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Evaluating Financial Sustainability and Risk Management: Critical Analysis and Factor Modeling

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ABSTRACT

The intricate nature of today's business and the unpredictability of global market events underscore the significance of financial risk management and the pressing need for strong and efficient financial sustainability metrics to reduce risk, strengthen the organization's resilience to such financial shocks, and assist managers and investors in making decisions. The review examines key financial theories, measurement approaches, and relevant outcomes. By using data from Indian companies in industries such as oil and gas and heavy machinery (2009–2023), this research highlights inadequacies, including the absence of a common definition and measurement technique for financial sustainability, and suggests a financial sustainability index based on factor analysis and principal component analysis (PCA). The findings provide information for risk management and decision-making, with three main components—financial health, liquidity/leverage, and profitability efficiency explaining 81% of the variance. To improve long-term sustainability, additional investigation directions and useful implications for investors and managers are recommended.

Keywords: Financial Sustainability, Financial Risk Management, Principal Components, Factor Analysis, FSI

1. INTRODUCTION

In the current business dynamics, where circumstances change constantly over time, organizations must function with flexibility and a situation-appropriate strategy in order to remain profitable over the long term. Conflicts, direct wars, trade wars, pandemics, financial recessions, and other events fundamentally altered the conventional corporate philosophy and pattern, necessitating a flexible strategy. Due to which the world has entered into the age of sustainability and sustainable development (Sachs, J. D. 2015). This literature review aims to critically examine existing research work on business sustainability and financial sustainability, mainly focusing on the key theories, measurement approaches, determinants, and obtained results. This review seeks to identify the challenges, trends in the sustainability research, patterns, emerging theories, and integration of different factors directly or indirectly affecting the financial and business sustainability. Moreover, this review research paper also identifies the gaps in the existing literature and suggests the future perspective of the research to enhance the field of study and its practice implications for the managers and investors for long-term sustainable business. Despite the growing trends in international business and the increasing length of supply chains domestically and globally, financial and business sustainability has become a critical and sensitive area of research due to its impact on businesses, corporations, institutions, and the stock market.

In the study of sustainability, financial sustainability is a rather new concept; it can be defined as the potential of firms to provide continuity of activities and create profit in long-term operations by using an optimal combination of investment and sources of financing (Zabolotnyy & Wasilewki, 2019; Qaim et al., 2021). In brief, it can also be defined as an organization's capability to maintain the finances to meet their financial and operational goals in the future

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(Irianto & Adiatma, 2023). However, business sustainability is a broader concept and does not have any specific definition that covers all the aspects of business sustainability; nevertheless, researchers defined business sustainability in brief terms as a firm's ability to respond to short-term financial obligations without compromising on the ability to achieve future needs (Bansal & DesJardine, 2014). In a more descriptive way, business sustainability refers to the practice of balancing financial, social, and environmental obligations in order to achieve sustainable growth (Elkington & Rowlands, 1999).

Business sustainability has evolved from being a specialized issue to a crucial strategic focus in recent years. Moreover, with the global bodies, individuals' companies are also putting steps forward towards business sustainability, such as Amazon co-founding The Climate Pledge, committing to achieve net-zero carbon emissions by 2040, and investing in renewable energy projects to support sustainable development. Similarly, IKEA and General Electric (GE) initiated activities supporting environmental sustainability, such as adhering to environmental and social obligations, optimizing efficiency, and so forth. Business sustainability is no longer a choice but has become an obligation due to climate change, consumer preferences, regulatory pressure, technological development, and changing business environments. In the current era, with the changing geopolitics and global crisis, institutions and firms are more focused on financial sustainability and taking the critical steps to mitigate the risks, overcome economic uncertainty and inflation, and try to boost the confidence of investors and stakeholders (Gleißner et al. 2022; Xin et al. 2024).

Despite the growing body of literature in business and financial sustainability, numerous gaps in the knowledge and results in the public domain still persist. Practitioners and researchers have not even agreed to one definition of sustainability (Fibuch & Way, 2012; Bateh et al., 2013). In this paper, we will review and indicate the method of analysis of financial sustainability for businesses and corporations with the help of factor analysis and principal component analysis (PCA). The illustration will be presented by the data collected from the Indian firms operating in the oil & gas refining and marketing, heavy machinery & vehicles, industrial machinery & equipment, and electrical components & equipment sectors. The objective of the paper is to check the feasibility of using the double classification of financial variables for the calculation of the financial sustainability index and providing insight to managers and investors for better financial and business risk management.

1.1 Understanding Financial Sustainability (Is its new concept?)

Sustainability was commonly defined by the WECD in 1987 (World Commission on Environment and Development), and based on the principle of intergenerational equity, several definitions of financial sustainability were given by academicians and researchers. Financial sustainability is considered a broader concept and can be defined from different perspectives. Historically, it can be associated with the Hicks (1945) first-time approach, but still no definition has been approved by all the researchers. In general terms, sustainability means "existing for the long term"; hence, financial sustainability is also aligned with the time dimension of the financial situation of an organization; however, it is multidimensional and can be studied along other dimensions also, such as scope or sector of application (Günther et al. 2016).

Table 1: Definition of Financial Sustainability along different Prospective

Reference	Prospective	Definition
Bolívar, M. P. R. (2016)	Public Sector Accounting	Financial sustainability can be understood as the ability of public administrations to continue current policies now and in the future without causing the debt to rise continuously.
Fiscal Sustainability Report 2012	Public Finance Prospective	It is the ability of a government to avoid excessive increases in liabilities and ensure it is able to deliver the necessary public services, including in times of hardship.
Gleißner et al. 2022	Business Prospective	Financial sustainability refers to the ability of a company's current financial success to not jeopardize or compromise future financial stability, aligning with the broader goal of sustainable value creation in the long-term operations.

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In this research paper, we will focus on the business and organizational perspective of financial sustainability. The financial sustainability of firms or organizations is influenced by several internal (system flexibility, material and technology availability, disposable financial resources, investor confidence, management and employees' qualifications, non-tangible assets, and so forth) and external (accounting, tax level, regional and geopolitical stability, type of market, supply chain situation, industry characteristics, and so forth) factors (Azarenkova et al. 2018).

With the understanding that it is also critical to measure the financial sustainability, there are several methods published in the previous research indicating the quantitative methodologies; however, there is still a need for the universal measurement methodology for the business and corporate to make the result available globally. Our article collects the most recent and relevant methodologies. Firstly, measurement is based on the accounting and capital market measure, which includes profitability, liquidity, and solvency ratios as parameters (**Beaver, 1966; Altman et al., 2017)**. Secondly, from the financial management perspective, which includes debt management, investment efficiency, and returns (**Zabolotnyy & Wasilewski, 2019)**. Thirdly, from the government and public finance perspective, that focus on fiscal responsibility and budget management includes fiscal deficit, tax stability, and debt-to-GDP ratios in measurement (Ghosh et al. 2013). Fourthly, CSR and ESG are widely used and globally accepted, as they include the several parameters of environment, social, and governance. It includes ESG scores, carbon footprint, carbon emission scale, social responsibility metrics, and related parameters (Friede et al. 2015; **Alsayegh et al. 2020)**. Lastly, nonprofit and social enterprise perspectives mainly focus on mission-driven financial sustainability to fulfill the obligation and achieve their objectives based on their good financial health and minimize the negative impact on the environment (Bowman, W. 2011; **Maier et al. 2016)**. In the measurement, multiple financial and non-financial parameters can be included, such as revenue diversification, operational self-sufficiency, fund-raising efficiency ratios, and related parameters. However, there are other perspectives also published by the researchers.

The main objective of the understanding and calculation of the financial sustainability is to reduce the risk for the investors, manager, and market. Thus, it is very important to understand the risk management and how the financial sustainability will help in the financial risk management for the companies and investors in the short term and long term.

1.2 Risk Management

Risk management is a well-studied topic of research and can trace its start to the 1730s, when the first futures contracts on the price of rice in Japan were introduced (Dionne, G. 2013). But financial risk management gained popularity among the researchers and businesses in recent times. Louis Bachelier in 1990 used Brownian motion to analyze the fluctuation in financial assets for the first time, which accelerated modern financial theory and financial risk management (Dionne, G. 2013). Previously, risk management was only associated with finance and insurance, but further, it attracted the other spheres of strategic, safety, operational, reputational, and so forth (Ahmed et al. 2021). The changing geopolitics and economic climate significantly increased the concern of the investors and managers. The trade war and increasing tariffs from the USA to different economies have shaken the financial predictions of several companies along with the USA. Moreover, all the global economies are preparing for the recession and escalation of the trade war in the long term. Moreover, the fluctuation in the exchange of different currencies, the falling of the stock price, the high rate of inflation, the loss of jobs, the reduction in the manufacturing scale, and the disruption in the supply chain are leading the companies to focus more on risk management and get ready for unprecedented financial shocks. Thus, it becomes more important for the business and companies to identify and manage the risk appropriately. In the wide definition, risk has been defined by Horcher, K. A. (2011) as "risk is the probable variability of returns on investment." Similarly, the Institute of Risk Management (IRM) also defined risk as "it is a combination of the probability of an event and its possible outcomes (consequences). Consequences can be positive, negative, or zero."

1.3 What is Financial Risk Management and Business Risk Management (Definition and Understanding)?

Risk management is a broad concept and can be defined from different perspectives. In this research, we are defining risk management in reference to business or corporate financial sustainability. Financial risk management and business risk management are two different concepts but interconnected with each other because of their

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organizational origin; however, both concepts are important for the financial sustainability of companies and financial institutions. If we closely observe the business risk management associated with the organizational goals (Bromiley et al. 2015), the financial risk management is mainly associated with the financial goal of the organization and focuses on the profitability.

Financial Risk Management	Basel committee (2001), Dionne, G. 2013; Pashchenko et al. 2017	Financial risk management can be defined with four key words: risk identification, assessment, minimizing the risk in reference to profitability, and mitigating risk to ensure financial security and prevent the possible reduction of the market value.
Business Risk Management	Kot & Dragon, 2017; Fraser and Simkins, 2016	Business risk management is a methodical process of identifying, evaluating, and mitigating risks associated with the organization, which makes it difficult for the organization to achieve their operational and strategic goals or objectives. It helps in safeguarding the assets and helps in attaining the stability along with improving the operational performance.

2. MEASUREMENT OF FINANCIAL SUSTAINABILITY BY FACTOR ANALYSIS

In the previous research, several researchers used factor analysis for the measurement of the financial sustainability of the business in the long term and short term. Literature like Osborne & Costello (2008), Bagnoli & Megali (2011), Ecer et al. (2017), Khan & Khan (2019), Zabolotnyy et al. (2019), Gleißner et al. (2022), and several other researchers identified the latent factors underlying financial sustainability and reduced them into the principal components to achieve the research conclusion.

In my research, I will select different parameters indicating the financial performance of firms/businesses across multidimensional contexts and reduce them into the key components. In order to illustrate how businesses are valued within a framework of financial sustainability, we use financial parameters outlined as Net Income after Tax, Total Current Assets, Debt-Total, Operating Expenses, EBIT Margin-%, Turnover, Total Current Liabilities, Total Non-Current Liabilities, Capital Expenditures-Total, Free Cash Flow, Retained Earnings, Net Debt per Share, and Gross Profit Margin-%. Furthermore, correlations to other homogenous items in a data set are crucial for drawing conclusions about a firm's financial sustainability. Thus, we need to apply the systematic evaluation method to address the reliability of the dataset and interpret uncertain and multidimensional information.

2.1 Factor Analysis Execution:

The dataset is constructed on the relevant variables based on the practical and theoretical relevance to the objectives of the research. In the methodology, we will integrate scale dependency, conduct factor analysis, and calculate the weighted index to provide a solid, data-driven way to evaluate the financial sustainability.

To check the suitability of the dataset for the factor analysis, the Kaiser-Meyer-Olkin (KMO) test can be conducted. It is a tool used for the measurement of the sampling adequacy, as it assesses the proportion of variance among the variables. It ranges from 0 to 1, but a value less than 0.5 is considered unacceptable for the analysis; however, a value nearer to 1 is considered more appropriate and acceptable for the factor analysis (Dziuban & Shirkey, 1974; Tabachnick et al., 2019).

$$KMO = \frac{\sum_{i \neq j} r_{ij}^2}{\sum_{i \neq j} r_{ij}^2 + \sum_{i \neq j} p_{ij}^2}$$

Where:

- r_{ij} = correlation coefficient between variables i and j
- p_{ij} = partial correlation coefficient between variables i and j after removing the effects of all other variables.

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The dataset is suitable for factor analysis if the total KMO value is greater than 0.8. However, if the ultimate objective of the research is to perform a more comprehensive examination, there are two instances in which the individual's KMO value of less than 0.5 can be omitted. Otherwise, it can be considered in the dataset that more than 0.8 overall KMO value is acceptable for the factor analysis.

In the measurement of financial sustainability, several financial parameters along several dimensions can be collected, and thus, it is critical to analyze them. In the second stage, to simplify and interpret the dataset, the Principal Component Analysis (PCA) with Varimax rotation can be used, which can reduce the dataset into the primary components while preserving most of its variance (Jolliffe & Cadima, 2016).

Based on the PCA result obtained, the principal components nature can be identified for the financial sustainability model formulation. The result obtained in the PCA analysis classified the financial parameters in the groups with the correlation based on the nature of the parameters. We assumed that the PCA analysis divided the financial parameters into the principal components.

Principal Components	**PC1 (Financial Position and Operations**	**PC2 (Liquidity and Leverage)**	**PC3 (Profitability Efficiency)**
Financial parameters	Net Income after Tax, Total Current Assets, Debt-Total, Operating Expenses, Turnover, Total Current Liabilities, Total non-current liabilities, Capital Expenditures-Total and Retained Earning	Free Cash Flow and Net Debt Per Share	EBIT Margin

Based on the classification of the financial parameters based on the nature and correlation amongst the parameters, profitability efficiency can be considered as the financial sustainability indicators. In the long-term operation of firms, the profitability efficiency plays major role. In this research paper we are using the double classification for formulating financial sustainability metrics.

2.2 Construct the Financial Sustainability Index (FSI)

With the mentioned principal components there are possible financial sustainability index metrics can be formulated:

$$FSI = w_1PC1 + w_2PC2 + \varepsilon_o \text{ ---------- } (i)$$

$$FSI = w_1PC1 + w_3PC3 + \varepsilon_o \text{ ---------- } (ii)$$

$$FSI = w_2PC2 + w_3PC3 + \varepsilon_o \text{ ---------- } (iii)$$

$$CFSI \text{ (Composite Financial Sustainability Index)} = w_1PC1 + w_2PC2 + w_3PC3 + \varepsilon_o \text{ ---------- } (iv)$$

Where;

W = *Weight each component by its proportion of variance explained (from the rotated solution)*

ε_o = *Errors*

In the interpretation of FSI and CFSI, reliable balance sheets and operational capabilities are essential for long-lasting economic downturns, as shown by high values. We are showing the first stage of classification of financial parameters for the formation of the financial sustainability metrics.

2.3 Data Collection

We collected the secondary data from Refinitiv for companies incorporated in India. The dataset provides financial and operational data for multiple companies, primarily in the oil & gas refining and marketing, heavy machinery & vehicles, industrial machinery & equipment, and electrical components & equipment sectors, spanning 2009 to 2023.

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We collected the data for the 75 companies initially, but due to the error in the data and missing financial parameters for certain years, we eliminated 7 companies, and finally the analysis has been conducted with the 68 companies. The panel data has been collected for the 15 years from the 2009 till the 2023 financial year.

3. RESULT AND DISCUSSION

We used the state for conducting the test for the analysis of the obtained data to understand the acceptability and reliability of the collected data. The aim of the result is to identify principal components from the selected financial parameters based on the correlation among the selected financial parameters. The obtained result presents Principal Component Analysis (PCA) conducted on a dataset with financial parameter variables to evaluate their suitability for factor analysis and contribution to financial sustainability and risk management. Firstly, the test has been conducted for checking the scale of reliability and obtained the Cronbach's alpha value of 0.8275, which is more than 0.8, indicating a good scale of reliability. For the further analysis, we conducted the Kaiser-Meyer-Olkin (KMO) test for understanding the suitability of the data set for the factor analysis.

Table 2: Result of Kaiser-Meyer-Olkin Test

Financial Parameters	MSA
Net Income after Tax	0.84
Total Current Assets	0.88
Debt Total	0.81
Operating Expenses	0.85
Turnover	0.95
EBIT Margin	0.87
Total Current Liabilities	0.90
Free Cash Flow	0.32
Capital Expenditures Total	0.91
Net Debt per Share	0.13
Retained Earnings	0.90
Total non current liabilities	0.88
Overall MSA	0.86

From the result obtained in Table 2, the obtained value of overall MSA is 0.86, which indicates that the dataset is well suited for the factor analysis, as if the value of overall MSA is more than 0.8, then the dataset is suitable for the factor analysis. However, we found some financial parameters have the MSA value less than 0.5, which indicates the weaker suitability for the factor analysis; however, if we want the more precious factor analysis, we can eliminate these financial parameters like free cash flow and net debt per share with the values of 0.32 and 0.13, respectively.

Further analysis used the first classification of the financial parameters and used the Principal Component Analysis (PCA) with the varimax rotation.

Table 3: Result of Component Loading for PCA (Applied rotation method is Varimax)

	PC1	PC2	PC3	Uniqueness
Total non current liabilities	0.97			0.06
Capital Expenditures Total	0.96			0.07
Total Current Assets	0.95			0.09
Total Current Liabilities	0.95			0.07
Net Income after Tax	0.94			0.08
Debt Total	0.94			0.06
Retained Earnings	0.88			0.22
Operating Expenses	0.86			0.25

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Turnover	0.75			0.42
Free Cash Flow		-0.81		0.27
Net Debt per Share		0.58		0.61
EBIT Margin			0.95	0.09

From Table 3, we can interpret that based on the loading of the analyzed financial parameters, they divided into the three principal components, and the interpretation can be for **PC1** (financial health and operational scale), **PC2** (liquidity and leverage risks), and **PC3** (profitability efficiency), indicating the financial health and the risk management in the firms. The majority of the variables are low (0.06–0.42), with the exception of Net Debt per Share (0.61), indicating that the components adequately describe the majority of the variables. However, net debt per share exhibits a distinct variance.

Table 4: Result for the component Characteristics

	Unrotated Solution			Rotated Solution		
	Eigen value	Proportion var.	Cumulative	SumSq. Loadings	Proportion var.	Cumulative
Component 1 (PC1)	7.61	0.63	0.63	7.56	0.63	0.63
Component 2 (PC2)	1.10	0.09	0.73	1.15	0.10	0.73
Component 3 (PC3)	1.00	0.08	0.81	1.00	0.08	0.81

From the table 4, considering an eigenvalue of 7.61, Component 1 in the unrotated solution explains 63% of the variation (cumulatively 63%), Component 2 contributes 9% (cumulatively 73%), and Component 3 adds 8% (cumulatively 81%) with an eigenvalue of 1.10. The Varimax-rotated solution indicates that Component 1 still explains 63% (cumulative 63%), Component 2 explains 10% (cumulative 73%), and Component 3 explains 8% (cumulative 81%) with a sum of squared loadings of 7.56, 1.15, and 1.00, respectively.

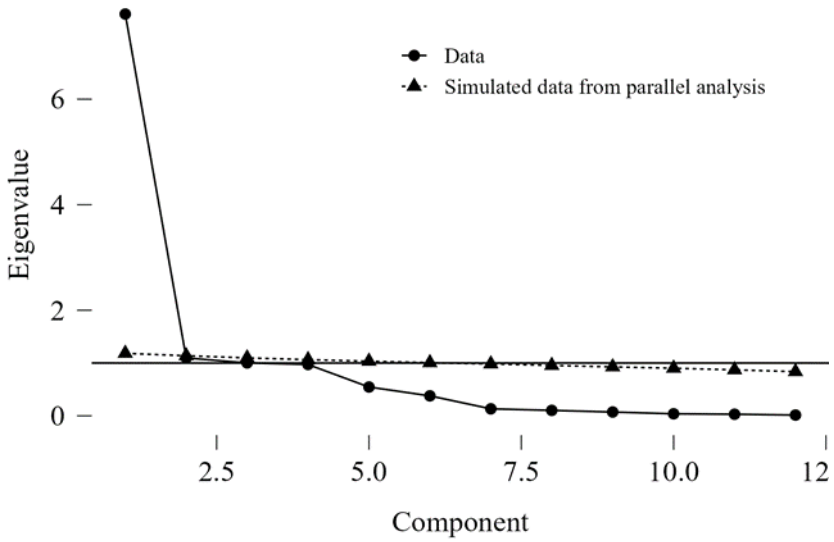

Figure 1: Scree plot of Principal components with Eigen value

Figure 1 represents the scree plot of principal components with eigenvalues. In the figure, the components are on the x-axis and the eigenvalues are on the y-axis. The scree plot shows the variance that each primary component takes

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into consideration. Actual data is represented by the dotted line, and simulated data for parallel processing is shown by the triangle line. Included are components where real data surpasses simulated data or whose eigenvalues are higher than the Kaiser requirement. Three components with eigenvalues over 1 (7.61, 1.10, and 1.00) are shown in the plot, and they account for 81% of the cumulative variance subsequent rotation as it is also represented in the above table 4.

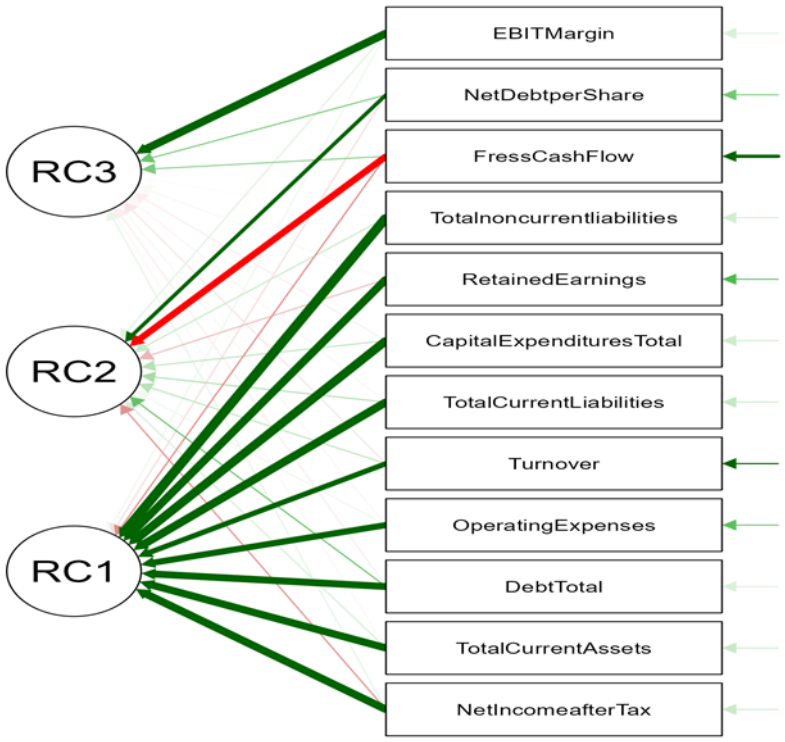

Figure 2: Components loading Plot (correlation between the financial parameters and Principal components)

Note (RC1 = PC1; RC2 = PC2; RC3=PC3)

In Figure 2, we can visually analyze how the financial variables are related to the principal components based on the loading. The green color code is used to indicate the direct correlation of the variable with the financial components, while the red color code is used to indicate the indirect correlation between the financial variables and the principal components.

4. CONCLUSION

Financial sustainability emerges as a powerful tool in financial risk management and provides complete insight into the financial health of the firms or businesses, which provides guidance to the investors and managers to make policy and in decision-making. To enable businesses to successfully navigate the complexities inherent in modern corporate environments signified by geopolitical shifts, economic uncertainty, and global crises, this literature study thoroughly covers the developing fields of financial and business sustainability.

The empirical analysis conducted on the secondary data of Indian companies (2009-2023) combines Principal Component Analysis (PCA) and component analysis to create an efficient Financial Sustainability Index (FSI) by using factor analysis. Financial position and operations (PC1), liquidity and leverage (PC2), and profitability efficiency (PC3) are the three main financial sustainability metrics identified in the study. The Financial Sustainability Index (FSI) is based on these factors, which account for 81% of the variance. The study identified profitability efficiency as a major metric for the long-term sustainability of the organization and helps in the risk management and decision-making for the investors and managers.

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This study concludes by highlighting the importance of financial sustainability as an essential component of successful corporate and financial risk management. In addition to advancing scholarly debate, the study gives stakeholders useful tools to manage financial risk by offering an organized, empirical method to its measurement. To further improve the FSI and ensure its relevance in a global economy that is becoming more integrated and sustainability-driven, future studies will examine global comparisons as well as different areas of operation, which will give more detailed insight into financial sustainability and risk management with the local factors' integration

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