

Management of Quality Costs and Their Relationship to Competitiveness and Operational Efficiency in Manufacturing Companies in Azogues, Ecuador

Gestión de los costos de calidad y su relación con la competitividad y la eficiencia operativa en empresas manufactureras de Azogues, Ecuador

Giovanny Javier Yumbra Sigua*
Santiago Alberto Campodónico Palma*

ABSTRACT

Quality cost management is a key factor in understanding the performance of manufacturing firms. The aim of this paper was to analyse the relationship between quality cost management, competitiveness and operational efficiency in manufacturing firms in Azogues, Ecuador. A predominantly quantitative, non-experimental and correlational study was carried out, using a probabilistic sample of 80 firms. Data were collected via a questionnaire and supplemented by a semi-structured interview. The results showed a predominance of micro-enterprises, the presence of continuous improvement practices, production control and favourable levels of customer satisfaction. Prevention and evaluation were positively correlated with competitiveness and operational efficiency, with a Spearman's rho of 0.816 and $p < 0.001$. A significant association was also observed using the chi-square test, with a Cramer's V of 0.520. It was concluded that a higher

* Maestrante de la Maestría en Contabilidad y Auditoría, mención en Gestión Tributaria
Dirección de Posgrados
Universidad Católica de Cuenca
Cuenca, Ecuador
ORCID: 0009-0001-4243-3977
gjyumbra42@est.ucacue.edu.ec

Maestría en Contabilidad y Auditoría, mención en Gestión Tributaria
Dirección de Posgrados
Universidad Católica de Cuenca
Cuenca, Ecuador
ORCID: 0009-0003-8601-1121
santiago.campodonico@ucacue.edu.ec

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prevalence of preventive and evaluation practices was associated with better business performance in Azogues. Management of quality costs and their relationship with competitiveness and operational efficiency in manufacturing companies in Azogues, Ecuador.

Keywords: Quality costs, competitiveness, operational efficiency, manufacturing companies, Azogues, Ecuador.

RESUMEN

La gestión de los costos de calidad es un factor clave para comprender el desempeño de las empresas manufactureras. El objetivo del manuscrito fue analizar la relación entre la gestión de los costos de calidad, la competitividad y la eficiencia operativa de las empresas manufactureras de Azogues, Ecuador. Se llevó a cabo un estudio predominantemente cuantitativo, no experimental y correlacional, utilizando una muestra probabilística de 80 empresas. Los datos se recopilaron mediante un cuestionario y se complementaron con una entrevista semiestructurada. Los resultados mostraron un predominio de microempresas, la presencia de prácticas de mejora continua, control de la producción y niveles favorables de satisfacción del cliente. La prevención y la evaluación se correlacionaron positivamente con la competitividad y la eficiencia operativa, con un rho de Spearman de 0,816 y $p < 0,001$. También se observó una asociación significativa mediante la prueba de chi-cuadrado, con un V de Cramer de 0,520. Se concluyó que una mayor prevalencia de prácticas preventivas y de evaluación se asoció con un mejor desempeño empresarial en Azogues. Gestión de los costos de calidad y su relación con la competitividad y la eficiencia operativa en empresas manufactureras de Azogues, Ecuador.

Palabras clave: Costos de calidad, competitividad, eficiencia operativa, empresas manufactureras, Azogues, Ecuador.

INTRODUCTION

For centuries, progress was a distant promise, an idea reserved for visionaries and The competitiveness of manufacturing companies is closely linked to their ability to maintain efficient processes without compromising the quality of their products. In this context, quality management is no longer limited to inspecting the finished product but has become an integral part of decisions related to error prevention, resource utilization, and the improvement of production processes. In smaller companies, rework, waste, returns, and disruptions can affect operational performance and limit their ability to respond to the market (Ghunaim & Jaaron, 2022). Therefore, quality costs make it possible to distinguish between resources allocated to preventing and evaluating deficiencies and those generated by internal and external failures, thereby integrating quality with resource management and decision-making (Tambunan, 2023).

Recent evidence shows that strengthening prevention can reduce the need to correct errors in later stages and lower the costs associated with failures (Indra et al., 2025). However, these practices are not implemented in the same way across all companies. In micro and small organizations, lower levels of formalization can make it difficult to track rework, waste, and nonconformities, although managing these has been positively linked to organizational performance (Ghunaim & Jaaron, 2022).

In Ecuador, this situation is particularly relevant due to the presence of smaller-scale manufacturing companies, whose competitiveness depends not only on infrastructure and technology but also on their ability to learn, adapt knowledge, and progressively improve their processes (Osorio et al., 2021).

In the Azogues area, difficulties have also been identified in establishing quality management practices that strengthen the performance of small and medium-sized industrial firms (Andrade-Pesantez et al., 2025).

Despite this background, there is still limited evidence to help understand how quality cost management relates to the competitiveness and operational efficiency of manufacturing firms in Azogues. This lack of information is particularly relevant in a context characterized by production units of varying scales and levels of formalization, where decisions related to prevention, control, rework, and waste can have direct implications for the day-to-day operations of organizations.

In light of this need, the research posed the following question: What is the relationship between quality cost management, competitiveness, and operational efficiency in manufacturing firms in Azogues, Ecuador? Consequently, the objective was to analyze the relationship between quality cost management, competitiveness, and operational efficiency in manufacturing firms in Azogues, Ecuador.

The hypothesis was that quality cost management is significantly related to the competitiveness and operational efficiency of the manufacturing firms studied.

MATERIALS Y METHODS

The research was predominantly quantitative, with a non-experimental design and a correlational scope. As a supplement, a semi-structured interview was conducted with a manager in the manufacturing sector, which allowed for the contextualization of practices related to prevention, failure control, waste reduction, and process improvement, without generalizing the results to the entire set of companies studied.

The population consisted of 462 manufacturing companies in Azogues. With a 95% confidence level, a 10% margin of error, and p and q values of 0.50, a sample of 80 companies was selected using simple random probability sampling.

Quantitative data were obtained through a survey administered to the selected companies. The questionnaire consisted of 20 items related to quality management practices, prevention, evaluation, failures, rework, waste, competitiveness, and operational efficiency. The instrument achieved an overall content validity index of 0.96. Qualitative data were obtained through a semi-structured interview with a manager of a microenterprise in the metalworking sector, who had technical training in engineering and six years of management experience. The interview addressed aspects related to quality control, waste, continuous improvement, technology adoption, and employee engagement.

Quality cost management was addressed through practices related to prevention, evaluation, and defects during production processes. Competitiveness and operational efficiency were analyzed using indicators related to production continuity, resource use, cost reduction, compliance with standards, customer satisfaction, and the perception of improvement in business performance.

Descriptive analysis included frequencies, percentages, and measures of central tendency and dispersion, depending on the nature of the variables. Normality was assessed using the Shapiro-Wilk test. Since several variables did not follow a normal distribution and were primarily from ordinal scales, nonparametric tests were used.

The association between variables was examined using Spearman's ρ and Kendall's tau-b coefficients. In addition, the chi-square test and Cramer's V were used to estimate the magnitude of the association. A significance level of $p < 0.05$ was considered significant. The analyses were performed using IBM SPSS Statistics.

The interview was analyzed interpretively, organizing the information around prevention, evaluation, failures, waste, continuous improvement, and human talent management. Its findings were used solely as a contextual complement to the quantitative results.

RESULTS

The sample consisted of 80 manufacturing companies in Azogues. Based on the number of employees, microenterprises accounted for the largest share, at 88.8% of the total. Small enterprises accounted for 5.0%, large enterprises for 3.8%, and medium-sized enterprises for 2.5%.

Table 1. *Distribution of Companies by Size*

Tamaño empresarial	Frecuencia	Porcentaje (%)
Microempresa (1–9 trabajadores)	71	88,8
Pequeña empresa (10–49 trabajadores)	4	5,0
Mediana empresa (50–199 trabajadores)	2	2,5
Gran empresa (200 o más trabajadores)	3	3,8
Total	80	100,0

Source: Author's own compilation

Regarding quality management practices, 42.5% of the companies indicated that continuous improvement was partially implemented, and 30.0% reported full implementation. 18.8% were in the initial stages, and 8.8% stated that these practices were not applied. Regarding control during the production process, 38.8% stated they always performed it, and 30.0% said they did so frequently, while 20.0% did so occasionally and 11.3% never did.

Table 2. *Continuous improvement and production control practices*

Indicador	Categoría	n	%
Mejora continua	En etapa inicial	15	18,8
	No se aplica	7	8,8
	Parcialmente implementada	34	42,5
	Totalmente implementada	24	30,0
Control productivo y calidad	Frecuentemente	24	30,0
	Nunca	9	11,3
	Ocasionalmente	16	20,0
	Siempre	31	38,8

Note: The percentages were calculated based on 80 companies. Source: Prepared by the authors.

The costs associated with rework and waste were rated as moderate by 61.3% of the companies, low by 23.8%, and high by 8.8%. The remaining responses were distributed among categories related to nonexistence, lack of knowledge, absence, or lack of precision. Regarding quality standards, 47.5% agreed and 38.8% strongly agreed that compliance with these standards had contributed to improving the company's image, accounting for 86.3% of the responses. The remaining 13.8% expressed some degree of disagreement.

Table 3. *Perception of compliance with quality standards and corporate image*

Respuesta	Frecuencia	Porcentaje (%)
Totalmente de acuerdo	31	38,8
De acuerdo	38	47,5
En desacuerdo	6	7,5
Totalmente en desacuerdo	5	6,3
Total	80	100,0

Source: Prepared by the author.

Customer satisfaction was rated as high by 50.0% of the companies and very high by 32.5%. 15.0% rated it as medium, and 2.5% as low. Overall, 82.5% of the responses fell into the high and very high categories.

Table 4. *Perceived Level of Customer Satisfaction*

Nivel de satisfacción	Frecuencia	Porcentaje (%)
Bajo	2	2,5
Medio	12	15,0
Alto	40	50,0
Muy alto	26	32,5
Total	80	100,0

Source: Author's own compilation.

Regarding cost reduction through quality management practices, 47.5% of companies indicated that this occurred frequently, and 23.8% said it always occurred. On the other hand, 20.0% indicated that it occurred rarely, and 8.8% said it never occurred. Combined, the "frequently" and "always" categories accounted for 71.3% of the sample. The continuity of production processes was considered stable by 57.5% of the companies and very stable by 18.8%. 17.5% rated their processes as somewhat unstable, and 6.3% as unstable. Collectively, the "stable" and "very stable" categories accounted for 76.3% of the responses.

Distribution of Composite Variables

Analysis of the composite variables showed a mean of 2.903 for prevention/evaluation and 1.969 for failure costs. The favorable overall management of quality costs reached a mean of 2.936, while the competitiveness/operational efficiency index had a mean of 3.125. The Shapiro-Wilk test showed p-values less than 0.05 for prevention/evaluation,

failure costs, and competitiveness/operational efficiency. In contrast, the favorable overall management of quality costs yielded a p-value of 0.112.

Table 5. Descriptive statistics and normality tests for the composite variables

Variable compuesta	n	Mediana	Mediana	DE	Mín.	Máx.	W de Shapiro-Wilk	Valor p
Prevención/evaluación	80	2903	3000	0,769	1000	4000	0,954	0,006
Costos de fallas	80	1969	2000	0,628	0,500	4000	0,936	< 0,001
Gestión global favorable de costos de calidad	80	2936	3000	0,539	1750	4000	0,975	0,112
Competitividad/eficiencia operativa	80	3125	3143	0,613	1714	4000	0,942	0,001

Source: Author's own work.

The nonparametric analysis revealed a positive relationship between the prevention/evaluation index and the competitiveness/operational efficiency index. Spearman's rho coefficient was 0.816 ($p < 0.001$), while Kendall's tau-b was 0.666 ($p < 0.001$). The chi-square test also showed a statistically significant association between the categories analyzed, $\chi^2(4) = 43.268$; $p < 0.001$. The magnitude of this association, estimated using Cramer's V, was 0.520.

Table 6. Tests of association between prevention/evaluation and competitiveness/operational efficiency

Prueba	Estadístico	Valor	p
Rho de Spearman	ρ_s	0,816	< 0,001
Tau-b de Kendall	τ_b	0,666	< 0,001
Chi-cuadrado	χ^2 (gl = 4)	43268	< 0,001
V de Cramer	V	0,520	—

Source: Author's own work.

Supplementary Qualitative Results

The interview conducted with the manager of a metalworking microenterprise allowed us to identify quality practices present at different stages of the production process. In

the preventive phase, the technical review of drawings was highlighted, while the evaluation phase included welding inspections and dimensional verification. When defects were found, decisions were primarily focused on resolving the problems detected during production.

Material waste emerged as a recurring issue within the metalworking industry. The participant indicated that the use of six-meter structural profiles generated scraps that could not always be reincorporated into the production process. He also linked continuous improvement to the incorporation of machinery and equipment, along with aspects related to the standardization of procedures, staff training, and worker participation in company activities.

The predominance of microenterprises in the sample (88.8%) helps to understand the context in which quality management took place, since company size is often related to the formalization of processes, the availability of resources, and the incorporation of management tools. Potkány et al. (2022) identified differences in these practices based on the size and characteristics of manufacturing firms, while Andrade-Pesantez et al. (2025) described similar conditions in the Ecuadorian industrial sector. In Azogues, this reality was reflected in an uneven adoption of quality practices: 72.5% of companies reported full or partial implementation of continuous improvement, and 68.8% indicated that they conducted production controls always or frequently. These findings are consistent with those of Anifowose et al. (2022), Zhou and Li (2020), and Liu et al. (2021), who linked process management, training, and quality practices to various dimensions of business performance.

Despite this incorporation of quality practices, 61.3% of companies reported moderate levels of rework and waste, indicating that continuous improvement did not completely eliminate internal failures. From the perspective of the prevention, evaluation, and failure model, these costs are part of nonconformity and must be analyzed alongside actions aimed at preventing or detecting them (Arce, 2020; Eraslan & Önal, 2021). Along the same lines, Clancy et al. (2023) and Daniyan et al. (2022) found that systematic process control and continuous improvement are associated with reduced waste and rework in manufacturing environments.

The results also showed a favorable assessment of the effects associated with quality: 86.3% believed that compliance with standards had improved the company's image, and 82.5% rated their customer satisfaction as high or very high. This suggests that quality management is not limited to the internal sphere of production but is also related to market perception. Navarro and Naranjo (2025) linked culture and quality management to financial and non-financial dimensions of performance, while Ghunaim and Jaaron (2022) found relationships between quality costs and the performance of manufacturing firms.

Similarly, 71.3% of companies reported that quality management practices reduced costs frequently or always, while 76.3% rated their processes as stable or very stable. These results are consistent with the approach that integrates prevention, evaluation, and

failures into strategic cost management (Tambunan, 2023) and with the need to identify the concentration of internal and external failures to guide business decisions (Hakem et al., 2024). Indra et al. (2025) also observed that a prevention-focused strategy could reduce total quality costs, while Memari et al. (2024) and Suroso and Santosa (2024) linked the reduction of waste and unnecessary time to improved levels of operational performance.

The inferential results reinforced this trend. Prevention/evaluation practices showed a positive relationship with competitiveness/operational efficiency, with a Spearman's coefficient of $\rho = 0.816$ ($p < 0.001$), a Kendall's tau-b of 0.666 ($p < 0.001$), and a Cramer's V of 0.520. In the analyzed sample, higher scores in prevention and evaluation were accompanied by higher scores in competitiveness and operational efficiency, consistent with the findings reported by Ghunaim and Jaaron (2022), Potkány et al. (2022), and Zhou and Li (2020).

The follow-up interview allowed us to contextualize these results based on the experience of a micro-enterprise in the metalworking sector. Reviewing blueprints, dimensional verification, welding controls, and inspection points were part of the prevention and evaluation practices, while material waste emerged as a recurring challenge. These elements align with the importance attributed to process control, error prevention, and resource utilization in manufacturing environments (Clancy et al., 2023; Dutta et al., 2021).

CONCLUSIONS

The research revealed a significant relationship between quality cost management, competitiveness, and the operational efficiency of manufacturing companies in Azogues. This relationship was most evident in prevention and evaluation practices, which were associated with higher levels of performance. Although many companies had implemented continuous improvement and production control measures, rework and waste still persisted, especially in a context dominated by microenterprises with varying levels of formalization.

A favorable perception was also observed regarding compliance with standards, customer satisfaction, and process stability. Overall, the results showed that quality cost management was linked not only to defect control but also to prevention, the efficient use of resources, and process organization. Within the correlational scope of the study, these practices were associated with improved competitiveness and operational efficiency.

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