link between front-end objects and back-end functionalities, making the work flow much easier and faster.

Because the programming language used was VB.NET, in order to achieve specific functionalities like displaying data in a dashboard or importing files with specific extensions such as Excel, it had to be done with help from the NuGet package manager, thus providing needed tools to achieve the desired result in terms of functionality.

Regarding NuGet package manager, it is package manager for the .NET platform, which is used to manage libraries and dependencies in .NET projects. It simplifies the process of incorporating third-party libraries into a project by automating the download, installation, and update of packages from a central repository. This helps developers to easily add, update, and remove libraries and tools without having to manually manage the dependencies and versions, ensuring that the necessary components are available for the project to function correctly. It is highly useful as it simplifies the inclusion of various libraries needed to complete the analysis process and because of the pre-built libraries it helps saving time and effort.

**Figure. 1**

*NuGet roles*



Source: https://learn.microsoft.com/en-us/nuget/what-is-nuget

Libraries that were provided by the NuGet package manager were:

* EPPlus
* LiveCharts
* Newtonsoft.Json
* System.Data.SQLite
* Alpha Vantage

In order for the user to be able to import an Excel file, EPPlus library was used. This package offered the ability to read and write Excel files using the Office Open XML format (.xlsx).

Because an analysis tool is not complete without a visual representation, LiveCharts provided the adequate methods for implementing a quick visual enhancement for displaying data in a manner in which would tell the user all the information needed just by looking at the dashboards made with this respective library.

The software also provides the user the option to collect data about other businesses by using an API called Alpha Vantage. It provides real-time and historical financial data, including stock prices, forex rates, financial statements, and more. Because is straightforward to integrate into the application it allows to quickly and efficiently incorporate financial data into the software. A key factor present in this API is that it provides a robust set of features at a lower cost compared to many other financial data providers, making it accessible for a wide range of applications.

Because retrieving information from an API requires parsing data, this could not have been done without a JSON (JavaScript Object Notation) In this context, JSON is a data interchange format that is commonly used for transmitting data between a server and a client in web application. When the data is returned by the API to our application it is returned as a JSON structure of key-value pairs making it straightforward to access and manipulate within software. A library to make this manipulation available was needed, thus the use of Newtonsoft.JSON package.

In order to store the data which is going to be used for a financial analysis a database is needed. Instead of going to a database based on a server like Microsoft SQL Server, this software opted for a smaller database already integrated in the software by using a package from NuGet which provides the option to create an embedded file with an extension dedicated to the database (.db). The main reason for implementing this method of storing the data comes from the necessity of allowing every user to make the most of this software by providing affordable solutions. For a smaller company with no dedicated department of IT there is no necessity for a complex database management, therefore there is no real reason of implementing a complex database solution. The way this database works is related to the abilities of SQLITE of providing seamless integration with the .NET ecosystem and ease of use with Visual Basic syntax.

Lastly, beside the use of NuGet package manager, an API was used as previously discussed. From all other available APIs on-line, this was the only one that provided use for this specific software. It does allow the user to retrieve data based on a business Symbol (in economics, a business *symbol* it is often referred as *stock symbol*, and it is a unique series of letters assigned to a publicly traded company on a stock exchange) and a specific financial year. After specifying desired parameters, the user will retrieve data from both Income Statement and Balance Sheet of the respective business which will further allow for market comparison.

### **Software architecture**

Software architecture plays a critical role in the development and success of business software systems. It represents the design decisions related to the overall system structure and behavior, ensuring that the software can meet essential qualities such as modifiability, availability, and security. Effective software architecture serves as a bridge between technical requirements and business goals, enabling organizations to achieve their strategic objectives through well-designed technological solutions. As for this particular software, a Layered Architecture Pattern was chosen due to its structured approach which enhances maintainability, scalability, and separation of concerns.

**Figure 2.**

*Layered Architecture Pattern*



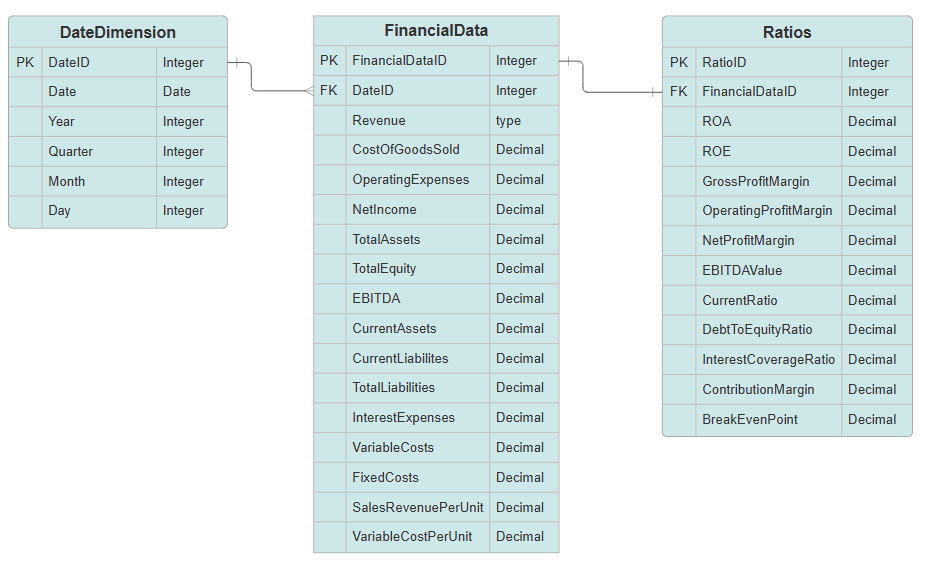
1. **Presentation Layer**
   1. This layer handles the user interface and interactions, displaying collected data and analysis results. It includes elements like dashboards, charts, forms, and reports for visualizing profitability data. Technologies used here often include HTML, CSS, JavaScript, and frontend frameworks like React or Angular.
2. **Business Logic Layer**
   1. The Business Logic Layer processes data according to business rules, performing calculations and analyses to transform raw data into meaningful insights. It handles core application functionality, ensuring correct and efficient data processing. This layer includes services for calling the Alpha Vantage API and implementing profitability calculations.
3. **Data Access Layer**
   1. The Data Access Layer manages data retrieval, storage, and updates from sources such as databases and APIs. It ensures seamless interaction with data storage systems to fetch real-time and historical financial data. This layer abstracts the complexities of data management, providing a simplified interface for data operations.

One of the key aspects of software architecture in business contexts is its ability to support and enhance business models. As highlighted by various sources, including the article “**The Relationship Between Software Architecture and Business Models** “(Jitendra Choudhary, 2023) software architecture is essential for enabling different parts of a business model. It helps in structuring software systems in a way that aligns with the business processes, there by facilitating smooth operations.

The respective software, uses a Three-layer architecture as shown in (FIG.2). which is well-suited in this kind of applications because it offers clear separation of concerns, enhancing maintainability, scalability and overall system efficiency. “The 3LPM can provide a blueprint for increased simplicity, resulting in higher productivity, enhanced product quality, and a longer life for systems overall. Although its implementation, whether completely or only in part, poses challenges as does any process of change companies should recognize that elements of the model already exist internally, often informally or in an ad hoc fashion. Adopting a more structured, explicitly managed approach can significantly benefit an organization’s profitability and continued viability in the market” (Jan Bosch, 2013); The 3LPM is the abbreviation used by the author for *Three-layer product model*.

### **Data management**

As stated earlier, the solution picked for the data storage was the package provided by NuGet with SQLITE. Because the DCM (Data Conceptual Modeling) and DLM (Data Logical Modeling) were not suitable for this project and do represent obstacles, the general database organization can be rendered as an intuitive approach, therefore in the following figure it can be seen the physical model of the database created through SQLite.

**Figure 3.**  
*Database Entity Relationship Diagram*

Explain why this format

Maybe I can talk about DCM and DLM? Do I need sources if I include some theoretical information learned throughout the year?

-Constraints, some associations, roles, cardinalities more clearly represented

-Maybe put into the Anexes the figures for related entities?

## **System characteristics**

The analysis will leverage real-time data collection to enable accurate market benchmarking for organizations. This approach allows companies to make decisions based on the current and precise state of their finances. This way, it will cover a variety of aspects regarding the financial situation of the organization. Specifically, it will examine businesses’ current status, determine their projected financial situations in the future, and evaluate the state of their financial metrics. As a result, companies will receive a detailed image of their current and future financial situation.

A couple of general steps are going to be followed to simplify the process of analyzing financial data. Therefore, data collection and processing will be the main step before proceeding with actual values and respective calculations. After ensuring everything is well-placed, the process can continue to relevant metrics and calculations. The analysis will be supported by custom dashboards that can be integrated by LiveCharts (NuGet package). These dashboards will provide real-time reports and will be clearly displayed, enabling users to identify patterns in the analyzed information. The results of the analysis will be compiled into reports. Companies will be able to download the reports in PDF, Word, and Excel formats. The reports will detail the specifics of the businesses’ needs and provide detailed answers and suggestions.

### **Functional features**

As for the source of data, there is going to be only one option available, through an already made database (SQLITE) which contains every aspect needed in order to conduct a profitability analysis and by using the real-time data API embedded in the software which will retrieve financial information in real-time from a specific business.

The actual values which will be used to start the process of financial analysis will be obtained through specific input mechanisms available within the system.

1. Input fields provided by the graphical user interface.
2. Excel file import functionality.

Because of the method of inputting data manually by using the GUI input fields, an option to correct errors will be also available. The process of adjustment will be represented by the ability to delete specific entries from the database.

Processing the data into the database will involve the following operations:

1. Use of input fields 🡪 Insert operations based on available input fields for end users.
2. Converting data types 🡪 Transforming string representations of numbers into numerical data types.
3. Handling missing values 🡪 Using the imputation procedure which allows to substitute the missing values with a mean, median or mode for numerical data and most frequent category for categorical data [(encord.com)](https://encord.com/blog/data-cleaning-data-preprocessing/).
4. Removal of faulty data 🡪 Select faulty entry based on an unique ID which can be seen by the end user.

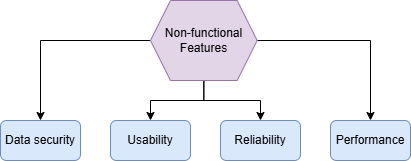
Focusing on the main part of the software, it will calculate metrics to obtain the necessary insight on business profitability. To achieve this desired outcome, the software will incorporate the following metrics:

1. Income Statement Metrics
   1. ROA
   2. ROE
   3. Gross Profit Margin
   4. Operating Profit Margin
   5. Net Profit Margin
   6. EBITDA
   7. Contribution Margin
   8. Break Even Point
2. Balance Sheet Metrics
   1. Current Ratio
   2. Debt-to-Equity Ratio
   3. Interest Coverage Ratio

Each calculation will be done by the software’s internal formulas with help from the defined database as source of data. After each calculation the obtained results are going to be available on memory unless specified otherwise by generating a report and exporting in a PDF or excel format the results.

### **Non functional features**

These features are also called “quality attributes” or “software quality requirements” because they describe different working aspects of the software. Therefore, it can be seen in the article written by (altexsoft, 2023) that “Nonfunctional requirements specify *how*the system must perform. … a nonfunctional requirement can be the speed with which a system must perform editing to satisfy user expectations.“

**Figure 4.**  
*Non-functional features in software development*

The software is modeled and implemented to incorporate the following attributes:

1. Performance
   1. Making use of asynchronous methods can ensure speed and scalability as it will process inputs and data retrieval faster.
   2. It will be able to handle increasing amounts of data by using SQL queries and SQL indexing.
2. Reliability
   1. Format validation which ensures that dates follow the YYYY-MM-DD format.
   2. Range Validation that checks if numerical values fall within acceptable limits
   3. Error handling mechanism which records errors and exceptions in log files
3. Usability represented by an user-friendly interface which provides information on the interface through intuitive layouts.
4. Data security is based on RBAC procedure which will ensure that the stored information is safe and cannot be altered by unwanted parties. Providing means of authentication before using the software. Role-based access control refers to the idea of assigning permissions to users based on their role within an organization [(auth0.com)](https://auth0.com/docs/manage-users/access-control/rbac).

## **Application workflow**

This section aims to provide comprehensive insights on the entire journey the user has when using the application. As a general rule, the workflow will follow a set path which is constituted by the next steps:

1. **Data collection**
   1. Assumes gathering financial data from either internal source such as business’s own financial department or from external source such as various current industries operating in the same market. This data collection process will be represented mainly by financial statements such as Income Statement and Balance Sheet.
2. **Data validation**
   1. After obtaining needed data, it will undergo rigorous processes as validation to maintain consistency.
3. **Obtaining relevant metrics**
   1. The entire process of obtaining valuable information about specific key ratios will represent the last stage of the user’s workflow as this will lead to a precise evaluation of financial performance to enhance the profitability and business growth.
4. **Access to results**
   1. As the desired metrics were obtained, the user can access the results by either using available displayed information through a list of values or switch to the specific application tab in which he can generate the final report.

## **Functional logic**

When developing this type of software, specific use cases and scenarios must be considered to provide an overview of the system functionality. Therefore, the main uses are represented by:

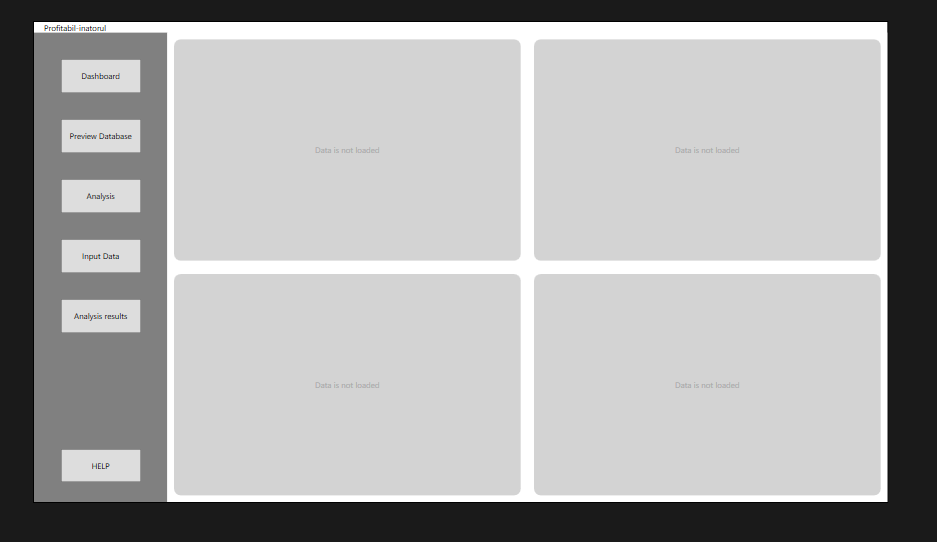
1. Ability of users to calculate various key profitability metrics essential for understanding the financial health of the business.
2. Generate comprehensive reports that detail various profitability metrics over specified time periods.
3. Creation of dashboards through previously mentioned helper NuGet package LiveCharts.

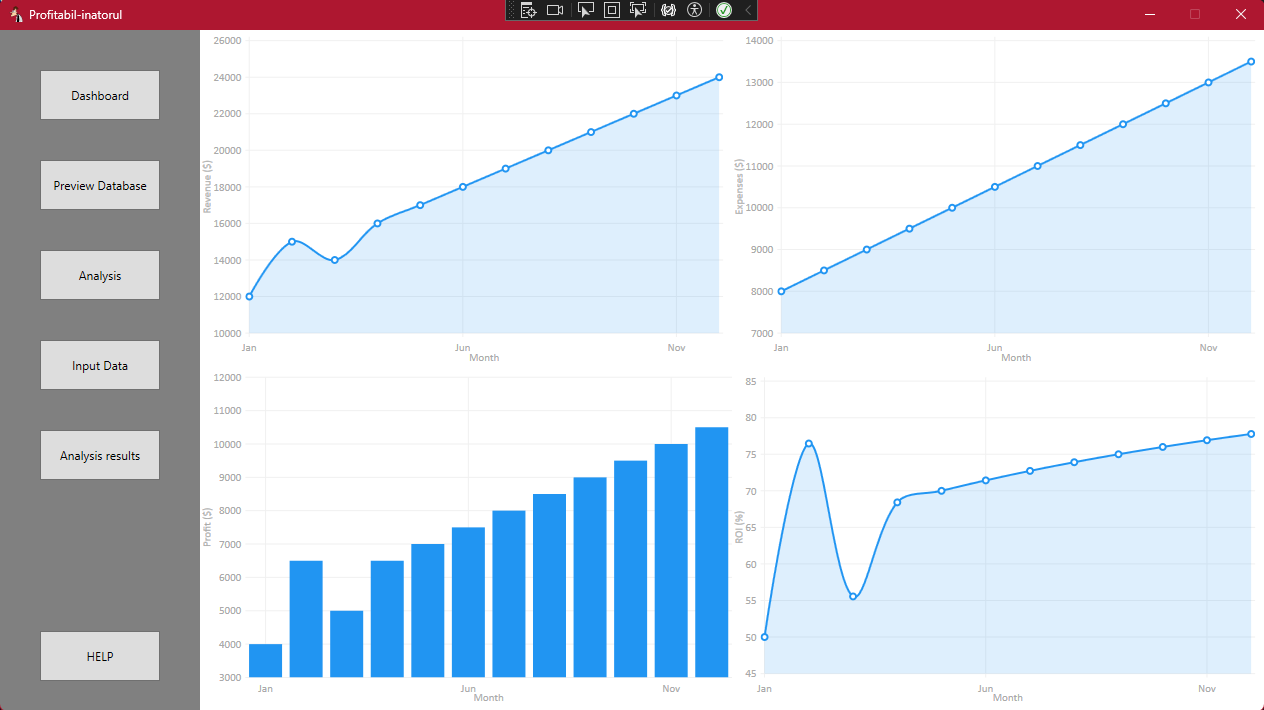
Before addressing individual use cases, the main capabilities and features of the application must be briefly presented. The first step, which cannot be skipped, is the authentication process. This requires the user to enter specific credentials, allowing access to the software and preventing unauthorized access, thereby maintaining data privacy

INSERT IMAGE OF THE SOFTWARE’S AUTHENTIFICATION PROCESS.

After obtaining access to the software, the user is greeted with a default tab selected, that being the dashboard on which the user can visualize information from the database. If there is no data stored yet, the application will display placeholders for the actual charts to directly show the user he needs to provide data in order to see summarized information on a chart.

INSERT MAIN TAB – DASHBOARD, BOTH CASES (DEFAULT NO DATA – ALREADY CALCULATED DATA)





THIS IS JUST AN EXAMPLE, IT WILL BE CHANGED LATER AFTER FINISHING THE GUI

The default window, namely the Dashboard, serves only as a starting point for the user. From the list of buttons available in the left side of the window, it can be seen that there is one distinct button called “HELP”. It will encompass quick tips and steps on how to use each section of the software so if the user gets stuck he can use it to solve his problem.

INSERT IMAGE WITH HELP BUTTON CONTENTS (A COUPLE OF TABS)

As stated previously, from the Dashboard tab the user can further proceed to seeing the actual database values in form of a grid. In this window, it will also be offered the option to delete specific information from the database that the user thinks are wrong or should not exist in that database, therefore it will allow to select a specific database ID associated with the faulty entry and delete it.

INSERT IMAGE WITH THE PREVIEW DATABASE BUTTON

Because the database preview option could show an empty grid with no rows or columns as a consequence of no data stored yet in the database, therefore it will also use a placeholder in form of text to indicate that the database needs values first before displaying any information. So, the user will be forced to jump to the “Input Data” tab of the software where he will be welcomed by a window filled with graphical controls regarding manual input of the needed values to be stored.

INSERT IMAGE WITH THE INPUT BOXES FOR NUMERICAL VALUES

If the user does not want to enter the values by hand using available controls due to various motives such as time efficiency, the user can opt for a much quicker solution importing Excel files directly into the software and allowing the user to preview the dataset he provided so he can change it before inserting the actual data into the database. The same display of data in form of a grid will be used as seen previously in the “Preview Database” tab.

INSERT IMAGE WITH THE DATAGRID AND BUTTONS FOR IMPORTING AND INSERTING THE VALUES IN THE DATABASE

The next step after the user is done importing and checking the data will be to preview the changes made to the database with help from a message box pop-up that will confirm the data had been successfully inserted into the database, then the user can actually check the changes by switching to the “Preview Database” tab.

At this stage, the user can use the “Analysis” tab effectively, as the software's database holds enough information to calculate the specified ratios. In the 'Analysis' tab, the user can select a date range using a date picker and choose which metrics to calculate using individual checkboxes, depending on various information needs.

INSERT IMAGE WITH THE OPTIONS OF CALCULATING RATIOS IN THE ANALYSIS TAB  
Beside the ability to calculate metrics with internal data gathered from financial statements, the user will also have the option to pick any industry symbol and specific financial year starting with the current year to calculate the same metrics as he did with own dataset. This provides the ability to compare own business performance with its peers. Both results from calculated metrics are going to be shown in forms of percentages in a separate list-box.

INSERT IMAGE WITH THE OPTIONS TO GATHER MARKET DATA AND LIST-BOX RESULTS FOR BOTH

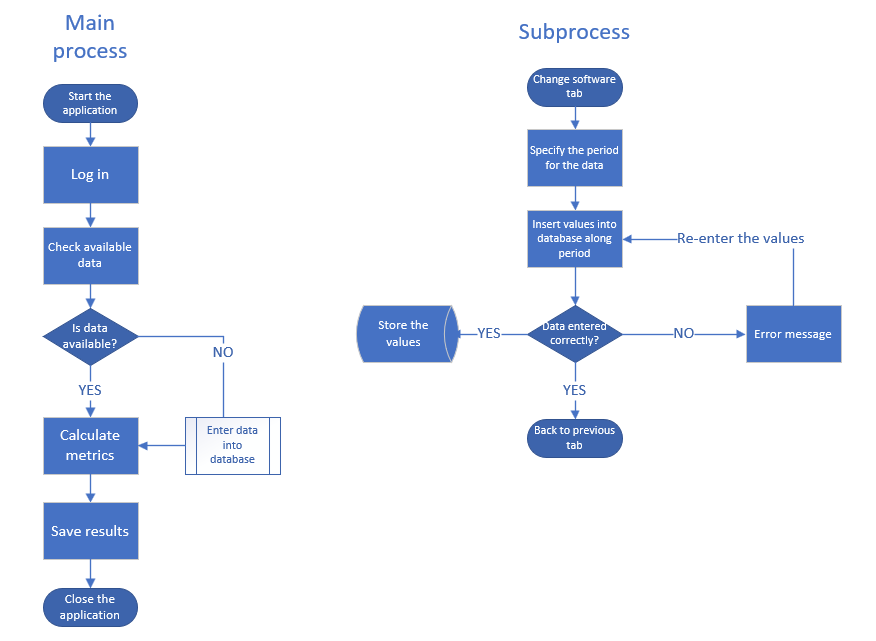
Lastly, this software allows the user to generate a final report in PDF or excel format, displaying metrics results from either internal, external, or both sources. Each metric will include a basic financial interpretation and highlight possible risks if necessary. To generate the final report, the user can go to the 'Analysis Results' tab, where graphical controls are provided to specify the report contents.

INSERT IMAGE WITH “ANALYSIS RESULT TAB” AND HOW THE PDF WILL LOOK

For a comprehensive understanding of the application workflow, below is presented a specific use case for a general process which includes a subprocess.

**Use case: Generate profitability report**

In this case, it is assumed that the user successfully authenticates and proceeds to generate a profitability report for the business which will be further used to provide insight to the management. In order to achieve this goal, it is assumed the following flow of operations:



# **Conclusions**

The software developed for analyzing business profitability stands out as an important asset because of its ability to calculate and analyze profitability ratios which provides essential knowledge on financial metrics such as ROA, ROE, Operating Margin, etc.; allowing a business to efficiently allocate resources based on their current financial health. This process is crucial in a business environment because understanding different areas strengths and weaknesses could increase business efficiency thus resulting in higher revenues. As these ratios represents how a business it is utilizing its resources to generate revenue, it can provide guidance when making decisions, therefore enhancing operational efficiency and profitability. To sustain this process of assessing business’ current financial situation it needs a reference point as in comparing results with peers from the same industry; for this to happen, external data has to be gathered in order to calculate necessary metrics. Therefore, a notable strength of this software is the benchmarking functionality which lets the user leverage real-time market data from an API like the one used in this software, namely Alpha Vantage, which is a Nasdaq licensed provider of realtime and 15-minute delayed US market data.

The utility of this software is highly represented by the ability to visualize current financial data available in the database and future calculation of metrics to ease the process of understanding the results provided by the software. It represents a key factor when discussing non-functional features as intuitive interface and overall comprehension of obtained results. Also, another key factor that highlights the utility it is represented by the ability of generating reports in formats like PDF and excel (.xls) which can further assist the decision-making process and present the results in a more appropriate way from a business point of view. Another key factor that recommends the utilization of this software in a business context it is the time-efficiency which is made possible through the import functionality which allows the user to import a financial situation from an excel file and insert it into the database without providing values for each section by hand, thus improving significantly the time it would take to fill the database and use it later for a profitability analysis.

Because there is no such thing as “perfect” the software could get some meaningful updates in the near future. To be more concise, as for now the user it is allowed to pick only one business at a time and compare it to his own business, thus reducing the efficiency for the benchmarking functionality. To improve this functional feature, in the future the software could allow the user to select a range of symbols and retrieve data for all the businesses involved in the process. Also, another update that could be possible in the future but for the non-functional features it is represented by security as in this current state the software does not have other authentication methods than RBAC and it could benefit from a 2-factor-authentication or another form of additional security.

Overall, despite its early form, the software could represent a boost in efficiency and ease the work of doing everything manually. It is possible to achieve the same results with other software that allows easy calculations and data visualization but later on it will not depend just on the calculations or the ability to visualize data and results, problems like performance drawbacks and time management could occur so having a dedicated software that can handle large amount of data with a short response time for operations could enhance overall system reliability and user satisfaction.

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1. “This consideration applies even when core metric indicators are broken into provincial or district-level blocks

   of data. Indicators can show different levels of activity or effect from area to area, but core metrics are designed to

   provide reliable measurement using a like standard across all areas” (ISAF Afghan Assessment Group, 2009) [↑](#footnote-ref-1)