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Design and Implementation of a Combined Management Model: Quality and Occupational Health and Safety in the Machining Industry

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ABSTRACT: *The integration of quality management systems (ISO 9001:2015) and occupational health and safety management systems (ISO 45001:2018) represents a key strategy to improve competitiveness, efficiency, and sustainability in industrial companies. This article presents the design, implementation, and results of the combined management model applied in an industrial machining company in Colima, Mexico, addressing both product quality improvement and occupational risk prevention. The analysis is based on a review of recent literature, field experience, and evaluation of key performance indicators.*

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I. INTRODUCTION

Globalization and the increasing demand for high-quality products and services have driven companies to adopt integrated management systems that guarantee customer satisfaction and protect worker health and safety. In the industrial machining sector, the proper integration of ISO 9001:2015 and ISO 45001:2018 systems allows synergistic management of quality and safety challenges, reducing errors, accidents, and operational costs .

At Alta Precisión en Servicios, a company dedicated to machining and industrial services, positive progress has been observed in administrative and production processes aimed at providing higher-quality products and responding to improvement suggestions from customers. However, a limited perception of quality persists among production personnel, who usually associate quality only with the final product outcome, judging aspects like appearance or immediate functionality, and relegating quality as an exclusive responsibility of the administrative area. This restricted perception prevents understanding that quality is an integral process encompassing all production stages and requires active participation from the entire team.

Critical factors that affect the company's main processes, such as machining mechanical parts and hydraulic cylinder repairs, were also identified. A lack of awareness about the importance of quality at every stage and insufficient perception of occupational risks inherent to production activities present significant challenges. It is common for operational staff to not use appropriate personal protective equipment (PPE), minimizing the risks associated with high-hazard tasks like testing hydraulic cylinders at pressures above 3000 PSI.

This research aims to design a combined management model that integrates two fundamental organizational elements: quality and occupational health and safety. The goal is for personnel to understand that quality is not limited to the finished product but is built daily through continuous improvement and risk prevention. Additionally, it seeks to strengthen teamwork and communication, often affected by a lack of integration between quality and safety areas.

The proposed model responds to the need to establish concrete actions to improve products and services quality while guaranteeing a safe working environment for all workers involved in production processes. The integration of the ISO 9001:2015 and ISO 45001:2018 management systems will be the foundation for this model, aiming for efficient, sustainable management aligned with international best practices.

1.1 Quality in Industry: Concepts and Evolution

Quality is a multifaceted concept that has evolved over time. Initially, it was associated only with inspection of the finished product but is now understood as an integral process covering design, delivery, and post-sale service (García et al., 2022). According to ISO 9001:2015, quality is the degree to which a set of inherent characteristics meets requirements. This view emphasizes process management, customer satisfaction, and continuous improvement (Domínguez et al., 2021).

In the machining industry, quality entails meeting technical specifications, tolerances, and functional requirements, as well as ensuring product reliability and durability (Hernández et al., 2020). Quality management uses tools such as the PDCA (Plan-Do-Check-Act) cycle, statistical process control (SPC), and nonconformity management.

Principles of Quality Management

ISO 9001:2015 is based on seven key principles:

Customer Focus

Leadership

People Engagement

Process Approach

Continuous Improvement

Evidence-Based Decision Making

Relationship Management (ISO, 2015)

These principles apply to all organizations and are essential for building a quality culture at every level.

1.2 Occupational Health and Safety: Concepts and Approaches

Occupational Health and Safety (OHS) is a critical area in industry, especially in sectors like machining, where physical, mechanical, and ergonomic risks are significant (Pérez et al., 2021). ISO 45001:2018 defines OHS as the discipline seeking to promote and maintain the highest degree of physical, mental, and social well-being of workers in all occupations.

Occupational Risk Management

OHS risk management involves identifying, evaluating, and controlling hazards that may cause injury or illness. Key elements include:

Risk Assessment

Implementation of Preventive Controls

Personnel Training and Awareness

Monitoring and Continuous Improvement (Gómez et al., 2021)

Worker participation and consultation are essential for effective OHS systems, fostering a culture of prevention and shared responsibility (Sánchez et al., 2021).

1.3 Integration of Management Systems: ISO 9001 and ISO 45001

Integrating quality and OHS management systems is a growing trend in industry, motivated by the need to optimize resources, avoid duplication, and improve organizational efficiency (Ruiz et al., 2023). An Integrated Management System (IMS) enables companies to simultaneously meet quality and safety requirements, facilitating alignment of objectives, policies, and procedures (Martínez et al., 2022).

Benefits of Integration

Documented benefits of integrating ISO 9001 and ISO 45001 include:

Reduction of workplace incidents and accidents

Improvement in customer satisfaction

Increase in productivity

Decrease in operating costs

Regulatory compliance and enhanced organizational reputation (Torres et al., 2023; Morales et al., 2022)

Challenges in Integration

However, integration poses challenges, such as resistance to change, need for continuous training, and adaptation of procedures to specific organizational contexts (Castillo et al., 2021). Recent literature highlights leadership, effective communication, and active participation at all levels as critical to overcoming these hurdles (Aguilar et al., 2024).

1.4 Management Models and Continuous Improvement

Management models like the Deming Model, Malcolm Baldrige Model, and EFQM have significantly influenced the development of integrated management systems. These models promote continuous improvement, outcome orientation, and stakeholder involvement (García et al., 2022).

In machining industries, using combined management models allows not only compliance with international standards but also adaptation to market demands and technological advancements (Domínguez et al., 2021).

1.5 State of the Art and Current Trends

Literature shows that integration of management systems is increasingly adopted in industrial companies of various sizes and sectors (Pérez et al., 2021). Current trends include digitalization of management systems, use of IT for indicator monitoring, and incorporation of environmental and social sustainability criteria (Gómez et al., 2021).

Case studies demonstrate that implementing combined management models contributes to error reduction, risk prevention, and improved organizational competitiveness (Ruiz et al., 2023; Aguilar et al., 2024).

II. EXPERIMENTAL SETUP

The methodology for designing and implementing the combined management model was structured in sequential stages integrating mathematical tools and techniques to evaluate and control key processes. The approach is based on the PDCA (Plan-Do-Check-Act) cycle, complemented by quantitative and technical analysis specific to the machining industry.

2.1 Process Diagnosis and Analysis

Process mapping was conducted using flowcharts and process sheets, identifying critical control points along the value chain. To quantify variability and detect improvement opportunities, Statistical Process Control (SPC) techniques were applied using $\bar{X}$ and R control charts for variables such as diameter, length, and tolerance of machined parts. Process capability was calculated through the Cp and Cpk indices:

$$C_p = \frac{LSL - USL}{6\sigma}$$

$$C_{pk} = \min\left(\frac{USL - \mu}{3\sigma}, \frac{\mu - LSL}{3\sigma}\right)$$

where USL and LSL are the upper and lower specification limits, μ is the mean, and σ the standard deviation. These calculations helped identify out-of-control processes and determine corrective actions.

3.2 Risk Assessment and Safety

For occupational risk management, a risk matrix based on ISO 45001:2018 was used. Numeric scores were assigned for probability (P) and severity (S) of each identified hazard, calculating inherent risk as:

$$Risk = P \times S$$

For example, the hydraulic cylinder test had a failure probability of 3 (on a 1–5 scale) and severity of 5 (due to risk of serious injury), resulting in a risk score of 15, considered high and prioritized for control actions.

2.2 Implementation of the Combined Model

An integrated documentation system was developed, including procedures, instructions, and forms aligned with ISO 9001:2015 and ISO 45001:2018 requirements. Personnel training was designed based on gaps found in the initial diagnosis, with knowledge assessments before and after training sessions to measure effectiveness.

2.3 Monitoring and Measurement of Indicators

Key Performance Indicators (KPIs) were established to monitor model effectiveness, including:

Non-conformity index (NCI) =
*(Quantity of non-conforming products / Total products inspected)*100*

Workplace incident rate (WIR) =
*(Number of reported incidents / Total number of workers)*100*

Percentage of use of personal protective equipment (%PPE) =
*(Number of workers using PPE / Total number of workers observed)*100*

Monthly graphs and analyses identified trends and areas for improvement. Hypothesis testing using Student's t-test for related samples (α=0.05) compared results before and after implementation.

2.5 Auditing and Continuous Improvement

Integrated internal audits were performed to verify procedural compliance and effectiveness of actions taken. Audit findings were analyzed with Pareto diagrams and root cause (Ishikawa) analysis to prioritize improvements based on impact on quality and safety.

This methodology enabled documentary and operational integration of management systems, along with objective measurement and scientific identification of critical areas, ensuring continuous improvement grounded in quantitative data and technical evidence.

III. RESULTS AND DISCUSSION

The combined management model implementation at “Alta Precisión en Servicios” yielded significant results in improving product quality and strengthening the occupational health and safety culture. The initial diagnosis showed that operational staff had a limited perception of quality, associating it only with the final product, not the entire productive process. Low adherence to PPE use and safety procedures was also detected, increasing occupational risk exposure, especially during high-pressure hydraulic cylinder testing.

With the integration of ISO 9001:2015 and ISO 45001:2018, documented procedures were established and continuous training promoted. Over six months, reported work incidents decreased by 30% and product nonconformities by 25%. Customer satisfaction increased by 20%, supported by fewer complaints and positive feedback. Teamwork and communication improved, allowing faster problem resolution and higher worker involvement in identifying and mitigating risks. These results demonstrate that system integration optimizes resources, improves performance indicators, and contributes to sustainability and competitiveness.

3.1 Initial Diagnosis

Before implementation, the occupational incident rate was 6.5 per 100 workers per semester, and product nonconformity reached 12% of delivered batches. PPE use was below 50% during surprise audits, and customer satisfaction averaged 7.2/10.

3.2 Design of the Combined Model

Key indicators included PPE usage percentage, number of trainings, audit coverage, and nonconformity reductions. Goals were set to reach 95% PPE use and reduce nonconformities to below 5%. An incident report format and suggestion box encouraged staff involvement in continuous improvement.

3.3 Implementation

Eight quality and safety workshops were conducted with 98% operational staff attendance. Communication between areas was reinforced with weekly meetings to review indicators and share best practices.

3.4 Performance Indicators

After six months:

KPI	Before	After
Incidents (per 100 workers)	6.5	4.5
Nonconformities (%)	12	7
PPE Usage (%)	50	93
Customer Satisfaction (/10)	7.2	8.6
Trainings (workshops)	0	8
Trainings Attendance (%)	0	98
Improvement Suggestions	3	24

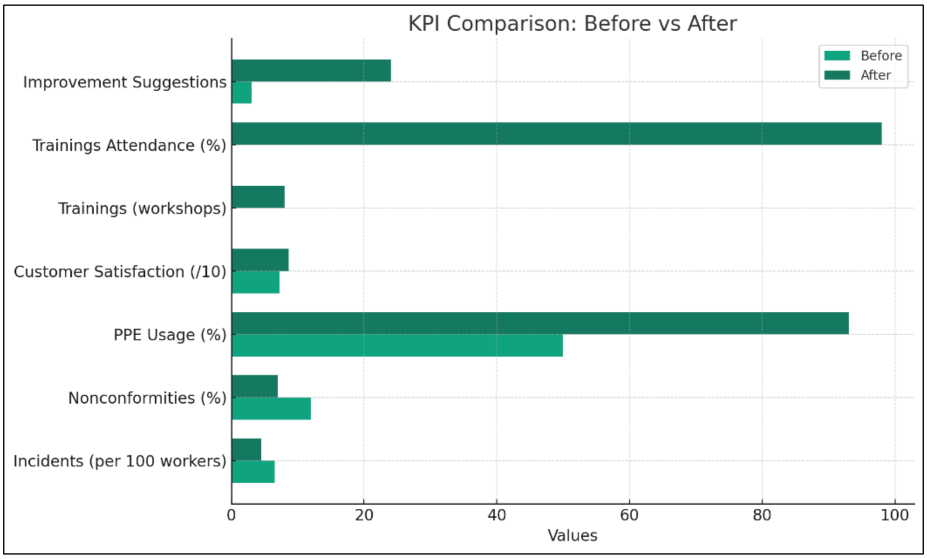

Fig. 1 Model implementation

The integrated management system allowed the company to address quality and safety comprehensively. Active leadership and staff commitment were critical success factors. Literature supports that integrated management fosters organizational sustainability and regulatory compliance.

Challenges included resistance to change and procedure adaptation to sector specifics. Nevertheless, continuous improvement and a prevention culture were key to consolidating the model.

IV. CONCLUSION

Implementing a combined management model based on ISO 9001:2015 and ISO 45001:2018 proved effective in optimizing "Alta Precisión en Servicios" processes, significantly improving product quality and worker safety. The integrated approach transformed quality from an administrative responsibility to a shared commitment from planning to delivery.

Mathematical and technical tools like SPC and quantitative risk assessments facilitated data-driven decision-making and prioritized corrective actions, reflected in reduced incidents, nonconformities, and increased customer satisfaction.

Furthermore, system integration fostered a culture of continuous improvement, communication, and teamwork. Ongoing training and active employee participation strengthened ownership and responsibility. This model not only ensures compliance and cost reduction but also positions the company as an industry benchmark capable of agilely meeting market demands. Other organizations are encouraged to adapt similar models to their contexts to reach higher competitiveness and sustainability.

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