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Sustainability models in Zone 3 manufacturing SMEs

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Abstract

In this research, the objective was to determine the optimal financial sustainability model for manufacturing SMEs in zone 3 for the years 2017 - 2020. For the development of the study, 107 medium and small companies that met the requirements of complete information obtained from the Superintendence of Companies, Securities, and Insurance were taken into account. Observation sheets were used to classify the information in the financial statements and allow understanding of their financial situation by applying the solvency prediction models, Z-Altman, Springate, Fulmer, and CA-Score. In the analysis of the financial indicators of manufacturing, SMEs evidenced a strong correlation with their financial sustainability, especially in the year 2019. A comparative analysis of the effectiveness of the four models of financial sustainability is made, for the selection of the most optimal model. In addition, a SWOT analysis was performed in order to identify the strengths and weaknesses of each of them, so, it is revealed that the most optimal and reliable model is Springate, due to its multidimensional approach, adaptability for manufacturing SMEs, simplicity and ability to provide a clear and truthful score. However, it is always advisable to consider the specific context of other models to each company.

Keywords: Financial sustainability, Financial indicators, Springate model, Manufacturing sector

1. Introduction

1.1. Problem

For the problem for small and medium-sized manufacturing companies in Ecuador is the lack of understanding of the economic and financial value of the industry [1]. Some companies are not aware of the importance of implementing a management model or may underestimate its potential benefits, this is due to the lack of information or understanding on how a management model can improve efficiency and operational effectiveness, thus making it difficult to make conscious financial decisions. In addition, [2] expresses that another common problem is that some management models can be complex and difficult to implement, especially in companies with complex organizational structures or consolidated operational processes.

The lack of ability to understand and apply the model effectively may deter companies from trying to implement it. Sometimes companies may not perceive a need to apply or implement a management model especially if they are not facing significant challenges. These companies do not take into account the use of financial sustainability measurement models when executing their activities or evaluating the fulfillment of their goals and objective [3].

According to [4], the SME manufacturing sector in Ecuador faces multiple challenges, such as lack of access to financing, high competition, and economic instability. These companies, which are critical to the country's economic development, often lack the resources to invest in technology and training, which limits their capacity for innovation and process improvement. In addition, the COVID-19 pandemic exacerbated these difficulties, resulting in a significant decrease in revenues and an increase in operating costs. Inefficient cost management and lack of financial planning have led many SMEs to face liquidity and solvency problems, putting their long-term sustainability at risk.

In this context, [5] mentions that financial analysis becomes crucial, as it allows companies to identify areas for improvement, optimize resources, and make informed decisions. A sound financial approach can help SMEs adapt to changing market conditions, manage their debts effectively, and establish strategies that foster their growth and competitiveness. The implementation of financial analysis practices not only contributes to the stability of these companies but also strengthens the country's economic fabric, promoting a more resilient and sustainable environment.

1.2. Importance

The financial sustainability of small and medium-sized manufacturing companies is a fundamental pillar for economic and social development in any region, so this study seeks to analyze the importance of identifying and applying the most appropriate financial sustainability model for manufacturing SMEs. In addition, the choice of an optimal model not only ensures the survival of these companies but also promotes their growth, improves their competitiveness and contributes to job creation.

Therefore, it is of great importance to take into account a financial sustainability model for manufacturing SMEs as they determine a plan or process in order to generate income in a sustained manner [6]. In other words, financial sustainability models are a set of steps, stages, phases, or activities for an appropriate analysis of economic resources that contribute to the company and financial development [7]. Similarly, financial sustainability models are important for decision-making, risk evolution, strategic planning, the establishment of key performance indicators, communication and transparency, compliance with regulations and laws, resource management, market adaptation, and finally social and environmental responsibility [8].

1.2.1. Manufacturing sector

The manufacturing sector in Ecuador faces a complex situation, representing approximately 20.8% of the national gross value added [9]. Despite its importance, the development of this sector has been limited, and manufacturing companies have struggled with challenges such as lack of financing and the need for technological modernization. Manufacturing production has shown moderate growth but has been affected by external factors such as fluctuating raw material prices and international competition.

1.2.2. Importance of the manufacturing sector study

Contribution to GDP: The manufacturing sector is a fundamental pillar for the growth of Ecuador's Gross Domestic Product (GDP), with a 99% positive correlation between the growth of this sector and real GDP. This indicates that any improvement in manufacturing can have a significant impact on the national economy [10].

Employment Generation: This sector is responsible for approximately 11% of total employment in the country, highlighting its crucial role in creating job opportunities and reducing unemployment [1].

Innovation and Competitiveness: Modernization and financial analysis are essential for manufacturing SMEs to innovate and compete in a global market. Lack of investment in technology and training limits their ability to adapt to market demands.

Sustainable Development: A robust manufacturing sector not only boosts the economy but also contributes to sustainable development by generating value-added products and promoting responsible resource use practices.

1.3. Background

According to [11], microenterprises prioritize the formation of an unshakable financial sustainability in their organization, but they are eluded by the high level of financial risk, the variability of the environment, and the market. Therefore, most microenterprises do not underwrite financial expenses, which shows that they are not leveraged with institutions, so liquidity in these companies is a circumstantial value in the sustainability of SMEs. However, the microenterprise context is a project with a not-so-remarkable need for capital in the development process, the requirement will be high since it is necessary to know the means of financing that facilitate the necessary monetary resources and that adapt to the operational needs of the entity. For several companies, sustainability represents an opportunity or a change towards obtaining a new way of doing business, proposing new management models so that their prosperity and quality are compatible [12].

For [13], the most prominent companies are small and medium-sized enterprises, as they are a staple of the business structure in Latin America, representing approximately 99% of the total number of companies in the region and providing employment opportunities for almost 70% of workers. However, in Ecuador, in order to achieve adequate management, it is necessary to adopt strategies to enable small enterprises to adapt to a sustainable production and consumption model [14]. Microenterprises in Ecuador, being categorized as organizations with low monetary capital find it difficult to perform in a market with high competitiveness [15]. Rationale of the research question: What is the most reliable financial sustainability model for manufacturing SMEs in Zone 3 in the years 2017 - 2020?

1.4. Theoretical framework

1.4.1. Financial sustainability models

These are valuable tools for corporate economic and financial analysis. These models are based on the use of financial ratios to diagnose and predict financial sustainability [3]. However, financial sustainability models are used by companies, especially manufacturing SMEs, to ensure their long-term survival and ability to create value. These models are not one-size-fits-all recipes, but general frameworks that allow each company to adapt its strategies to its specific circumstances [16].

1.4.2. Altman's Z model

Altman's Z model is a collection of well-selected, weighted, and aggregated financial indicators summarized into a single metric. If the derived Z-score or Z-score is greater than the calculated score, the company is considered financially healthy. Anything below the threshold is generally considered a potential failure. The Z-Altman model is a widely used financial tool for estimating the probability that a company will fail within two years. Developed by Edward I. Altman in 1968, the model classifies companies into risk categories based on a statistical analysis of multiple financial variables [17].

1.4.3. Springate model

The Springate model is a statistical method used to assess the probability of corporate failure. Developed by Gordon Springate, this model is based on the analysis of a set of financial ratios to determine the financial health of a company. It includes indicators that identify the financial strength of a company and define whether the company has reached the threshold of insolvency or bankruptcy. This model was created in 1978 at Simon Fraser University, Canada, following the method developed by Altman [18]. The Springate model is based on the idea that companies in financial distress exhibit specific patterns in their financial ratios. By identifying these patterns, the model can predict the probability of bankruptcy.

1.4.4. Fulmer model

This model was created in 1984 and bears the surname of its creator John Fulmer, who also employs iterative multiple discrimination analysis [19]. It evaluates 40 financial ratios for a sample of 60 companies, of which 30 are solvent and 30 are insolvent. Applying his model one year in advance of insolvency, Fulmer achieved 98% accuracy and 81% with more than one year. With the objective of providing benchmarks to facilitate decision-making related to the company's overall strategy. Consequently, in this Fulmer model, if the result is less than zero, the company is considered to be at risk of bankruptcy, and, conversely, the higher the positive number, the stronger the company.

1.4.5. CA-Score model

The insolvency prediction model was developed by Jean Legault of the University of Quebec and takes its name from the Institute of Chartered Accountants of the same Canadian city [3]. The model was built after analyzing 30 financial ratios for 173 manufacturing companies with annual sales between 1 and 20 million Canadian dollars [19]. Furthermore, the CA-Score model is a valuable tool for assessing financial sustainability and promoting a more resilient and sustainable economy. However, its implementation requires careful design and consideration of various factors. In the present research, it aims to "Determine the optimal financial sustainability model for manufacturing SMEs in Zone 3 in the years 2017 - 2020".

2. Research method

In this context, the data collected in this study initially corresponds to 616 companies in the manufacturing industry, of which 107 companies in Zone 3 of Ecuador were considered. The data used for the analysis were taken from the Portal of the Superintendence of Companies, Securities and Insurance, information available to the public. The information gathered is fundamental for the research and the expansion of knowledge on the subject with the companies that met the specifications described.

The present research considered the manufacturing companies of sector 3 of Ecuador which are Tungurahua, Cotopaxi, Chimborazo, and Pastaza, which present information in the database "Superintendencia de Compañías, Valores y Seguros", therefore, it is considered to work with 107 manufacturing companies that remained constant with their financial indicators in the years 2017-2020.

In addition, it is important to note the following financial indicators:

2.1. Current liquidity

This refers to the ability to convert assets into cash quickly and without incurring significant losses. This means that the company can pay short-term debt obligations, such as payroll, suppliers, utilities, and other operating expenses as they come due. Its formula is:

LC= Current Assets / Current Liabilities.

2.2. Working capital

It is a measure of a company's ability to continue with the normal development of its activities in the short term. Its formula is as follows:

CT= Current Assets - Current Liabilities

2.3. Net margin

Indicates the company's efficiency, after covering the company's costs and expenses. It is the percentage that the company has left for each dollar it sells. Its formula is:

MN= Net Income / Net Sales.

2.4. Return on equity

Measures the rate of return on the company's net worth. Its formula is as follows:

RSP= Net Income / Net Equity

2.5. Level of indebtedness

Reflects the percentage of total funds obtained from creditors, it also means what portion of the assets has been financed with borrowed funds. Its formula is:

NE= Total Liabilities/ Total Assets

2.6. Financial leverage

It shows the relationship between the company's equity and total liabilities payable. Its formula is:

FA= Total Liabilities/ Total Equity

2.7. Asset turnover

Measures the number of times the total assets were sold in relation to the investment amount.

AR=Net Sales / Working Capital

2.8. Z-Altman model

The Altman Bankruptcy Model Formula is mathematically expressed as follows:

Z = 1.2 X1 + 1.4 X2 + 3.3 X3 + 0.6 X4 + 1.0 X5

X1 = Working Capital / Total Assets
X2 = Retained earnings / Total assets
X3 = Earnings before interest and taxes / Total assets
X4 = Book value of shareholders' equity / Total liabilities
X5 = Sales / Total assets

The Z Altman model includes indicators that identify the financial strength of a company and define whether the company has reached the threshold of insolvency or bankruptcy [20].

2.9. Springate model

Springate used an iterative multiple discriminant statistical analysis to select four of the 19 commonly used financial indices that best differentiate top-tier firms from bankruptcy candidates [21].

The Springate model has the following formula:

Z = 1.03A + 3.07B + 0.66C + 0.40D.

Where:

A = Working capital / Total assets (Liquidity)
B = Net income before interest and taxes / Total assets (Yield)
C = Net income before taxes / Current liabilities (Profit on liabilities)
D = Sales / Total assets (Productivity)
When Z < 0.862, the firm could be considered “insolvent”

2.10. Fulmer model

This model uses iterative multiple description analysis, where its objective is to determine the capacity of companies to generate liquidity by applying this model, it consists of 9 variables based on Liquidity, leverage, profitability, productivity, payment capacity, indebtedness, and asset structure [19].

The final model integrates nine financial ratios based on the following equation:

$H = 5.528X1 + 0.212X2 + 0.073X3 + 1.270X4 - 0.120X5 + 2.235X6 + 0.575X7 + 1.083X8 + 1.083X8 + 0.894X9 - 6.075$.

Where:

X1= Retained Earnings/ Total Assets (Leverage)
X2= Sales/ Total Assets (Productivity)
X3 =Earnings Before Taxes/ Stockholders' Equity (Profitability)
X4 =Cash Flow / Total Liabilities (Ability to Pay)
X5 =Total Liabilities / Total Assets (Indebtedness)
X6 =Current Liabilities / Total Assets (Short-term Indebtedness)
X7 =Tangible Total Assets (Structure of Assets)
X8 =Working Capital / Total Liabilities (Borrowings)
X9 =Log Operating Income/ Financial Expense (Indebtedness)

When H is less than 0 the firm may qualify as insolvent.

2.11. CA-Score model

According to [17] the model was built after analyzing 30 financial ratios for 173 manufacturing companies with annual sales between 1 and 20 million Canadian dollars, resulting in this function:

CA - $SCORE$ = 4.5913($X1$) + 4.5080($X2$) + 0.3936($X3$) - 2.7617.

The variables determined are:

X1 = Stockholders' Equity/Total Assets

This financial indicator represents the value of each unit of equity invested in total assets, if the result of this indicator is greater than or equal to 1, it means that the total assets are financed with the company's equity.

X2 = (Profit before taxes and extraordinary items + financial expenses) / Total Assets

This financial indicator reflects the relationship between the profits obtained and the total assets invested in the company.

X3 = Sales/Total Assets

2.12. Why choose models such as Z-Altman, Springate, Fulmer, and CA-Score in manufacturing SMEs?

The selection of models such as Z-Altman, Springate, Fulmer, and CA-Score to assess the financial health of manufacturing SMEs is due to a combination of factors that make them particularly suitable for this type of company, namely that they have characteristics such as:

Simplicity and accessibility: these models usually require basic financial information, which makes them easy to apply for smaller companies with limited resources.

Focus on insolvency prediction: They are specifically designed to identify companies at high risk of bankruptcy, which is vital for SMEs operating in volatile environments.

Extensive validation: They have been extensively studied and used in a variety of contexts, which gives them a high degree of reliability.

Consideration of multiple factors: They include a variety of financial indicators that allow assessing different aspects of financial health, such as liquidity, profitability, and indebtedness.

2.13. Why are other models excluded?

Complexity: Some models are too complex and require specific data that are not available for all SMEs.

Sector focus: Certain models are designed for specific sectors and may not be suitable for the manufacturing sector.Cost: The implementation of some models can be costly due to the need to hire experts or use specialized software.

Data availability: Not all companies have the necessary financial information to apply all available models.

2.14. Quantitative approach

A quantitative review of indicators was carried out as it is suitable for sustainability analysis in manufacturing companies because it allowed an objective and accurate assessment of the economic, social, and environmental performance of these organizations. Through metrics such as return on investment (ROI), resource efficiency, and employment generation, it is possible to identify trends and areas for improvement that are crucial for long-term sustainability. This quantitative approach provides concrete data that facilitates informed decision-making, allowing companies to set clear and measurable goals. Furthermore, by benchmarking these indicators against industry standards, companies can strategically position themselves in the marketplace, identify opportunities for innovation, and optimize their processes, which not only contributes to their economic viability but also promotes responsible and sustainable practices that benefit the community.

3. Results and discussion

Illustration 1 shows the distribution of the small and medium-sized companies selected for the analysis, classified according to their economic activity according to ISIC, in this subdivision, the significant presence of C10 stands out, which are companies dedicated to the manufacture of food products. This data is closely related to the findings of the study by [3] indicating that SMEs focused mainly on the manufacture of textiles and clothing because it creates opportunities for the economic development of the country.

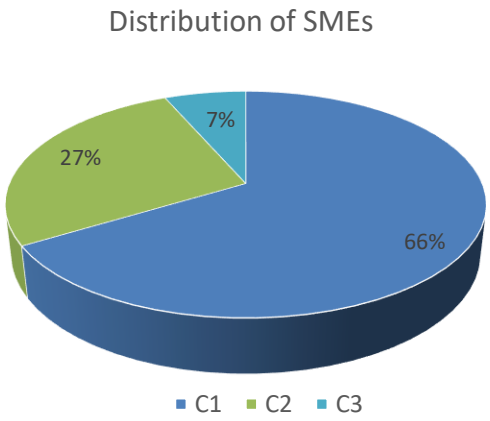

Figure 1. Distribution of SMEs in terms of economic activities

Once the corresponding calculations of the Z-Altman model have been made, Table 1 shows the results of the companies during the period 2017- 2020. It should be emphasized that the liquidity indicator is analyzed through the working capital based on total assets, where it can be determined that in 2017 of the total of 107 companies 59 are solvent corresponding to 55%. In 2018, there are 30 solvents corresponding to 57%; in 2019 there were 63 corresponding to 59%, and in 2020 there were 56 solvents with the percentage of 52%. In other words these companies have a good solid financial structure. In other words, these companies have a good solid financial structure, since they can convert their assets into cash in a period of less than a year without loss of value. They have good productivity and meet market demand.

However, there are companies that represent insolvency, so in 2017 there were 28 insolvent companies corresponding to 26%, in 2018 there were 30 corresponding to 28%, for 2019 there were 26 corresponding to 24%. In 2020, there were 33 insolvent companies with 31% being the year that has a high leverage due to the health pandemic, therefore these companies have to have problems to meet their obligations. In the range of companies with relative solvency for the year 2017, there were 20 corresponding to 19%; in 2018, 16 were obtained corresponding to 15%; for 2019 and 2020, 18 companies were found corresponding to 17% of which these companies must make decisions immediately to avoid bankruptcy. The year that has more solvent companies is 2019 with 59% reaching an optimal level of liquidity.

This result corroborates what was found in other studies, such as that of [22] who showed that in the years 2019 and 2020, in most companies because of the health crisis, a real unprecedented economic crisis occurred. The crisis caused a decrease in the productive capacity, with a collapse of the markets and the decline in demand, so that in these years there was an increase of insolvent companies.

Table 1. Results of the Z-Altman model

Z-ALTMAN				
	Insolvent	Solvent	Financial problems	Relative
2017	5	83	12	7
2018	4	88	7	8
2019	35	33	31	8
2020	80	17	10	0
	124	221	60	23

According to the results obtained from the Springate model in Table 2 in the years 2017 and 2018, it was obtained that 68 companies corresponding to 64% are solvent; for the year 2019, the solvent companies were 40 corresponding to 63%, which means that the companies have a solid financial structure because of that. They can convert their assets into money in a period of less than one year without loss of value. They also have a good management of their capital, allowing them to comply with their operating cycle or in other words they have good productivity and meet market demand. On the contrary in 2020, there are 61 companies representing 57% being the year with more financial insolvency where companies have a high level of indebtedness. They could not meet their obligations due to the health disease worldwide. Also the year that has more solvent companies is 2018 with 64% reaching an optimal level of liquidity. The study of [3] mentions that the Springate model allows predicting the insolvency risk in 77% for companies in the manufacturing sector with a margin of error of 13%. Therefore, in the year 2020, the companies represented a high level of bankruptcy risk.

Table 2. Results of the Springate model

SPRINGATE		
	Insolvent	Solvent
2017	39	68
2018	38	69
2019	40	67
2020	61	46
	178	250

According to the results obtained from the Fulmer model in Table 3 in the period 2017-2020 it can be determined that in 2017 of the total of 107 companies, 69 are solvent corresponding to 64%; in 2018, it has 63 solvent corresponding to 59%; in 2019 there were 62 corresponding to 58%; in 2020, there were 57 solvent with the percentage of 53%. It means that these companies have good financial strength since, they maintain an adequate mix of debt and equity to finance their operations, allowing them to comply with their operating cycle. In other words, they have good productivity and comply with market demand. However, there are companies that represent insolvency; so for 2017, there were 38 insolvent companies corresponding to 36%; in 2018, there were 44 corresponding to 41%; in 2019, there were 45, corresponding to 41%. In 2020, there were 50 insolvent companies with 57% being the year that has a high leverage due to the health disease. Therefore, these companies have problems to meet their obligations. In addition, the year that has solvency is 2017 with 64% reaching an optimal level of liquidity.

Table 3. Results of the Fulmer model

FULMER		
	Insolvent	Solvent
2017	38	69
2018	44	63
2019	45	62
2020	50	57
	177	251

According to the results obtained from the CA-Score model in Table 4 in the period 2017-2020 it can be determined that in 2017 of the total of 107 companies 62 are solvent corresponding to 58%. In 2018, 59 were solvent corresponding to 55%; in 2019, there were 56 corresponding to 52%; in 2020, there were 49 solvent with the percentage of 46%, i.e. these companies have a good management of their capital, allowing them to meet their operating cycle. In other words, they have good productivity and meet market demand. However, there are companies that represent insolvency so, for the year 2017 there were 45 insolvent companies corresponding to 42%; in 2018, there were 48 corresponding to 45%; for 2019, there were 51 corresponding to 48%. In 2020, there were 58 insolvent companies with 54% being the year that has a high leverage due to the health disease. Therefore, these companies tend to have problems to meet their obligations; in addition, the year that has more solvency is 2017 with 58% reaching an optimal level of liquidity.

Table 4. Results of the CA-Score model

CA-SCORE		
	Insolvent	Solvent
2017	45	62
2018	48	59
2019	51	56
2020	58	49
	202	226

According to the results in Table 5, the total number of solvent and insolvent companies for each year is shown, where the solvency prediction percentages are taken into account; whereby the Springate and Fulmer models predict an equal probability of 34%, there being a minimal difference between the two, with the Ca-Score and Z-Altman models coming in last with a percentage of 31% and 30%.

Table 5. Summary table of models

Summary Table								
	Z-ALTMAN		SPRINGATE		FULMER		CA-SCORE	
	Solvent	Insolvent	Solvent	Insolvent	Solvent	Insolvent	Solvent	Insolvent
2017	83	28	68	39	69	38	62	45
2018	88	30	69	38	63	44	59	48
2019	33	26	67	40	62	45	56	51
2020	17	33	46	61	57	50	49	58
TOTAL	221	117	250	178	251	177	226	202

4. Financial strategies for manufacturing SMEs in zone 3

In the present research which, consisted of 107 companies that have remained constant in the Superintendence of Companies, Securities, and Insurance in the year 2017 to 2020; so 50 are medium and 57 are small. There are also 11 manufacturing SMEs in the province of Chimborazo, 22 in Cotopaxi, 2 in Pastaza and in Tungurahua with 72 SMEs.

The author [16] in the work "Models for predicting business insolvency: A systematic review and meta-analysis" mentions that she compares the performance of the Springate model with Z-Altman, Fulmer, and CA-Score for predicting business insolvency in the manufacturing sector in Spain, using a data set of 234 companies. The author determined that the Springate model presents the highest overall accuracy with 92.3%, followed by Z-Altman (89.4%), CA-Score (87.1%), and Fulmer (83.2%), i.e. the Springate model is the most effective tool for predicting corporate insolvency in the manufacturing sector.

In addition, another research conducted by [23] found the same result showing that the Springate model presents the highest overall accuracy with a good predictive performance in Mexican manufacturing SMEs. Likewise, this corresponds with the same results of the authors [21] in their article "Analysis of the efficiency of insolvency prediction models in Colombian companies" where they evaluate the effectiveness of the four models and their results indicate that the Springate model is the most effective tool since it obtains the best accuracy, followed by Z-Altman, Fulmer, and CA-Score.

Based on this, we proceed to perform a SWOT analysis, which is obtained in the following matrix:

Table 6. SWOT analysis for manufacturing SMEs in Zone 3

SWOT MATRIX		
INTERNAL	STRENGTHS	Liquidity: Current Ratio: Manufacturing companies have a current ratio greater than 1, indicating that the companies are able to meet their short-term obligations. Working Capital: Most manufacturing companies have positive working capital indicating that the companies are able to meet their debts, are able to facilitate growth, and to run their operations. Profitability on sales: Net Margin: Manufacturing companies have a net margin of 3%, indicating that the companies are profitable and generate profits. Return on investment Return on Equity: The profit of the manufacturing companies corresponded to 4% of equity. Activity: Asset Turnover: The average total asset turnover of manufacturing companies is $1.70, meaning that companies earn $0.70 for every dollar held in Assets.
	WEAKNESSES	Indebtedness: Level of indebtedness: The level of indebtedness of the companies is 69%, which means that they are close to having financial risk because their maximum range is 70%. Financial Leverage: Manufacturing companies have a total leverage ratio of 605%, indicating that manufacturing companies use a large amount of debt in relation to their equity to finance their operations. Dependence on Imported Inputs: Dependence on imported materials can increase vulnerability to exchange rate fluctuations and supply problems. High fixed costs: The manufacturing industry has high fixed costs that can be difficult to manage in periods of low demand. Manufacturing companies are highly dependent on their suppliers, which can make them vulnerable to supply chain disruptions.

SWOT MATRIX		
EXTERNAL	OPPORTUNITIES	Identify new markets and growth opportunities. Development of new products or improvement of existing products. Adoption of new technologies can improve efficiency and reduce costs. Focus on sustainability can open new markets and enhance corporate reputation. Technology enables manufacturing companies to produce customized products on a large scale, which can increase demand and profit margins. Access new sources of financing, such as loans, grants, or investments.
	THREATS	Competition from global companies can put pressure on margins and reduce market share. New regulations, and changing environmental laws may increase costs. Fluctuations in raw material prices can affect profit margins. Lack of technological upgrading can lead to obsolescence and loss of competitiveness. Changes in consumer preferences could reduce demand for certain manufactured products. Intense competition in the market may affect the market share and profitability of the manufacturing company.

The SWOT analysis is complemented by a quantitative assessment using the Springate financial model. This model, represented by the formula $Z = 1.03A + 3.07B + 0.66C + 0.40D$, combines the averages of key financial indicators such as liquidity, profitability, activity, and indebtedness to obtain an overall score. This score allows us to have a more accurate view of the company's financial status.

At the same time, the liquidity indicator takes into account the current ratio which indicates the potential of the companies to face their short-term maturities. It is shown that the manufacturing companies from 2017 to 2020, for each dollar of their short-term debt have enough liquidity to be able to meet their current obligations. Likewise, they have positive working capital, which means that the company has more current assets than current liabilities.

In the same way, the profitability indicator takes into account the net margin, which means that the companies are efficient in generating profits, in this case with 3%, which translates into a greater amount of money remaining as profit after covering all expenses. However, in the return on equity, the profit corresponded to 4%, which means that the shareholders obtained a return on their investment of 4%.

Likewise, the activity indicator, in which the asset turnover indicator is taken, means that manufacturing companies earn $0.70 for each dollar they have in assets, which means that these companies are using their assets efficiently to generate sales.

Finally, the indebtedness indicator takes into account the level of indebtedness where manufacturing companies have 69% of their assets committed to their creditors, which indicates that manufacturing companies can obtain a higher financial risk if strategies are not applied. In addition, financial leverage has a percentage of 605% where companies are assuming a significant risk by relying heavily on borrowed funds to cover their expenses and make investments.

5. Conclusions

Finally, a comparative analysis of the effectiveness of the four financial sustainability models Z-Altman, Springate, Fulmer, and CA-Score, for the selection of the most optimal model for manufacturing SMEs in zone 3, has allowed identifying the strengths and weaknesses of each of them. Each model has its own ability to predict the financial sustainability of SMEs; however, the Springate model stands out for its accuracy and ability to detect companies with financial problems. The Z-Altman model, on the other hand, is shown to be a useful tool for the evaluation of the solvency and liquidity of companies, while the Fulmer and CA-Score models

present weaknesses in their ability to predict, limitations in their ability to capture the complexity of the financial situation of SMEs.

In addition, the Springate model is considered more comprehensive than other models such as Z-Altman due to several factors. First, its structure incorporates a broader set of variables related to environmental and social management, which allows for a more comprehensive assessment of a company's performance in terms of sustainability. In addition, the methodology used in the development of the Springate model is based on more advanced statistical techniques, which enhances its ability to identify complex patterns in the data. Finally, the Springate model has been validated on a larger and more diverse data set, suggesting that it is more generalizable and applicable to a larger number of companies and sectors."

In this sense, it can be concluded that the Springate model is the most optimal for the selection of manufacturing SMEs since it offers a more complete and accurate view of the financial situation of the companies. The choice of the Springate model is due to its ability to consider a wide range of financial variables, which makes it more suitable for the evaluation of financial sustainability. Therefore, the implementation of the Springate model is recommended as a tool for assessing and monitoring financial sustainability in manufacturing SMEs in order to promote informed decision-making and improved financial management in the sector.

Declaration of competing interest

The authors declare that they have no known financial or non-financial competing interests in any material discussed in this paper.

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Author contribution

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