“The influence of ISO 9001 certification on the productivity of the Ecuadorian manufacturing industry”

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THE INFLUENCE OF ISO 9001 CERTIFICATION ON THE PRODUCTIVITY OF THE ECUADORIAN MANUFACTURING INDUSTRY

Abstract

Today, manufacturing companies seek tools that enable them to remain competitive in an increasingly demanding global environment, with quality management systems being among the most widely adopted. Despite their broad implementation, empirical evidence regarding their benefits remains inconclusive. Evaluating productivity indicators in certified manufacturing firms is essential to identifying the variables that most influence operational and financial efficiency in this sector. This paper aims to determine the effect of ISO certification on productivity indicators by applying a multivariate discriminant analysis model to a sample of industrial firms with five consecutive years of certification during the 2019–2023 period. The results show that only three indicators – operating income relative to value added, net income relative to value added, and value added relative to working capital – exhibit statistically significant average improvements, associated with increased operational efficiency and value generation. The operating income relative to value added indicator stands out as the variable with the greatest discriminant power, suggesting that ISO 9001 certification positively influences operational productivity. However, the findings also reveal high variability, indicating that the certification's impact is not homogeneous and depends on both internal and external organizational factors. This study provides valuable empirical evidence in the Ecuadorian context, being the first to assess this relationship using discriminant analysis and contributing to the understanding of quality management system effectiveness in emerging economies.

Keywords systems, management, competitiveness, continuous improvement, operational efficiency

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INTRODUCTION

Throughout its history, Ecuador has positioned itself as an exporter of low-tech manufactured products. However, this sector remains highly relevant: in the second half of 2024, the manufacturing sector's GDP reached a historic high of USD 3.722 billion, and it is projected to rise to USD 3.821 billion by 2027 (Trading Economics, n.d.). According to Nina et al. (2022), the manufacturing sector plays a crucial role in national economic growth, with a 1% increase in its gross value added associated with a 0.33% rise in GDP. In the case of Latin America, the region exhibits relatively low income levels compared to other developing economies, largely due to weak productivity growth. In Ecuador, productivity levels are among the lowest in the region. According to the International Labour Organization (ILO), in 2022, labor productivity per worker in Ecuador was significantly lower than in countries such as the United States, where a worker produced on average USD 158,352, while Ecuador's figure was substantially lower (OIT, 2023). Moreover, a study by the Inter-American Development Bank (IDB) re-

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vealed that between 2012 and 2022, total factor productivity in Ecuador declined by 18%, marking one of the steepest drops in Latin America and the Caribbean during that period (Guaipatín et al., 2024).

Recognizing these challenges, Ecuador's Ministry of Production, Foreign Trade, Investment, and Fisheries has launched the National Quality Plan 2024. This plan emphasizes the importance of adopting international standards and conformity assessment systems as essential tools to improve production efficiency and facilitate international trade. Furthermore, it underscores the need to implement quality management systems that enhance business competitiveness by increasing productivity, expanding access to domestic and international markets, and ensuring compliance with citizens' rights (Government of Ecuador, 2023).

The relationship between quality management systems (QMS) and organizational performance is a topic of increasing relevance due to its impact on business sustainability and competitiveness (Guzman et al., 2021). In the case of Ecuador, where the absence of a national currency prevents the use of devaluation as a tool to enhance external competitiveness, improving productivity becomes a key strategy for achieving sustainable economic development.

ISO 9001 is an internationally recognized standard for quality management systems that helps organizations consistently meet customer and regulatory requirements while fostering continuous improvement. In this context, the present study evaluates the influence of ISO 9001 certification on the productivity of Ecuadorian manufacturing companies, employing operational and financial indicators to generate measurable evidence of its impact. It highlights how certification can enhance efficiency, foster value creation, and improve competitiveness in a sector facing significant productivity challenges. In doing so, it addresses not only the performance implications of quality management systems but also their potential role as a strategic instrument for strengthening the country's industrial capabilities in an increasingly demanding global market.

1. LITERATURE REVIEW

Quality management systems (QMS) are widely recognized as effective tools for enhancing a company's competitiveness and operational performance (Amutabi, 2024). Among the various approaches to implementing QMS, the ISO 9001 standard has emerged as the most universally adopted method. Since its introduction in 1987, ISO 9001 has provided a unified framework that enables organizations across different industries to develop structured practices for improving quality, ensuring compliance with both regulatory and customer requirements, and fostering continuous improvement (ISO, 2023). However, ISO certification does not necessarily guarantee product superiority; rather, it reflects an organization's adherence to systematic procedures based on documented quality protocols (Siougle et al., 2018).

Beyond financial results, effective QMS implementation influences a range of organizational dimensions, including operational efficiency, employee engagement, and sustainability. Focusing exclusively on financial metrics may obscure these broader benefits. For instance, Wassan et al. (2022) emphasize that total quality management (TQM) practices, including leadership commitment and process control, significantly enhance performance and sustainability in manufacturing industries. The implementation of process-based systems that consistently deliver high-quality goods and services while adapting to changing conditions promotes continuous quality improvement and organizational resilience. Similarly, Bakhtiar et al. (2023) highlight that ISO 9001 adoption leads to improvements in process efficiency, customer satisfaction, and waste reduction, though they caution that these outcomes are contingent upon organizational culture and leadership engagement.

Internal and external advantages of QMS implementation have been consistently documented. Internally, QMS promotes greater productivity, quality awareness, efficiency, and employee motivation, while reducing costs, waste, and defects,

and enhancing organizational structure and documentation processes (Pacana & Ulewicz, 2020). Externally, QMS implementation improves customer satisfaction and sales, increases market share and responsiveness to customer needs, and enhances competitive advantage and organizational reputation, factors that facilitate partnerships and mergers (Gębczyńska, 2018). However, ISO certification may also present certain drawbacks, including the financial costs associated with obtaining and maintaining the certification, increased administrative workload, insufficient emphasis on staff development, and limited attention to support functions, which should be carefully considered when adopting such systems (Pacana & Ulewicz, 2020).

Among the various benefits attributed to QMS, productivity stands out as a critical indicator of organizational efficiency. Productivity is the metric that evaluates the degree of resource utilization relative to the results obtained, generally expressed in monetary terms or as a percentage when measured in terms of time (Rueda, 2013). Productivity is an economic indicator that measures the amount of goods and services produced relative to the resources used. In other words, it reflects the efficiency of producing more output with less input (Contreras-Rivera et al., 2024). Increased productivity is linked to higher profits, wages, investment, tax revenue, and employment. Several studies have reported positive effects of ISO 9001 certification on productivity. For example, Siltori et al. (2021) found that the implementation of ISO 9001:2015 in Brazilian companies led to significant improvements in operational efficiency and process optimization. Similarly, Nurcahyo et al. (2021) demonstrated that quality management systems positively impact various dimensions of organizational performance, including productivity, in manufacturing firms. However, few researchers have directly assessed the specific impact of ISO 9001 certification on productivity (Fontalvo-Herrera et al., 2012; Gómez et al., 2013; Guzman et al., 2019; Serrano, 2005; Tzelepis et al., 2006). This gap may be due to the frequent confusion between productivity and financial performance, making it difficult to isolate the direct effects of certification (Iqbal Khan et al., 2020; Guzman et al., 2021).

Guzman et al. (2019) conducted a review of 49 academic articles focusing on quality management and productivity as a performance indicator. They found that most research was concentrated in Asia and Europe, while developing regions such as Latin America and Africa showed a significantly lower presence of studies. The manufacturing sector emerged as the most frequently studied field, surpassing other specific industrial sectors. Regarding methodologies, questionnaires were the most commonly used data collection instrument, with the Likert scale being the predominant measurement technique. Additionally, most studies relied on the opinion of a single respondent as the main source of information. In contrast, the combined use of multiple data collection tools remains limited, although its application has shown growth over the past ten years.

Additional studies reinforce the positive link between quality practices and productivity. Yangailo et al. (2023) sought to determine whether total quality management (TQM) has a positive influence on productivity in the railway sector. To achieve this, they collected data from 177 managers using structured questionnaires and applied multiple regression analysis. The results demonstrated that TQM practices have a positive and statistically significant impact on productivity, supporting their implementation as an effective strategy for enhancing organizational performance.

Additionally, Tzelepis et al. (2006) analyzed 1,572 manufacturing firms in Greece and concluded that ISO certification also has a positive effect on productivity. In their models, where ISO certification was treated as either a production-enhancing factor or a driver of inefficiency reduction, significantly better outcomes were observed compared to models that excluded the certification. This improvement is attributed to the fact that the implementation of ISO standards offers clear instructions and structured guidelines, which optimize the performance of both human and technological capital. However, as Chatzoglou et al. (2015) caution, it is crucial to ensure that the complexity of these standards does not hinder internal processes, since poorly managed implementation may reduce productivity and increase operational costs.

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Several studies have examined the effects of ISO standards implementation on business operations. In the case of manufacturing firms, Fontalvo-Herrera et al. (2012) and Gómez et al. (2013) provide evidence analyzing the impact of ISO 9001 certification on six productivity indicators in Colombian industrial companies. Their findings reveal statistically significant differences in the indicators across two periods, demonstrating a positive relationship between quality certification and the selected productivity measures. Similarly, in a study by Serrano (2005), conducted with 183 certified Spanish companies, 58% reported that ISO 9001 certification had led to an increase in productivity. This percentage remained consistent even when focusing exclusively on manufacturing firms. Furthermore, the study concluded that the longer a company had been certified, the greater the observed increase in productivity.

Defining the ISO 9001 standard and incorporating it into organizational processes is essential; however, real improvements in productivity are achieved through the systematic organization of work, analyzing tasks, and optimizing operational flows to deliver the final product (Siltori et al., 2021). In other words, organizations must acknowledge that implementing ISO standards demands a significant investment of time and resources for the benefits to become evident (Salikon & Saadon, 2023).

Quality management systems (QMS) play a crucial role in enhancing organizational performance, competitiveness, and customer satisfaction. By addressing both internal and external aspects of quality, these systems promote greater operational efficiency, reduce costs, and foster a culture of continuous improvement. However, for organizations to fully capitalize on these benefits, QMS implementation must go beyond regulatory compliance and adopt a comprehensive strategic approach. When effectively applied, a QMS not only meets the immediate needs of the company but also strengthens its reputation and adaptability in an ever-evolving global market.

In summary, the literature confirms that quality management systems, particularly those based on ISO 9001, positively influence organizational performance and productivity. These systems drive both internal efficiencies and external competitiveness, while promoting a culture of continuous improvement. However, the relationship between QMS adoption and productivity is influenced by several contextual factors, including leadership commitment, organizational culture, and sectoral characteristics. Crucially, most studies focus on Asia and Europe, with Latin America receiving limited attention, despite potentially unique implementation challenges due to differing economic, political, and institutional contexts. In this context, the present study aims to determine the effect of ISO certification on productivity indicators by applying a multivariate discriminant analysis model to a sample of Ecuadorian industrial firms with five consecutive years of certification during the 2019–2023 period.

Considering the existing empirical evidence and the research gap identified in the Latin American context, particularly in Ecuador, this study examines the extent to which ISO 9001 certification influences productivity in the manufacturing sector. Specifically, it evaluates whether certified companies exhibit statistically significant improvements in operational and financial efficiency. To achieve this, a multivariate discriminant analysis model is applied, enabling the identification of the productivity indicators most affected by certification and thereby contributing to a deeper understanding of the role of quality management systems in enhancing industrial competitiveness.

2. METHODOLOGY

Data from the Superintendence of Companies, Values and Insurance (SCVS-SUPERCIAS) databases were used, from which information was collected on Ecuadorian manufacturing companies that reported their financial statements for the period under study. For the sample refinement, the first step was to exclude manufacturing companies that were not ISO 9001 certified during the period of interest. Subsequently, companies with five or more years of reported financial statements were selected, in order to include the largest number of companies with consecutive annual information. Finally, from the remaining companies, only those with continuous financial data and five consecutive years of ISO 9001 certification were included (Rueda, 2025). The sample refinement process is detailed in Table 1.

Table 1. Sample refinement

Sample Description	Number of Companies
Manufacturing companies with complete financial information	8,516
Companies without ISO 9001 certification in any year of the analysis period	8,107
Manufacturing companies with at least one year of ISO 9001 certification	409
Companies reporting fewer than five consecutive years of ISO 9001 certification	378
Manufacturing companies with complete financial data and five years of continuous certification (2019–2023)	31

Additionally, following Fontalvo-Herrera et al. (2012), productivity and performance indicators were constructed using the formulas detailed in Table 2.

Productivity is measured through value added, which is defined as the wealth created by the products or services generated by an organization (Shimizu et al., 1991). It can be described as the difference between the production sales received and the costs incurred in production, after making the necessary inventory adjustments (Solano et al., 2021). Value-added productivity indicators make it possible to quantify company performance, thus supporting strategic planning and serving as a basis for continuous improvement (Solano et al., 2021). To calculate value added, a company's financial statements are required. Shimizu et al. (1991) propose two methods for its calculation:

a) creation or subtraction method (net sales minus purchases, plus inventory of work-in-progress and finished goods);

b) distribution or addition method (summing the costs of human resources, financial costs, depreciation, rents, net profits, taxes, and other non-operating items).

This paper used the first method because it allows observing how the value added is distributed.

To identify the relationship between obtaining ISO 9001 certification and the company's productivity and performance indicators, a multivariate discriminant analysis (MDA) model is proposed. The objective of this method is to predict the predefined category membership of the independent variables

Table 2. Productivity and performance indicators of companies

Source: Fontalvo-Herrera et al. (2012).

Variable	Productivity indicators
IP1	$\frac{Gross\ Profit}{Value\ Added}\cdot 100 = \frac{Gross\ Profit}{Sales - Payments\ To\ Suppliers + Inventory}\cdot 100$
IP2	$\frac{Operating\ Profit}{Value\ Added}\cdot 100 = \frac{Operating\ Profit}{Sales - Payments\ To\ Suppliers + Inventory}\cdot 100$
IP3	$\frac{Net\ Profit}{Value\ Added}\cdot 100 = \frac{Net\ Profit}{Sales - Payments\ To\ Suppliers + Inventory}\cdot 100$
IP4	$\frac{Value\ Added}{Working\ Capital}\cdot 100 = \frac{Sales - Payments\ To\ Suppliers + Inventory}{Current\ Assets + Non\ Current\ Assets}\cdot 100$
IP5	$\frac{Operating\ Profit}{Working\ Capital}\cdot 100 = \frac{Operating\ Profit}{Current\ Assets + Non\ Current\ Assets}\cdot 100$
IP6	$\frac{Net\ Profit}{Working\ Capital}\cdot 100 = \frac{Net\ Profit}{Current\ Assets + Non\ Current\ Assets}\cdot 100$
Net Profit Margin (NPM)	$\frac{Net\ Profit}{Sales}\cdot 100$
Operating Profit Margin (OPM)	$\frac{Operating\ Profit}{Sales}\cdot 100$
Gross Profit Margin (GM)	$\frac{Gross\ Profit}{Sales}\cdot 100$

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based on their known values and classification scheme. In the case of this study, the grouping dependent variable corresponds to the years 2019 and 2025, and the independent numerical variables include the set of previously mentioned productivity and performance indicators of the companies.

The discriminant analysis process is based on a series of discriminant functions, which are linear combinations of the numerical variables that best distinguish the categories. These functions follow the form:

$$f_{km} = \mu_0 + \mu_1 x_{1km} + \mu_2 x_{2km} + \ldots + \mu_p x_{pkm} \quad (1)$$

where f_{km} is the value of the discriminant function for situation m in group k; x_{ikm} is the discriminant variable for observation i, in situation m in group k; and μ_i is the coefficient for each discriminant variable (Mures Quintana et al., 2005). The number of functions is equal to the number of categories of the dependent variable minus one. Finally, based on the value of the discriminant function obtained from the estimation, the cases are assigned to each of the categories of the dependent variable (Mures Quintana et al., 2005).

The application of the multivariate discriminant analysis model requires the fulfillment of the following assumptions:

1) the assumption of normality of the independent variables;

2) the assumption of homogeneity of covariance matrices;

3) the assumptions of linearity, multicollinearity, and singularity.

To verify the assumption of normality, the Shapiro-Wilk test was applied. However, it is worth noting that discriminant analysis is not significantly affected by the violation of the normality assumption as long as the sample size exceeds twenty observations (de la Hoz Granadillo et al., 2014). In the case of this study, 31 companies were considered.

To verify the assumption of homogeneity of covariance matrices, Box's M test was applied. This test compares the variation in covariances in multivariate samples and determines whether the covariance matrices for each analyzed group are homogeneous. In this context, the test assumes that the covariance matrices of the populations corresponding to each group do not differ from one another. The null hypothesis (H_0) states that there are differences in the covariance matrices. The null hypothesis is rejected when the p-value is less than 0.05.

Wilks' Lambda test is used to determine the discriminant power of the analysis variables. To conclude that the selected variables have high discriminant power, the coefficient of the test must be close to 0; otherwise, it is concluded that the discriminant power is low. Additionally, a p-value < 0.05 indicates that the variables have high discriminant power. Wilks' Lambda test assesses the equality of means across groups.

Finally, following de la Hoz Granadillo et al. (2014), the assumptions of linearity will not be analyzed in this study since the tolerance criterion was taken into account for the selection of the model variables.

3. RESULTS

Table 3 shows the results of the Shapiro-Wilk test, which assesses the normality assumption. It is observed that none of the independent variables meet this assumption; however, due to the sample size considered for this study, discriminant analysis is not affected.

Table 4 shows the results of Box's M test for homogeneity of covariance matrices. The test statistic M equals 1,632.749, with an associated F value of 30.244 and a p-value of 0.000. These results lead to accepting the null hypothesis, indicating that there are no significant differences between the covariance matrices of the analyzed groups, thus fulfilling the homogeneity assumption.

Table 5 shows the results of the Wilks' Lambda test. A p-value less than 0.05 and a Wilks' Lambda coefficient close to 0 were observed. Therefore, it is concluded that the selected variables have a high discriminant power. Additionally, the linearity assumption is verified.

Table 3. Shapiro-Wilk test

Normality Test							
Indicator		Shapiro-Wilk 2019			Shapiro-Wilk 2023		
		Statistic	df	Sig.	Statistic	df	Sig.
IP1	Gross Profit / Value Added	0.202	29	0.000	0.251	29	0.000
IP2	Operating Profit / Value Added	0.834	29	0.000	0.202	29	0.000
IP3	Net Profit / Value Added	0.754	29	0.000	0.197	29	0.000
IP4	Value Added / Working Capital	0.768	29	0.000	0.933	29	0.066
IP5	Operating Profit / Working Capital	0.778	29	0.000	0.426	29	0.000
IP6	Net Profit / Working Capital	0.732	29	0.003	0.322	29	0.000
NPM	Net Profit / Sales	0.227	29	0.000	0.214	29	0.000
OPM	Operating Profit / Sales	0.184	29	0.000	0.225	29	0.000
GM	Gross Profit / Sales	0.602	29	0.000	0.346	29	0.000

Table 4. Box's M test

Box's M		1,632.749
F	Approx.	30.244
	df1	45
	df2	10,945.278
	Sig.	.000

Table 5. Wilks' Lambda test

Discriminant Functions Test	Wilks' Lambda	Chi-square	df	Sig.
1	0.497	37.431	9	.000

Table 6 presents the classification coefficients for manufacturing companies certified with ISO 9001 for the years 2019 and 2023, along with the annual variations in the coefficients for each independent variable. Through the discriminant analysis, it was determined that the variables IP2 (Operating Profit / Value Added), IP5 (Operating Profit / Working Capital), IP6 (Net Profit / Working Capital), and OPM (Operating Profit / Sales) showed good discriminatory power between 2019 and 2023. In contrast, the variables IP1 (Gross Profit / Value Added), IP3 (Net Profit / Value Added), IP4 (Value Added / Working Capital), NPM (Net Profit / Sales), and GM (Gross Profit / Sales) did not show improvement from one year to the next.

Table 7 shows a high classification effectiveness, with 75.9% and 81.7% of the cases from the original grouping correctly classified.

Table 6. Variation in indicator coefficients

Indicator		Years Analyzed		Variation
		2019	2023	
IP1	Gross Profit / Value Added	–0.001	–0.001	0.000
IP2	Operating Profit / Value Added	0.044	0.032	0.011
IP3	Net Profit / Value Added	0.059	0.097	–0.038
IP4	Value Added / Working Capital	0.038	0.081	–0.043
IP5	Operating Profit / Working Capital	0.038	–0.121	0.159
IP6	Net Profit / Working Capital	–0.278	–0.313	0.035
NPM	Net Profit / Sales	0.165	0.225	–0.061
OPM	Operating Profit / Sales	–0.000	–0.000	3.61E–06
GM	Gross Profit / Sales	0.194	0.260	–0.066

Table 7. Classification results

Predicted Group Membership					
Cluster		Year of Study	2019	2023	Total
Original	Count	2019	22	7	29
		2023	4	27	31
	%	2019	75.9	24.1	100.0
		2023	12.9	87.1	100.0

Note: 81.7% of originally grouped cases were correctly classified.

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Based on the classification coefficients that showed good discriminative power and on the indicator means for each year presented in Table 8, it can be inferred that only the variables IP2 (Operating Profit / Value Added), IP3 (Net Profit / Value Added), and IP4 (Value Added / Working Capital) show, on average, an improvement from one year to the next. This positive trend suggests a possible favorable impact of ISO 9001 certification on these specific productivity aspects in Ecuadorian manufacturing companies during the 2019–2023 period.

The comparative analysis of financial indicators in the manufacturing sector between 2019 and 2023 reveals significant changes in key aspects such as operational efficiency, profitability, and capital utilization. Overall, the results suggest a transformation in the financial dynamics of organizations, influenced both by the economic effects of the pandemic and by efforts to adapt to a more challenging environment. Indicators IP2 (Operating Profit / Value Added), IP3 (Net Profit / Value Added), and IP4 (Value Added / Working Capital) show an increase in their averages between the two analyzed years, suggesting an improvement in operational efficiency and value generation from utilized resources. However, these indicators exhibit high dispersion, indicating that not all companies in the sector experienced consistent improvements. This heterogeneity may reflect structural differences, scale, or varying capacities to adapt across organizations. Indicator IP1 (Gross Profit / Value Added) also presents a considerable standard deviation, reinforcing the existence of disparities in financial performance within the sector. This variability suggests that while some companies managed to improve their efficiency and profitability, others faced greater difficulties in adapting to changes in the economic environment. In contrast, indicators IP5 (Operating Profit / Working Capital) and IP6 (Net Profit / Working Capital) show a significant decline, evidencing a deterioration in capital profitability. This may be due to an increase in working capital without a proportional rise in generated profits, or to higher financial and non-operational costs that limit the conversion of value added into real gains.

Regarding return on sales, the indicators GM (Gross Profit / Sales), OPM (Operating Profit / Sales), and NPM (Net Profit / Sales) show a decrease on average, possibly due to difficulties in maintaining consistent net margins caused by higher operating costs, competitive pressure, or demand fluctuations. Comparing the net margin indicators (IP3 and NPM) and operating margin indicators (IP2 and OPM) for the year 2023 reveals the impact of non-operating expenses, which significantly reduce net profits despite maintaining a certain level of operational efficiency. Likewise, the decline in IP6 may also be related

Table 8. Means of productivity indicators

Year	Indicator		Mean	Standard Deviation
2019	IP1	IP1 Gross Profit / Value Added	687.4287	3161.1485
	IP2	IP2 Operating Profit / Value Added	28.3121	33.1482
	IP3	IP3 Net Profit / Value Added	6.6786	22.4074
	IP4	IP4 Value Added / Working Capital	60.9051	61.4271
	IP5	IP5 Operating Profit / Working Capital	14.5434	15.5343
	IP6	IP6 Net Profit / Working Capital	6.6187	10.4786
	NPM	MN Net Profit / Sales	2.4203	3.7656
	OPM	MO Operating Profit / Sales	33.9462	31.2705
	GM	MB Gross Profit / Sales	6.0980	5.0818
2023	IP1	IP1 Gross Profit / Value Added	52.2441	124.38
	IP2	IP2 Operating Profit / Value Added	69.1998	353.83
	IP3	IP3 Net Profit / Value Added	66.0704	354.39
	IP4	IP4 Value Added / Working Capital	105.1231	58.33
	IP5	IP5 Operating Profit / Working Capital	0.7559	39.39
	IP6	IP6 Net Profit / Working Capital	–3.4093	37.62
	NPM	MN Net Profit / Sales	–28.6229	170.90
	OPM	MO Operating Profit / Sales	23.8350	70.70
	GM	MB Gross Profit / Sales	–25.3289	171.58

to an increase in operating capital, which dilutes the profitability obtained. It is important to frame these results in the context of the years 2020 to 2022, during which many organizations faced profound restructurings, declines in sales levels, and sustained cost increases as a direct consequence of the pandemic. This period generated lasting financial impacts and forced many companies to rethink their operational and financial models.

4. DISCUSSION

When analyzing the discriminant functions (see Table 7), it is observed that IP2 (Operating Profit / Value Added), IP5 (Operating Profit / Working Capital), IP6 (Net Profit / Working Capital), and OPM (Operating Profit / Sales) discriminated well between 2019 and 2023. This is consistent with the membership percentages of the studied indicator populations, which partially aligns with the analysis conducted by Fontalvo-Herrera et al. (2012) for indicators IP2 and IP6, and with Gómez et al. (2013) for the indicator OPM.

Regarding the means presented in Table 8, it was identified that only the variables IP2, IP3, and IP4 showed an average improvement from one year to the next. These results can be associated with greater efficiency in production costs and operational processes, possibly related to the ability of certified companies to generate value and wealth, as suggested by Gómez et al. (2013). Moreover, the consistency of the IP2 indicator observed both in the classification analysis and in the means and standard deviation demonstrates that the ISO 9001 standards model has a positive impact on productivity, measured by the ratio of operating profit to value added. This aligns with the purpose of such systems, which aim to generate efficiency that is directly reflected in operating profit as a consequence of quality, differentiation, and added value in products. However, it is important to clarify that the variability of this indicator increased significantly in 2023, suggesting that not all companies experienced the same improvement, and therefore, the results should be interpreted with caution.

The improvement in efficiency comes from a clear understanding of processes, which allows the elimination of wasted efforts or duplicated steps, resulting in a reduction of necessary inputs (capital and labor) and consequently greater productivity (Su et al., 2020). Additionally, the repeatability of processes emphasized in this certification reduces the time required to carry out activities and decreases variations in processes, which increases the consistency of product output while using fewer inputs and thereby boosting productivity (Su et al., 2020). In this sense, although a direct causal relationship between ISO 9001 certification and improvement in financial indicators cannot be established solely based on this descriptive analysis, the findings are consistent with the literature that links quality practices to greater competitiveness and productivity in manufacturing companies in response to market demands (Salikon & Saadon, 2023).

The achievement of productivity improvement by manufacturing companies with ISO 9001 certification can motivate other companies to implement quality management systems and seek certification in order to enhance their performance and better withstand the global environment (Iqbal Khan et al., 2020). These goals are achieved through process management required by the standard and process control activities that reduce process variation, making production more consistent and reducing defects, that is, generating consistent results (Su et al., 2020). These benefits are recognized in Ecuador's National Quality Plan, which proposes medium- and long-term activities aimed at improving productivity by promoting an industry with a culture of quality, innovation, and continuous improvement (Government of Ecuador, 2023).

However, certification alone does not automatically improve productivity in organizations. Astrini (2021) argues that the effectiveness of ISO 9001 in enhancing performance largely depends on the procedures themselves and their implementation, rather than merely the certification status. Singels et al. (2001) maintain that an organization's motivation to obtain certification plays a significant role in explaining its positive impact on performance. Most organizations still seem to pursue certification due to external pressures, which often results in hollow achievements. When the motives behind certification are marketing benefits and customer demands, certification will only lead to

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minor gains (Kakouris & Sfakianaki, 2018). As these articles state, only when an organization is internally motivated to improve its organizational processes will certification result in improved performance. Companies that have substantially improved productivity through the application of ISO 9001-based management systems should consider that the improvement does not focus solely on obtaining certification but rather on the impact of the implementation process and its sustainability over time. Therefore, the commitment of personnel and leadership from top management after adopting the standard becomes imperative (Albulescu et al., 2016; Bakhtiar et al., 2023). Additionally, according to Espín et al. (2022), ISO 9001-certified companies that invest more in R&D exhibit higher levels of productivity than organizations with limited innovation activities.

In summary, it can be stated that the companies that improve productivity are those that view the ISO 9001 standard not merely as a way to document what they usually do, something that only generates expenses, but rather those that have decided to implement a quality management system and manage it effectively without any external pressure. However, while there are internal decisions within companies that affect productivity, the influence of external factors stemming from public policies is also evident. Therefore, it is important to have studies that allow policymakers to establish measures and direct efforts toward increasing productivity (taxes, imports, exports, access to resources, trade policies, sources of financing, among others) (Simbaña & Carrión, 2021).

For future research, it is recommended to include qualitative studies to enrich the results through in-depth interviews. Additionally, other indicators could be added that measure not only productivity but also competitiveness, integrated operational and commercial performance, along with customer satisfaction. Finally, it is also important to consider how the quality management system was implemented and how it is maintained over time.

CONCLUSION

This study aimed to explore the relationship between the adoption of quality management systems based on the ISO 9001 standard and the productivity of manufacturing companies. The comparative analysis between the years 2019 and 2023 shows that only three of the nine financial indicators analyzed (IP2, IP3, and IP4) presented an improvement in their averages, suggesting a specific improvement in aspects related to operational efficiency and the generation of added value. However, this improvement was not generalized, and several indicators showed deterioration in capital profitability and sales margins. The improvement in these three indicators demonstrates that quality management systems enable companies to achieve efficiency in their production processes. While operational improvements are acceptable, long-term sustainability depends on these companies' ability to maintain an appropriate balance between operating and non-operating costs. If net margins continue to decline, the ability to reinvest in innovation, distribute dividends, or maintain solvency could be compromised in the long term.

The multivariate discriminant analysis provides initial empirical evidence supporting the existence of a positive relationship between the adoption of the ISO 9000 standard and certain levels of productivity, particularly reflected in the IP2 indicator (Operating Profit / Added Value). This evidence is consistent with the literature that associates the implementation of quality management systems with improvements in operational efficiency, waste reduction, and greater process standardization.

The analysis highlights the importance of comprehensive management of production processes aimed at maximizing operational efficiency to achieve a stronger competitive position in the face of the economic challenges of the manufacturing sector. It also emphasizes the need for this sector to adopt the best global continuous improvement practices, ensuring its sustainability and adaptability to the dynamic environment in which it operates.

The adoption of quality management systems, such as the ISO 9001 standard, not only improves a company's internal efficiency but also strengthens its competitive position in the market. This is especially crucial in highly competitive sectors like manufacturing, where the ability to quickly adapt to market conditions is a key differentiating factor. Companies that successfully integrate these best practices can position themselves as quality leaders, which can also translate into greater customer trust and a lasting competitive advantage.

Finally, the findings of this study highlight the importance of considering not only the adoption of ISO 9001 standards as an isolated factor but also the interaction between the specific characteristics of companies in the Ecuadorian manufacturing sector. Factors such as company size, prior experience in implementing quality management systems, and the ability to adapt to organizational changes play a crucial role in the different productivity outcomes observed after adopting these standards. These elements suggest that, while ISO 9001 may offer an opportunity to improve competitiveness and efficiency, its effects are not uniform and should be interpreted with a nuanced perspective, considering each company's unique characteristics and the economic environment in which it operates.

AUTHOR CONTRIBUTIONS

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