

Lecture Notes in Networks and Systems 1041

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Innovation and Research — Smart Technologies & Systems

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Innovation and Research – Smart Technologies & Systems

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Preface

The 4th edition of the International Research and Innovation Congress – Smart Technologies and Systems, CI3 2023, took place from August 30 to September 1, 2023, at the facilities of the Instituto Tecnológico Universitario Rumiñahui, located in the city of Sangolquí, Pichincha, Ecuador.

The conference was organized by the Red de Investigación, Innovación y Transferencia de Tecnología RIT2, made up of the most relevant university institutes in Ecuador, among which are ITCA, BOLIVARIANO, ARGOS, VIDA NUEVA, ESPÍRITU SANTO, SUDAMERICANO, ISMAC, SAN ISIDRO, ARTES GRÁFICAS, ORIENTE, HUMANE, SUCRE, CENTRAL TÉCNICO, POLICÍA NACIONAL and RUMIÑAHUI.

Additionally, the event is sponsored by the Secretaría de Educación Superior, Ciencia, Tecnología e Innovación SENESCYT, Laboratorio de Comunicación Visual de la Universidad Estatal de Campinas—Brazil, Universidad Ana G. Méndez—Puerto Rico, Centro de Investigaciones Psicopedagógicas y Sociológicas—Cuba, Instituto Superior de Diseño de la Universidad de La Habana—Cuba, GDEON and the Corporación Ecuatoriana para el Desarrollo de la Investigación y la Academia—CEDIA.

The main objective of CI3 2023 is to generate a space for dissemination and collaboration, where academia, industry and government can share their ideas, experiences and results of their projects and research.

“Research as a pillar of higher education and business improvement” is the motto of the Conference and suggests how research, innovation and academia must coincide with the productive sector to leverage social and economic development.

CI3 2023 had 145 papers submitted, of which 52 were accepted for publication and presentation. To guarantee the quality of the publications, the event has a staff of more than 70 experts, from different countries such as Spain, Argentina, Chile, Mexico, Peru, Brazil, Ecuador, among others, who carry out an exhaustive review of each proposal sent.

Likewise, during the event a series of keynote conferences were held, given by both national and international experts, allowing attendees to get in touch with the latest trends and technological advances around the world. Keynote speakers included: Ph.D. Carina González, University of La Laguna, Spain; Ph.D. Gabriel Gómez, State University of Campinas, Brazil; Ph.D. Carlos Sanchez, University of Zaragoza, Spain; Ph.D. Juan Minango, Instituto Tecnológico Superior Rumiñahui; Dr. Iván Chérrez, Universidad Espíritu Santo, Ecuador; and Ph.D. Nela Paustizaca, Escuela Politécnica del Litoral, Ecuador.

The content of this proceeding is related to the following topics:

- Smart Cities
- Innovation and Development
- Applied Technologies
- Economics and Management
- ICT for Educations.

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Efficiency as a Competitive Factor in MSMEs to Generate Profitability

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Marco Verdezoto Carrillo , Sergio Carrera Guerrero , and Alain Quintana 

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Abstract. Competitiveness and efficiency are important aspects in business management as they generate a competitive advantage of sustainability in the market. The objective of this study is to determine the predominant factors that influence the achievement of efficiency and competitiveness results in MSMEs in the textile production sector. The analysis was based on the Data Envelopment Analysis (DEA) methodology, which describes the results of the input variables versus the incidence they have on the output variables of a system. The input variables considered were assets and equity, while the output variables were net income and total income. On the other hand, the hypotheses raised in this research were tested for their validity through the acceptance or rejection of the chi-square test by means of factor analysis. The research was based on a database of the Superintendencia de Compañías de Ecuador. The results obtained yielded important data showing and concluding that no region of the country exceeds 33% efficiency in its MSMEs. In addition, it was observed that the constructs of assets and equity generate influence in the generation of income and finally in the net profit, which is considered a key factor for the financial management and sustainability of a company.

Keywords: Efficiency · competitiveness · MSMEs · competitive advantage · profitability

1 Introduction

The data for the last five years presented by the Comisión Económica para América Latina y el Caribe, CEPAL, shows that MSMEs represent 99.5% of the region's companies, but account for only 24.6% of production, due productive diversity [1]. The description of these data counteracts the sustainability of these companies in the market, so it becomes an important problem to be studied, to understand the root causes that affect the efficiency and competitiveness of these companies for sustainability over time, through their strategies, systems and processes. In this area, Ecuador's manufacturing industry comprises a considerable portion of MSMEs, and their presence in the textile sector contributes to economic development. According to the 2021 business ranking published by the Superintendencia de Compañías y Seguros de Ecuador, there are 264 entities belonging to the segment of micro, small and medium-sized enterprises (MSMEs) in this sector.

Productive entities make profits with the resources they have in the company throughout an economic period, but not all companies do. Not all companies reach the optimal level of efficiency, as shown by net profits and total revenues. This is shown by comparing them with those companies with similar characteristics and conditions that are at the edge of efficiency, according to the application of the methodology of Data Envelopment Analysis (DEA). This research is based on the change of variables that should be considered to achieve business efficiency and competitiveness as a factor of sustainability, being assets and equity as input variables versus net income and total income as output variables. Competitiveness brings added value to companies and in this area the aim is to determine the efficiency variables that affect the sustainability of companies and their profits, understanding sustainability as an integrated system [2] of inputs and outputs, which are the financial results.

The scope of the research is to show the variation that the variables of results, such as net profit and total income can have, through the fluctuation of the variables of assets and equity in the MSMEs of a productive sector, in order to obtain information that will allow to adopt new financial, productive or commercial strategies to achieve efficiency with the optimal utilization of resources.

Research on related topics can be referred to as follows: Business innovation: Factor of competitiveness and quality of life in Popayan, Colombia [3], where it details that MSMEs have implemented quality and competitiveness systems, but these have been incipient. Another study refers to the factors that impact the sustainability of MSMEs in the food sector of the municipality of Monterrey [4], where it refers to the use of technology and quality of service as factors for sustainability, likewise, in the article: Sustainability of commercial MSMEs as a factor of competitiveness, it refers to the relationship between suppliers and customers to obtain sustainability [5]. Different articles such as: Las Pymes y factores para obtener el éxito, inicio para el marco referencial [6], La competitividad de las pequeñas y medianas empresas manufactureras de Bogotá y su percepción del apoyo que les brinda la política de competitividad [7], Evaluación de la eficiencia social en el sistema de cooperativas de ahorro y crédito del Ecuador [8], and the article: Customer service quality in financial entities, a factor for generating competitiveness in times of covid 19 pandemic, outlines the importance of customer service as a competitive factor [9]. All the publications mentioned here show competitiveness as a considerable factor for the profitability or sustainability of companies. In business sustainability, it is important to identify, processes, or vital systems, vital being understood as that which allows the model under study to be functional.

In order to continue with the study of this context, important factors that have an influence on this research, and the relationship of its variables, are detailed below.

1.1 Efficiency

According to Coll, & Blasco [10] describes the efficiency in three important areas of the evaluation of the data envelopment analysis, DEA, for the context of study “the Technical Efficiency, shows the capacity that a unit has to obtain the maximum output from a given set of Inputs, it is obtained by comparing the observed value of each unit with the optimal value determined by the estimated production edge (isoquant efficiency). (p. 12)”.

Price or allocative efficiency refers to the Unit's capacity to use the different Inputs in optimal proportions given their relative prices.

Global or economic efficiency is given by the product of Technical Efficiency and Price Efficiency [10].

Technical efficiency, defined by Farrell as the capacity of an entity to obtain the maximum output from a given set of inputs [11].

1.2 Sustainability

In this study, sustainability is considered as a systemic approach and for this purpose "a system is simply a set of elements (or subsystems) related to each other. The elements can be molecules, organisms, machines [1], or parts of them, social entities and even abstract concepts. Likewise, the relationships, interconnections, or "linkages" between the elements can show up in very different ways (economic transactions, flows of matter or energy, causal links, control signals, among others)".

In this way, open systems maintain energy, matter and information exchange with their environment in order to work, as well as depending on the factors, elements or variables coming from the system's environment and that influence it (input variables); on the other hand, the system produces variables that affect the environment (output variables or products) [2].

Sustainability focuses on the importance of identifying the factors that allow companies to maintain business sustainability through profitability.

1.3 Competitiveness

The concept of competitiveness has some aspects related to human and technological capital or natural resources and emphasizes the generation of a competitive advantage in the market, either by creating capabilities or skills that are developed in a product, system or process. García and Coll state that these capabilities do not constitute an advantage for all products. García and Coll [11], "The possibility that this transformation will take place depends on the product itself, the company, the sector and the environment". Under this concept, it becomes important to define the characteristics and capabilities that are appropriate and the way to transform all of them into a single position that makes the product stand out in an advantageous way, i.e. it becomes a competitive strategy [11].

According to Chiavenato [12], Collins [13] business competitiveness as a process for creating competitive advantages once the resources, skills and competencies that create value have been found and analyzed. In this aspect, competitiveness depends on the characteristics of the products of each company and its strategy to achieve a differentiation or competitive advantage considering that efficiency is the core in the context of the study.

1.4 Competitive Strategy

Becerra Bizarron shares Porter's concept, Porter says that competitive strategy consists of taking defensive or offensive actions to establish a defensible position in an industry

that allows facing its competitive forces to achieve a return on investment, and for this purpose companies must find the strategy according to their particular circumstances [14].

In another context, strategy specifies the way in which an organization adjusts its own capabilities with the existing opportunities in the market to achieve its objectives [15]. Based on these notions for this research, it is concluded that each company has the power to insert a strategy that allows it to obtain profitability and sustainability in the market, under the absent factors such as management, liquidity, technology, risks and resistance to change [4].

Strategy is also seen as a pattern of objects, policies, plans to achieve goals, which allows a company to know what kind of organization it wants to be and where it stands [13].

As described above, each organization must identify the factor or factors that will allow it to obtain a competitive strategy in order to get efficiency based on the profitability or usefulness of the investment.

1.5 Variables Considered for the Analysis of Efficiency with the DEA Methodology: Assets, Equity, Performance, Income

In the DEA Data Envelopment Analysis methodology, this study reviews the input variables, which in this case are the equity and assets, as data presented by the MSMEs in the textile manufacturing sector in Ecuador, and the output variables that will be defined as the results, and are the data reflected in the yield or net profit and total income.

Asset. A resource controlled by an entity, as a result of past events, from which the entity expects to obtain future economic benefits.

Equity. The residual portion of the entity's assets, after deducting all its liabilities [16]. The International Accounting Standards Board defines assets as "present economic resources controlled by the entity as a result of past events" [17].

Income. Increases in economic benefits, produced during the accounting period in the form of inflows or increases in the value of assets, or decreases in liabilities, which result in an increase in equity and are not related to the contributions of the owners to this equity [16].

Profit (equity). The elements directly related to the measure of profit are revenue and expenses. The profit figure is often used as a measure of the entity's performance, or is the basis for other evaluations, such as return on investments or earnings per share [16].

With the published literature, the research of the efficiency of the MSMEs is carried out through the methodology of the Enveloping Analysis of data, in order to know the companies that are located in the edge of the efficiency, and on the other hand, the following hypotheses, based on the methodology of the factorial analysis are raised:

1.6 Hypothesis

The proposed conceptual model is presented in Fig. 1, which details the relationship of the factor variables and the direct relationship between them.

For the hypothesis statement, we considered the feasibility of admitting or excluding the null hypothesis that details that the input variables do not generate income and these

do not generate net profit, for this purpose the following alternative hypotheses were also proposed.

- H0: Assets do not generate total revenues or profits when they show efficiency.
- H1: Assets generate total revenues
- H2: Assets generate total revenues
- H3: Total revenues generate net income in a range of efficiency.

The null hypothesis H0 is rejected under the results achieved in the Chi-Square study and the KMO Test analysis, once the results are obtained, this analysis recommends working with the alternative hypotheses H1, H2, and H3, as described in Fig. 1.

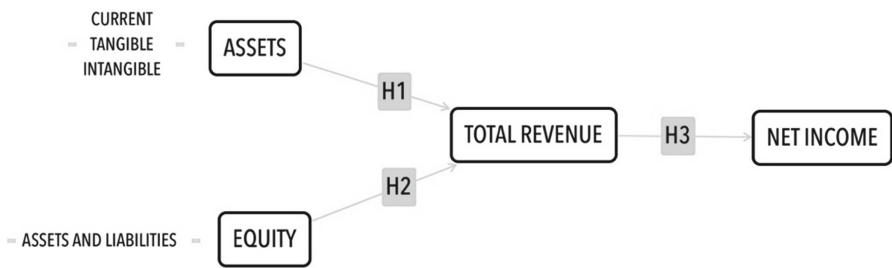


Fig. 1. Proposed conceptual model

Once the study was carried out, the results show that the companies located in the provinces of Pichincha, Guayas and Tungurahua, show a percentage that ranges between 5% and 6% of efficient companies, while the rest of the companies show unfavorable results compared to these, the comparative study is carried out in a group of companies of similar characteristics.

In this context, it can be deduced that MSMEs need to adopt new financial, commercial or productive strategies, to obtain positive results in their profit or total income variables, in order to achieve sustainability in the market, since it is obvious that there are companies that make excellent profits with lower asset values, as they manage to be on the efficiency curve.

The sustainability of companies is based on strategies, systems or processes that companies can adopt according to their needs and characteristics, allowing them to achieve development and competitiveness.

2 Methodology

This study was an exploratory, descriptive and correlational research that allowed the observation of the behavior of the object of study. The database published by the Superintendencia de Compañías y Seguros del Ecuador for the year 2021 was considered, focused the study on MSMEs in the textile manufacturing sector of the country. This research was based on the Data Envelopment Analysis, DEA, in the CCR-O model [18], which analyzes the fluctuation of the output variables, in this case, total revenues and net

income. In this occasion the total income and net profit; against the constant of the input variables, which are represented in the assets and equity, which defined the efficiency of the MSMEs in the most representative provinces and in the different regions of the country, which is detailed below from Figs. 2, 3, 4, 5 and 6.

On the other hand, for the reliability analysis the confirmatory factor analysis [19, 20], was used, which allows countering a model built in advance, which allows the researcher to determine how the elements match and how the data is structured, based on a defined theory, technically it seeks to “explain the covariances or correlations between a set of observed variables through a reduced set of latent variables or factors” [21], to find the link that exists between the elements of the assets and equity variables with the total income variables and finally with the net profits, which led to describe the correlation that exists between the factors proposed through the correlation and anti-image matrix.

The Chi-square index and Bartlett’s Sphericity Test were used to test the null hypothesis, the data reflected in the result provided a Chi-square value of 103.781 with a degree of freedom of 6, determining the acceptance of the alternative hypothesis.

The analysis of the KMO, Keiser-Meyer-Olkin measure, allowed observing the correlation that exists between the variables of the factors or constructs raised, as detailed in Table 1, in the same way it indicates that it is appropriate to apply the factor analysis, [20] with a result of 0.715, which is considered acceptable.

Table 1. Bartlett KMO test

Kaiser-Meyer-Olkin measure of sampling adequacy		0,715
Bartlett’s test for sphericity	Approx. chi-squared	103,781
	Gl	6
	Sig.	,000

The results obtained through the DEA methodology and factor analysis, performed in SPSS, are shown below.

3 Results

The efficiency of MSMEs in the textile manufacturing sector in Ecuador was observed in the results of the Data Envelopment Analysis, DEA, which is detailed in the Sierra and Costa regions, in the most representative provinces. The Oriente region has only one company in the sector studied, so it has not been considered for comparison.

Figure 2 shows the efficiency of MSMEs in the Sierra region, in the province of Pichincha, according to the data collected, 95% of the object of study showed that they are not efficient, compared to 5% (4 companies) that were efficient, according to the results of net profits, reflected in the output variables of the DEA methodology. These results were related to those values identified with 1, indicating that they are located in the periphery of efficiency when performing an analysis and comparing them among themselves, additionally, it was observed that inefficient MSMEs should make

a movement in their input variables which are assets and equity, to achieve the output variables of total income and net profits to be in the efficiency edge.

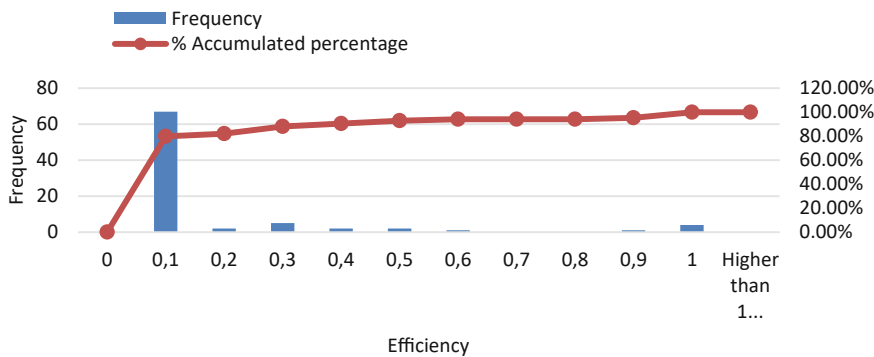


Fig. 2. Efficiency of MSMEs in Pichincha

The following results, detailed in Fig. 3, show the efficiency results obtained under the DEA methodology for MSMEs in the textile manufacturing sector in the province of Azuay in the Sierra region of Ecuador. The data obtained show an efficiency of 32% in the companies studied, while 68% of the companies are outside this range.

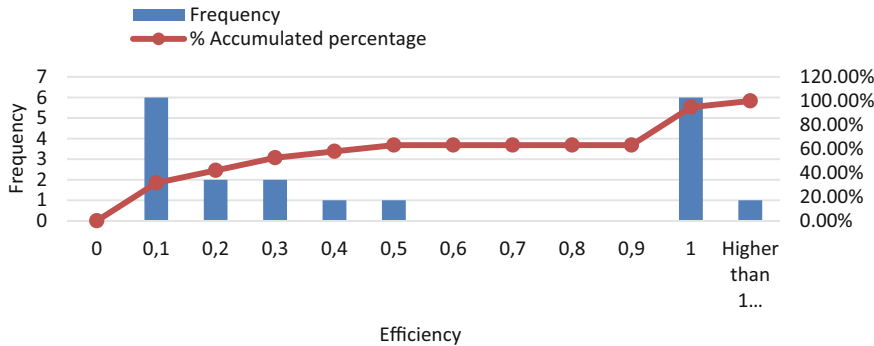


Fig. 3. Efficiency of MSMEs in the Province of Azuay

The results of the Fig. 4 show the efficiency in the province of Tungurahua, these data were obtained by entering the input and output variables in the DEA methodology, which basically shows that 25% of the MSMEs show an efficiency that is found in the net profits.

Continuing with the context of the study, it was noted that in the province of Imbabura and in the rest of the provinces of the Sierra, the MSMEs showed average efficiency values of 27% and 29%, respectively, as shown in Figs. 5 and 6, while the companies that do not show efficiency levels according to the methodology applied correspond to the difference of these levels.

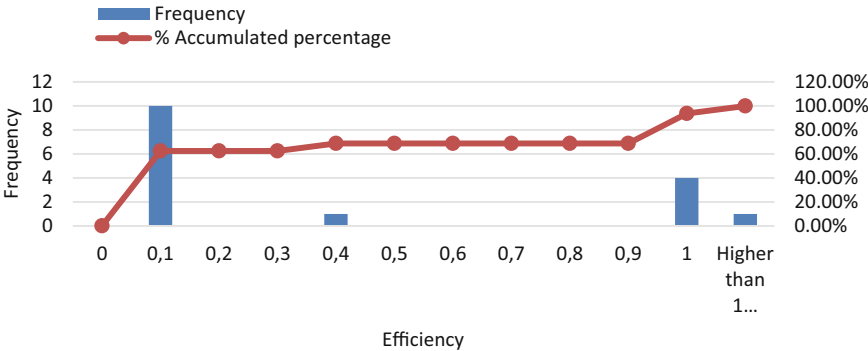


Fig. 4. Efficiency of MSMEs in the Province of Tungurahua

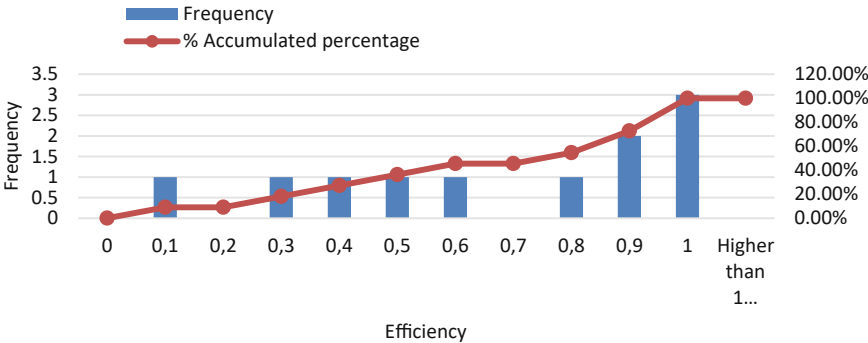


Fig. 5. Efficiency of MSMEs in the Province of Imbabura

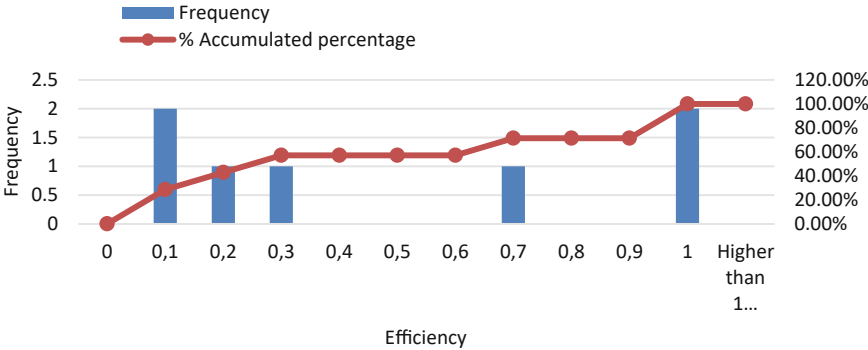


Fig. 6. Efficiency of MSMEs in other provinces of the Sierra.

In the Costa region, the province of Guayas was analyzed according to the number of MSMEs in the sector, in this case 99 companies; other provinces were analyzed as a single group because the number is not representative for individual analysis. Figure 7

shows that 4% of MSMEs in Guayas are efficient, while 96% are not at or near the efficiency edge.

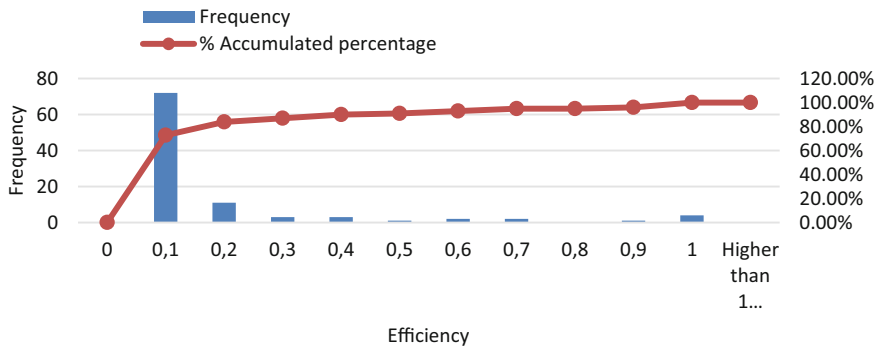


Fig. 7. Efficiency of MSMEs in the Province of Guayas

Finally, Fig. 8 shows the efficiency values represented by the other Costa region provinces, where 33% were found to be at the efficiency edge.

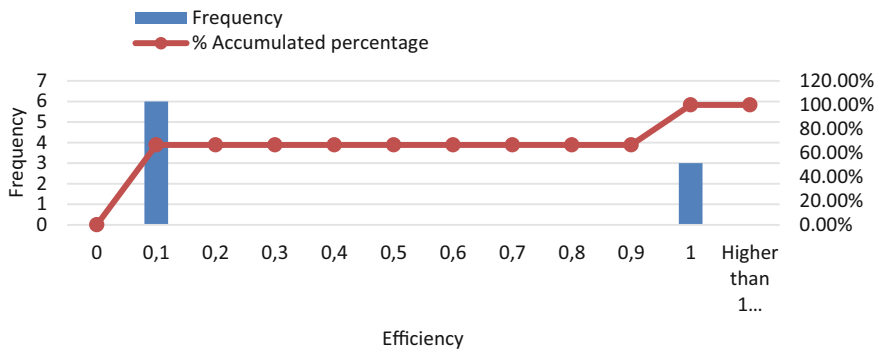


Fig. 8. Efficiency of MSMEs in other provinces of the Costa region.

In another context, through the data obtained from the factor analysis in SPSS IBM, it was found that there is correlation in the variables studied and a linear relationship as detailed in Table 2 of the Correlation Matrix, with a determinant close to zero, which indicates the suitability of the analysis.

In Table 3 of the Total Variance Explained, the analysis showed the direct relation of the variables of the assets construct and the equity construct, understanding that in the first factor are the current, tangible, and intangible assets, while in the second factor or equity construct the variable of the assets minus the liabilities has been considered.

This factor in turn has a direct impact on total income and will subsequently influence the net income variable. This result is shown in Table 2 of the Correlation Matrix.

The results of the proposed model showed that with high levels of significance ($p\text{-value} < 05$), the hypotheses H1, H2, H3 were fulfilled, as described in Table 4, showing

Table 2. Correlation matrix^a

		Asset values	Equity values	Net income values	Total revenue values
Correlation	Asset values	1	0,739	0,542	0,924
	Equity values	0,739	1	0,843	0,787
	Net income values	0,542	0,843	1	0,596
	Total revenue values	0,924	0,787	0,596	1

a. Determinant = ,015

Table 3. Total variance explained

Component	Initial eigenvalues			Sums of the squared saturations of extraction			Sum of the saturations squared by rotation		
	Total	% of variance	Accumulated %	Total	% of variance	Accumulated %	Total	% of variance	Accumulated %
1	3,223	80,566	80,566	3,223	80,566	80,566	2,064	51,604	51,604
2	,595	14,864	95,430	,595	14,864	95,430	1,753	43,827	95,430
3	,110	2,760	98,190						
4	,072	1,810	100,000						

Extraction method: Principal Component Analysis.

that the assets construct and the equity construct influenced total income and, in turn, this had an impact on net income. This scenario allows to understand the efficiency of the companies focused on the perceived profit as a factor of sustainability, additionally it allows to know the impact that a change in the input variables will have on the output variable, which in this case is the net profit.

Table 4. Chi-square tests

	Value	gl	Bilateral asymptotic significance
Pearson's Chi-square H1	143,003	1	0,000
Pearson's Chi-square H2	24,578	1	0,000
Pearson's Chi-square H3	11,193	1	0,001

In another context, the companies that were profitable on their assets were surveyed through the ROI, both in the year 2021 and 2022, and shows values greater than zero, which are shown in Table 5, however, the companies that have remained profitable and

efficient, in the period studied, reach 8.89%, for a better comparison, three decimal places have been taken in the profitability index.

In this way, it was possible to show that the companies that remained efficient and profitable, adopted strategies in their input variables to get better results in their output variables or in their efficiency and profitability.

Table 5. Rentabilidad 2021, 2022

Profitable 2021 & 2022		2021	2022
Province	Company	ROI = profitability net income/assets	ROI = profitability net income/assets
Pichincha	Reyes industria textil cia. Ltda	0,0002%	0,1803%
Pichincha	Silkproducts cia.ltda.	1,7389%	0,4761%
Pichincha	Sportslocker sociedad anónima	0,0045%	11,386%
Azuay	Dicovs, diseños, confecciones y ventas c. Ltda.	3,3396%	58,682%
Azuay	Industria de la moda inmoda cia.ltda.	0,8097%	5,150%
Azuay	Maki-fairtrade s.a.	0,0287%	48,598%
Azuay	Procostura cia. Ltda.	0,0003%	2,316%
Azuay	Soluciones industriales y medicas soinmed cia. Ltda.	1,5832%	3,033%
Tungurahua	Arfatexcia c.l.	0,0008%	8,327%
Tungurahua	Incalza s.a.	0,0003%	21,404%
Tungurahua	Industrias y textiles pequeñin cia. Ltda.	5,794%	0,093%
Imbabura	Importgroup cia.ltda.	5,413%	10,399%
Guayas	Cristex creaciones textiles y merchandising cristexcreaciones s.a.	66,807%	57,465%
Guayas	Salvadanio s.a.	0,0001%	0,069%

With the study carried out and under the hypotheses proposed, the conclusions of the present investigation are defined below.

4 Conclusions

The analysis showed that the MSMEs in Ecuador show a variation in the efficiency limit according to the Data Envelopment Analysis, the characteristics of the manufacturing sector show a similarity because no province shows an efficiency of more than 33% and for the most representative provinces such as Pichincha and Guayas, its index is 5%, representing a minority in its scope.

The sustainability of the companies is based on the capacity of these entities to adapt to new changes and to adopt strategies in their productive, commercial and economic areas, strategies that will be in accordance with the needs and characteristics of each of the MSMEs.

The constructs of assets and equity influence the obtaining of total income and these generate net profits in the companies, which is why the companies must carry out a financial management that allows variations in the variables of assets and equity. It is concluded that the low efficiency indexes found in the results of the DEA analysis are affected by the lack of management in the correct use of the assets and equity variables.

Finally, the profitability and efficiency indexes show a low percentage of 8.89% of the total number of companies studied, evidencing the importance of business management for the creation of competitiveness and sustainability in the market, through the efficient management of tangible or intangible resources and systems such as organizational productive capacity.

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