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Integración de sistemas de gestión en la industria metalmecánica

Integration of management systems in the metalworking industry

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Resumen

Introducción: en un mundo globalizado y sujeto a vertiginosos cambios, las industrias metalmecánicas se esfuerzan para lograr

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calidad, medioambiente, seguridad, metalmecánica.

capacidad de competencia, minimizar impactos ambientales negativos y controlar los niveles de riesgo laboral, mediante el diseño y despliegue de una combinación de estrategias empresariales. **Objetivos:** esta investigación tiene como objetivo desarrollar una guía de implantación de un sistema integrado de gestión para una industria genérica del sector metalmecánico, utilizando normas y metodologías internacionalmente reconocidas que, contribuyan a la satisfacción de los grupos de interés. **Metodología:** este estudio tiene un enfoque cualitativo, de alcance descriptivo y transversal, que involucra un diagnóstico del sector metalmecánico en la provincia del Azuay-Ecuador, la selección de un modelo de integración y el desarrollo de una guía de implantación. La primera fase del estudio involucró una búsqueda bibliográfica en bases de datos científicas, seguido de una cuantificación del tamaño del sector económico investigado; posteriormente, se practicó una investigación en la Web mediante muestreo probabilístico intencional para estimar el número de empresas certificadas bajo normas internacionales; en la segunda fase, se elaboró una guía de implantación de un sistema integrado de gestión para una industria metalmecánica bajo directrices del anexo de alto nivel, del ciclo de la mejora continua y de las cláusulas normativas de los sistemas a integrar. **Resultados:** esta investigación desarrolló una guía de implantación de un sistema integrado de gestión para una industria metalmecánica genérica, bajo los estándares de las normas ISO: 9001, 14001 y 45001. **Conclusiones:** una de las estrategias para aportar a la eficiencia, a la competitividad y a un adecuado cumplimiento legal del sector productivo de la metalmecánica, es la adopción de un sistema integrado de gestión, articulando a la norma ISO 9001 los requisitos no comunes de la norma ISO 14001 e ISO 45001. **Área de estudio general:** administración. **Área de estudio específica:** gestión.

Keywords: management, integration, quality, environment, safety, metalworking.

Abstract

Introduction: In a globalized world subject to dizzying changes, metal-mechanic industries strive to achieve competitive capacity, minimize negative environmental impacts, and control labor risk levels, through the design and implementation of a combination of business strategies. Objectives: the objective of this research is to develop a guide for the implementation of an integrated

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management system for a generic industry of the metal-mechanic sector, using internationally recognized standards and methodologies that contribute to the satisfaction of stakeholders. Methodology: this study has a qualitative, descriptive, and transversal approach, involving a diagnosis of the metal-mechanic sector in the province of Azuay-Ecuador, the selection of an integration model and the development of an implementation guide. The first phase of the study involved a bibliographic search in scientific databases, followed by a quantification of the size of the economic sector under investigation; Subsequently, a Web research was carried out through intentional probabilistic sampling to estimate the number of companies certified under international standards; In the second phase, an implementation guide for an integrated management system for a metal-mechanic industry was developed under the guidelines of the high-level annex, the continuous improvement cycle and the normative clauses of the systems to be integrated. Results: This research developed a guide for the implementation of an integrated management system for a generic metal-mechanic industry, under the standards of ISO 9001, 14001 and 45001. Conclusions: one of the strategies to contribute to the efficiency, competitiveness and adequate legal compliance of the metal-mechanic productive sector is the adoption of an integrated management system, articulating to ISO 9001 the non-common requirements of ISO 14001 and ISO 45001. General area of study: administration. Specific area of study: management.

Introduction

Today, in the midst of a globalized and disruptive environment, industries are making parallel efforts to achieve greater competitiveness, legal compliance, and responses to social pressures on environmental protection and safety in work environments. Faced with this reality, management systems [MS] are conceived as effective strategies to improve organizational performance in an orderly and systematic manner. For the International Organization for Standardization [ISO], these MGS are conceived as: “a set of elements of an organization that are interrelated or interact to establish policies, objectives and processes to achieve these objectives” (International Organization for Standardization [ISO], 2015a, p. 17). Based on the theories on quality management formulated by: Joseph Juran, Edward Deming, Kaouru Ishikawa, Armand Feigenbaum,

Phillip Crosby, among others, these SG have been kept perfected and in 2012 ISO published Guide 83 which would later become Annex SL or High Level Structure, constituting the recommended model for integration. This harmonization structure allows companies to achieve a set of important advantages among which the following stand out: coverage of needs and expectations of interested groups, better organizational image, integrated management to objectives, controls and improvement, greater efficiency and effectiveness of operations, among others (Barafort et al., 2017;Talapatra et al. (2019; Perdomo & Hernández, 2020). Nunhes et al. (2017) analyze14 Brazilian companies certified under ISO 9001, ISO 14001 and OHSAS 1800 standards, identifying senior management responsibility, internal communication, and accountability as the most integrated elements; benefits include improved efficiency and internal communication, faster decision-making, higher quality and reliability of goods and services offered; and the main difficulties include the amount of work and human resources required by the integration process.

Algheriani et al. (2019) develop a risk model to integrate ISO 9001, ISO 14001, ISO 27001, ISO 45001 and ISO 22000, thereby reducing the amount of resources involved and increasing organizational performance. In the same sense, Alzate et al. (2019) develop a model of an integrated management system [IMS] for quality and environment in a steel mill; this model is structured in two stages: on the one hand, the diagnosis and on the other the IMS. In the diagnosis stage, compliance levels are identified ranging from 33% in terms of the organization's context to 78% in improvement; the most pronounced weaknesses refer to thedata analysis and performance evaluation; the second stage is designed from a systemic approach, based on the high-level structure [HSL] and the PDCA cycle [Plan, Do, Check and Act].

Molina et al. (2022) implement a GIS for the ISO 14001 and ISO 45001 standards in the construction field in Colombia, showing benefits such as: savings and synergies, greater confidence and visibility in the market, unification of controls and operations. According to Chiarini & Cherrafi (2023), the opening of a new debate on integration is directed towards the coexistence of a GIS with the new requirements of Industry 4.0 and, specifically, in the face of advances in terms ofartificial intelligence.Delgado et al. (2019) develop a mechanism to implement a GIS under ISO 9001:2015, ISO 14001:2015 and ISO 17025:2015, at the National Polytechnic School, in Ecuador; this research uses two methodologies, the first of total integration and the second of alignment.According to a situational diagnosis carried out by Quezada et al. (2018), the strategic focus of Ecuadorian metalworking SMEs is limited or absent, where environmental and social factors are not considered in a timely manner, a situation that significantly limits their ability to compete.

From this contextualization it follows that the integration of the SG has been gaining space in business administration, generating evident benefits in the organization, translating into: improvements in the image towards the market, greater positioning, competitiveness and compliance with legislation and other requirements. In the legal field, the Interinstitutional Committee for Occupational Safety and Health of Ecuador (CISHT, 2018), through resolution No. 2018-001, categorizes the activity: manufacturing of finished metal products, except machinery and equipment, as a high occupational risk activity, and that the Ministry of the Environment of Ecuador (MAE, 2012), through Ministerial Agreement 142, Annex B, considers: Manufacturing of finished metal products within the List of Hazardous Waste; consequently, it becomes necessary to answer the question through research: how to develop an integrated management system applicable to the metalworking industries, under the ISO 9001, ISO 14001 and ISO 45001 standards? The objective of this research is to develop a guide for the implementation of a GIS under ISO standards, for a generic industry in the metalworking sector, using internationally recognized methodologies, which contributes to the coverage of the requirements of the interested parties, seeking to contribute to the efficiency and competitiveness of the referred productive sector in the province of Azuay-Ecuador.

Theoretical Framework

Structure, models and strategies for implementing management systems

In a globalized, disruptive and increasingly competitive business environment, it is crucial that organizations design strategies aimed at optimizing processes and innovating products and services [P&S] (De Oliveira et al., 2019); in this scenario, continuous improvement becomes the key to achieving significant progress in terms of: quality objectives, environmental sustainability and safety in work environments (Gutiérrez & Ibáñez, 2021). Continuous improvement, for its part, is defined as a: "recurring activity to improve performance"(ISO, 2015a);On the other hand, Lay De León et al. (2022), conceive continuous improvement as an agent to increase organizational productivity, add value for the customer and contribute to competitiveness, using among the toolsthe PDCA cycle, which allows for continuous improvement, applicable to projects, processes and a management system as a whole (González et al., 2020).

Systems such as ISO 9001, ISO 14001 and ISO 45001 [ISO/9K1-14K1-45K1] are guided by: the process approach, customer focus, leadership, decisions made based on evidence, commitment to those involved and relationship management 9000:2015 (ISO, 2015a). The ISO 9001:2015 standard guides the application of technical requirements in the implementation of a quality management system [QMS] (ISO, 2015b); the ISO 14001:2015 standard guides the application of technical requirements in the implementation of an environmental management system [EMS] (ISO, 2015c) and the ISO 45001:2018 standard seeks to establish an occupational health and safety

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management system [OHSMS] (ISO, 2018). Although these technical standards are not mandatory for companies in Ecuador, they have been established as a fundamental axis that complements strategic planning.

A GIS is one of the administrative documents that has recently experienced a significant deployment; several authors justify this evolution in terms of globalization, trade agreements, profitability, technological disruption, legal requirements and social pressures on environmental risks and risks to the health of employees (Gisbert & Esengeldiev, 2014; Duque, 2017). Various models have been proposed for the integration of systems; Karapetrovic (2002) proposes a GIS configured by a core of common requirements for the systems being integrated, and another structured with exclusive requirements, which are integrated into the QMS adopted as the base system. The Spanish Association for Standardization (AENOR, 2005), in the UNE 66177:2005 standard, provides guidelines on the process of integrating ISO standards based on the PDCA cycle. Sampaio et al. (2012) identifies three integration models: 1) Systemic Model, which combines the SGC, SGA and the SGSST, 2) Evolutionary Model, which bases the integration on the ISO 9001 standard and, 3) Synergistic Model, which considers the union of common requirements of these three standards.

Table 1

HSL structure for ISO standards

No.	Clause	IS0 9001:2015	ISO 14001:2015	ISO 45001:2018
4.	MM Context	4.1; 4.2 4.3 Scope 4.4 SGC	4.1; 4.2 4.3 Scope 4.4 SGA	4.1; 4.2 4.3 Scope 4.4 SGSST
5.	Leadership	5.1 5.2 Quality Policy 5.3 -	5.1 5.2 Environmental Policy 5.3 -	5.1 5.2 OSH Policy 5.3 5.4 Consultation and participation of workers
6.	Planning	6.1 Quality Objectives 6.2 6.3	6.1 Environmental Objectives 6.2 6.3	6.1 SST Objectives 6.2 6.3
7.	Medium	7.1; 7.2; 7.3; 7.4; 7.5	7.1; 7.2; 7.3; 7.4; 7.5	7.1; 7.2; 7.3; 7.4; 7.5

Table 1

HSL structure for ISO standards (continued)

No.	Clause	IS0 9001:2015	ISO 14001:2015	ISO 45001:2018
8.	Operation	8.1 8.2 p&s requirements 8.3; 8.4; 8.5; 8.6; 8.7	8.1 8.2 Emergency preparedness and response -	8.1 8.2 Emergency preparedness and response -
9.	Performance evaluation	9.1; 9.2; 9.3	9.1; 9.2; 9.3	9.1; 9.2; 9.3
10.	Improvement	10.1; 10.2; 10.3	10.1; 10.2; 10.3	10.1; 10.2; 10.3

Note: Adapted from ISO/9K1-14K1-45K1.
Fountain:ISO (2015b), ISO (2015c), ISO (2018)

Maier et al. (2013), proposed the integration based on the PDCA cycle, taking the QMS under ISO 9001 as the backbone. For Rojas et al. (2020), theIntegration is manifested in the congregation of systems in a single scenario, but with alignment in policies, objectives, procedures and improvement.For ISO, the harmonization and development guideline for new standards called HSL, seeks to standardize and synchronize basic requirements of ISO standards, promoting the integration of SG for better adaptability, cost reduction and stakeholder satisfaction.

Some of the most common integration combinations use the following standards: ISO 9001, ISO 14001, ISO 22000 (ISO, 2018), ISO 27001 (ISO, 2022), ISO 45001 and ISO 50001 (ISO, 2018). Lessons learned by implementers recommend starting with ISO 9001 as the backbone of a GIS and then incorporating requirements from other standards as required. Taking into account the HSL, Table 1 shows the clauses of three commonly integrated ISO systems.

A GIS implemented facilitates coordination and cooperation in business operations, saves time and costs, optimizes efficiency and effectiveness with organizational objectives and drives business growth, mainly (Ornelas et al., 2016;Rodriguez, 2017; Cubillos, 2021).

The metalworking industry

Metalworking is considered one of the most complex disciplines, the backbone and catalyst of industrial development, due to the diversity of processes it comprises, the technologies it uses, the capital goods and inputs it demands, the products it generates, as well as the environmental aspects and hazards it involves. The metalworking industry integrates a heterogeneous set of manufacturing processes that, using products from the steel industry, add value to them and obtain a vast range of goods that are key to the development of other productive activities. The main processes involved in the

metalworking industry are: 1) cold or hot shape change processes; 2) material removal processes; 3) assembly processes and; 4) property improvement processes (López et al., 2016; Pinto, 2017).

Considering this diversity of processes, it is necessary to assume that they generate environmental risks, as well as occupational health and safety risks (Association of Private Banks of Ecuador [ASOBANCA], 2022). Among the main aspects that can affect the environment are the generation of: 1) solid waste; 2) noise; 3) spillage of chemical substances; 4) gaseous emissions and; 5) liquid discharges. The significant occupational risks detected in these processes are related to exposure to: 1) chemical substances, vapors, mists and fumes; 2) manual handling of loads, forced postures, repetitive movements and physical overexertion; 3) noise; 4) dust and projection of particles; 5) high temperatures; 6) blows, cuts, punctures and entrapments; 7) falls; 8) exposure to high voltage and radiation and; 9) fires and explosions.

To size the metalworking sector, the Ecuadorian Federation of Metal Industries (FEDIMETAL, 2023) shows that this industry has a 60% used installed capacity, contributing to the economy with $3,268 million USD annually, with average exports of $340 million USD, which contributes between 10% and 15% to the Manufacturing Gross Domestic Product [GDP] and between 1.5% and 3% to the national GDP. The Ecuadorian steel and metalworking industry generates 92,822 direct jobs and 400,000 indirect jobs, which corresponds to 10% of non-oil manufacturing employment. At the Azuay level, these data would be expressed in proportion to the 1,925 active taxpayers that make up the metalworking sector [1,679 natural persons and 246 companies] that are registered in the Registry of the Internal Revenue Service of Azuay (Servicio de Rentas Internas del Ecuador [SRI], 2023).

Methodology

This study has a qualitative approach, with a descriptive and transversal scope. In its first part, a bibliographic review was carried out in databases such as Science Direct and in electronic libraries such as SciELO and Redalyc. In the legal field, the regulations that classify the industry in terms of environmental and safety risks were identified. Subsequently, the SRI taxpayer registry was analyzed to quantify the size of the sector in Azuay and guide a web-based research, which allowed 40 companies to be analyzed regarding the availability of certification in: ISO/9K1-14K1-45K1; the data collected was tabulated and the availability of certified SG was quantified.

Finally, prior to sufficient understanding of the technical standards referred to, an implementation guide for a GIS was designed, applicable to the ISO/9K1-14K1-45K1 construct, under the HLS structure, following the guidelines of the UNE 66177:2005 standard, focused on processes and under the stages of the PDCA cycle.

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Results

According to the SRI database, 155,599 taxpayers in Azuay are active, 1,925 taxpayers belong to the metalworking sector, distributed as follows: 1,679 natural persons and 246 companies. With a sample of 40 companies of the 246 identified, the proportion of certifications was quantified, the data of which are shown in Table 2.

Table 2

Survey of the number of certifications in metalworking industries in Azuay

	Certifications			
	ISO 9001	ISO 14001	ISO 45001	NEXT
Number of certificates	8	4	2	2
Percentage	20%	10%	5%	5%

Note: The table shows the adoption of technical standards in the sector studied.
Fountain:ISO (2015a), ISO (2015c), ISO (2018)

Development of the GIS implementation guide

The integration proposal considers a generic metalworking industry under the name MM; the structure proposal articulates the clauses and requirements of the ISO/9K1-14K1-45K1 technical standards, taking as reference the PDCA cycle and the integration method described in the UNE 66177:2005 standard.

The Context of MM

Information regarding relevant internal and external factors [factors under and outside the control of MM] that may influence: the results, objectives and the development of MM operations, is kept documented and is the input information for strategic decision-making. External and internal issues [positive and negative aspects] are based on the analysis and monitoring of the sectors of interest, involving factors such as: political, economic, social, technological, environmental and legal [PESTAL]; current competitive, market and legal factors; and the analysis of internal capabilities through the SWOT analysis [strengths, opportunities, weaknesses and threats], which shows the organizational gaps to be addressed through strategic actions in the corresponding plan. The results of these analyses are documented, and they are updated at least annually, in the first quarter, or when necessary and involves changes in the GIS.

Based on the analysis of the external and internal environment, MM determines the interested parties to be: [list], whose requirements are: [list requirements of each party]

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and the legal requirements are: [list legal requirements]. MM monitors, reviews this information [define frequency and circumstances] and, if appropriate, the conditions are modified,characteristics or requirements.

The scope of MM is: [clear description of the processes included in the SIG, P&S offered, the sector it covers and the legal and regulatory provisions in force]; this scope covers from process "X" to process "Y". MM publishes and keeps its digital P&S catalogue up to date and applies the requirements of ISO 9001:2015 [declare exclusions if necessary]; the standardsISO/9K1-14K1-45K1are implemented fully.

MM involves the processes described in the process manual [include the macro process map from the company's GIS].MM structures its MIS under three macro processes: strategic, operational and support processes, and evaluates its processes according to the indicator, use of installed capacity [specify goal]; the source information for the evaluation resides in physical and/or digital technical documents. MM processes and subprocesses are characterized in the process manual, which describes their interaction and the information related to: sources of inputs, inputs, procedure, outputs and receivers of outputs; in each process the objective, scope, person responsible, necessary resources, indicators, applicable requirements and related documents are specified.

Leadership

MM Management leads and commits to the IMS by: a) reporting on its effectiveness annually [including the nature, magnitude, and environmental impacts as well as prevention of work-related injuries/illnesses]; b) establishing the integrated policy and objectives for the IMS; c) integrating the IMS requirements into the stated processes; d) promoting the process approach and risk-based thinking; e) allocating and funding the budget for the IMS; f) communicating the relevance of integrated management; g) ensuring the achievement of planned results; h) managing for IMS effectiveness; i) promoting improvement; and, j) supporting other management roles. MM Management leads the customer focus by: a) delivering P&S, in quantity, as designed, without defects, and meeting all stated requirements; b) addressing risks and opportunities; c) continually increasing customer satisfaction. MM's stated policy is consistent with its Vision and Mission, is reviewed annually and communicated to all interested parties via the Web [wording of the mission, business vision and integrated policy]. MM's organization includes: organizational chart, roles, functions, responsibilities and competencies for each process.

MM carries out the consultation and participation through the intranet: approved hygiene and safety regulations [HHS], risk matrix, elimination of hazards, training, work licenses, drills, health promotion and other legal requirements. Table 3 shows a set of documents required for the implementation of the GIS.

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Table 3

Mandatory, non-mandatory documents and legal requirements for the GIS: Stage P

No.	Clause	Documents
4.	Organizational context: internal and external factors.	PESTAL analysis, Internal capabilities analysis; SWOT; Stakeholder matrix and their requirements; Scope of the GIS, Exclusions for QMS; Macroprocess map, Process manual, Process characterization template.
5.	Leadership: direction and participation.	Mission, vision and corporate values; Integrated Policy determination method; Functions and competencies manual; Organizational chart, Staff roles and responsibilities.
6.	Planning: addressing risks and opportunities.	Procedure for planning and addressing risks and opportunities; Methodology for addressing risks and opportunities; Criteria for assessing significant environmental aspects; Matrix of associated environmental impacts; Record of compliance obligations; Method for determining objectives; GIS action plan; Format for managing changes in the GIS; List of legal requirements.

Note: Adapted from ISO/9K1-14K1-45K1.

Planning

MM identifies and addresses risks and opportunities based on contextual information, including: environmental aspects, hazards, risks and possible emergency situations. For this purpose, MM applies the methodologies established in the IS0 3100:2018 standard and the Failure Mode and Effects Analysis [FMEA], declares the prioritized opportunities and risks and they are included in the action plan to address them. The plan to manage risks and exploit opportunities includes at least: the opportunity or risk to be addressed, the associated context, the related stakeholders, the root causes, the effect, the specific causes, the actions, the time frame, the budget and those responsible. The definition of the GIS objectives and their planning are based on the strategic direction of MM and its integrated policy and are communicated to the interested groups through the website [selectively]. Each GIS objective is structured considering: strategy, specific objective, indicator, calculation formula, goal, actions, activities, resources, time frame, those responsible and expected results. Changes to the GIS are made as needed for its effectiveness and are documented.

Support

MM has administrative and operational staff working in its establishment [specify location]; resources are allocated through the annual budget, which is evaluated semi-annually. The role, responsibilities and number of staff are stated in the organizational structure. The infrastructure required for operations includes: [description of buildings, machines, equipment and associated services] and its availability is managed through an annual maintenance plan. MM ensures an adequate environment in accordance with the

risk matrix, the legalized RHS and the budgeted resource planning. Measurement traceability is carried out through certified internal gauges and standards; measuring equipment is subject to internal verification and registration before use; external calibration of measuring equipment and standards is carried out at least once a year in certified laboratories. MM appoints and hires competent people according to current labor legislation; employee awareness of the GIS is evaluated semi-annually and internal and external communication is documented through: [description of channels].

MM's documentary information is executed in accordance with the procedure for managing documented information and is available to users through clouding. The dissemination and management of access keys is registered and confidential.

Operation

MM's P&S requirements are communicated to customers and executed according to a marketing and sales procedure, and include: a) P&S information; b) queries, orders, changes and other related information; c) customer feedback and complaints; d) control of customer property; and e) contingencies attributable to MM detected by the customer. The P&S requirements offered comply with related national and international technical standards and current legislation. MM reviews, documents and communicates the customer's specified and unspecified requirements for the P&S and ensures their compliance, including delivery time and decisions involving changes to requirements.

The P&S design and development [D&D] is established, implemented and maintained according to its scope and its subsequent provision is ensured. The applied process is the following: 1) identify the need for P&S; 2) plan the D&D; 3) define D&D inputs; 4) execute the D&D process; 5) generate D&D results; 6) validate the D&D; and, 7) present the D&D. The specific information of the stages, methods and controls for the D&D is executed according to the procedure for the D&D. The D&D of the P&S is executed according to the D&D procedure considering: 1) the inputs for the D&D; 2) the controls of the D&D and; 3) the outputs of the D&D. The changes in the D&D are documented and maintained.

Control of MM processes and P&S provided externally [suppliers or contractors] is verified to ensure that they comply with quality requirements, including their life cycle, potential environmental impacts and compliance with SST requirements. MM determines the relevant controls when: a) these P&S are incorporated into the Company's P&S; b) the P&S are provided directly to customers and; c) any process or part of it is delivered by an external supplier. MM coordinates its purchases with suppliers, identifies hazards, assesses and controls SST risks within the work area and verifies legal compliance and other related requirements. Management of processes and P&S provided externally is documented and executed according to the purchasing and contracting procedure,

preferring to negotiate with certified suppliers. MM ensures that the requirements are adequate before communicating to the external supplier.

The details of the production and/or delivery of the MM service are established in the production planning and control procedure and the procedures applicable to each process in the value chain [description of applicable procedures]. MM controls the following aspects at this stage: a) documented information available to users; b) the use and availability of monitoring and measurement resources; c) the performance of monitoring and measurement; d) the acceptance criteria for the P&S; e) the use of the facilities and the present work environment; e) the competence of the collaborators; f) the frequent validation and revalidation of their capacity to achieve declared results; g) preventive measures against human error and; h) the activities related to the release, delivery and post-delivery of the P&S.

MM identifies that the outputs comply with the P&S requirements and ensures their traceability by identifying the products permanently or indelibly. MM protects the property of the client or external supplier; in the event of any alteration, the owner is informed.

MM preserves the products in accordance with the procedure for storage and dispatch of finished products. MM replaces or repairs products damaged in transport or under conditions of use that differ from their need or requirement, the responsibility for which can be attributed to MM. The scope of operations after delivery considers the applicable legal and regulatory requirements and the expected useful life of its P&S [time specified]. Modifications in production and service are controlled and documented according to the requirements.

MM releases P&S to the market only when the requirements have been satisfactorily met; the resulting information is retained to ensure traceability of the revisions.

Non-conforming outputs in MM are treated as follows: a) correction, which eliminates the defect or the cause of non-conformity [NC], b) separation, containment, return or suspension of delivery of P&S; c) information to the customer about non-conforming outputs that are required to be dispatched to the customer and; d) authorization to admit under concession [the benefit to the customer is specified]. The adjustment to the requirements once the NC are corrected is verified and documented.

MM manages OSH risks in the following order: a) elimination of the hazard; b) substitution of processes, materials or equipment with others of lesser hazard; c) application of engineering controls; d) execution of administrative controls and training; e) application of appropriate personal protective equipment [PPE].

MM prepares and responds to emergencies by: a) legalised environmental and HRH plan; b) planned response to real emergency events and first aid; c) relevant information and training for staff and other interested parties; d) periodic testing and verification of the planned response capability, where feasible. This information is kept documented. Table 4 summarises the minimum documents required by MM in stage H of the improvement cycle.

Table 4

Mandatory, non-mandatory documents and legal requirements for the GIS: Stage H

No.	Clause	Documents
7.	Support: resources, awareness and communication.	Annual and executed budget; Updated resume; Registered employment contract; Health examinations; List of machines, equipment and facilities; Annual maintenance plan; SST risk matrix; RHS; List of measuring equipment; Equipment calibration certificate; Measuring equipment control record; Worker folder; Training and registration plan; Communications record; Procedure for managing documented information; Master list of documents; Key delivery-receipt record.
8.	Operation: proactive execution of planning.	Procedures, instructions, specifications and working documents for each process (clouding); List of suppliers; Customer order; Purchase order; Supplier evaluation; Supplier survey; Customer property record; Procedure for emergency preparation and response; Emergency plan.

Note:adapted from ISO/9K1-14K1-45K1

Performance evaluation

MM demonstrates the compliance of its P&S, its environmental performance, the monitoring of the health of its employees, compliance with current legislation, statistics and continuous improvement by monitoring and measuring the objectives of the SIG. To do this, it: a) verifies the achievement of the proposed results through data and statistical analysis and; b) monitors, measures, analyses and evaluates quarterly information using information generated by the Company's computer system. MM evaluates the efficiency and effectiveness of the SIG based on the evaluation of the objectives; the information that shows the results is kept.

MM assesses customer satisfaction through a semi-annual online survey, customer feedback on shipped orders, and frequent customer visit reports.

MM audits its IMS at least once a year [specify month] and determines the compliance of its IMS with the requirements. The audits are carried out in accordance with the ISO 19011 standard, guaranteeing the objectivity and impartiality of the internal audit with auditors from the company itself or contracted.

MM management reviews the IMS at least once a year. This review involves: a) the results of internal and external audits; b) customer feedback on the P&S; c) performance of each process and product conformity [customer satisfaction, feedback from stakeholders, achievement of IMS objectives, performance of each process and P&S conformity, NC and corrective actions, results of monitoring and measurement, and supplier performance]; d) the adjustment of resources as evidenced in the annual budget; e) the effectiveness of risk and opportunity management; and; f) opportunities for improvement. The management review generates the following outputs: a) opportunities for improvement; b) the need for changes in the IMS; and; c) the determination of resources for improvement. MM documents and maintains these reviews.

Improvement

MM continuously improves the effectiveness of the IMS using its integrated policy and IMS objectives. Actions include: a) improving the P&S to meet future requirements and needs; b) preventing, correcting or reducing undesirable effects; c) improving the performance and effectiveness of the IMS. MM considers an NC as non-compliance with requirements specified in its IMS [complaints, internal and external audits, non-conforming product, management forecast, NC of processes and the IMS, accidents and incidents and risks identified in the SGSST and in the EMS or other sources]. Evidence of the NC and the actions taken are kept. MM, with the management review, undertakes improvement actions, which are described in the improvement plan. An incident and an NC in environmental and SST matters are managed without delay, to eliminate or minimize the associated risks. Documents related to stages V and A are presented in table 5.

Table 5

Mandatory, non-mandatory documents and legal requirements for the GIS: Stages V and A

No.	Clause	Documents
9.	Performance evaluation: verification of GIS implementation.	Internal audit plan and program, Internal audit report, Monitoring and measurement results, Legal compliance assessment, Management review report, Results of corrective actions, Improvement plan, Customer satisfaction survey.
10.	Improvement: preventive and improvement actions	NC, incidents and corrective actions, Results of corrective actions.

Note:adapted from ISO/9K1-14K1-45K1

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Discussion

According to the survey applied to the sample of 40 metalworking companies in Azuay, it was found that 20% have ISO 9001:2015 certification, 10% have ISO 14001:2015 certification, 5% have ISO 45001:2015 certification and 5% have GIS certified under the three standards mentioned, observing that the greatest interest of the administration is oriented towards quality management. According to Guzmán (2019a, p. 21), in Ecuador, at the end of 2017, he identified 1,169 companies certified under ISO 9001 [equivalent to 0.14% of the 843,745 registered companies], 192 companies certified under ISO 14001 [equivalent to 0.02%] and in the case of OHSAS 18001, he did not detect information available in official sources; It also states that, at a global level, the ratio between ISO 9001 certification and ISO 14001 is 3:1 and that of ISO 9001 and OHSAS 18001 [now ISO 45001] is 12:1, confirming the predominance of the ISO 9001 standard over the other standards.

This research proposed the integration of the ISO/9K1-14K1-45K1 standards for the metalworking industry, by virtue of the competitiveness of the sector, the categorization of the sector by the CISHT as a high occupational risk activity, and the inclusion of the manufacture of metal products within the List of Hazardous Waste by the MAE. Ortiz (2018) argues that, due to the rise of international standards, a GIS articulated between the SGC, SGA and SGSST has become popular; for Guzmán (2019b, p. 111) in Ecuador, 78.5% of the companies that have certified a GIS have opted for the SGC-SGA-SGSST scope; 7.6% for the SGC-SGA scope, 8.9% for SGC-SGSST and 5.1% for the SGA-SGSST scope.

This integration proposal was based on the HSL model, the PDCA cycle and the UNE 66177:2005 guidelines to articulate the clauses of ISO/9K1-14K1-45K1; a combination similar to the five-step model proposed in PAS 99:2012 by the BSI Group of the United Kingdom (Rebelo et al., 2016). The model proposed by the research coincides with the systemic model identified by Domínguez et al. (2015), shares the evolutionary approach for implementation based on the QMS and agrees with the synergy sought between the requirements of the standards to be integrated.

Kauppila et al. (2015) argue that, among the most notable current trends for the harmonization of ISO systems is the application of the HSL, a proposal that is shared by Alzate et al. (2019) in the model for the implementation of a quality and environmental GIS in a steel company, whereThey apply a model built with a systemic approach, based on the HSL and the PHVA cycle; this last model fully coincides with the proposal of this research.

Conclusions

- The benefits for industries of implementing a GIS are evident and are manifested in the different business dimensions, translating into a better image and confidence projected towards the market, in a greater positioning and competitiveness of the brand, high levels of efficiency and productivity, as well as in a better legal compliance and other requirements of the interested parties.
- This research developed a guide for implementing a GIS for a generic metalworking industry, under the ISO/9K1-14K1-45K1 standards, seeking to contribute to efficiency, competitiveness and adequate legal compliance in the productive sector.
- The analysis of the data collected from metalworking companies allowed us to determine that, in terms of certification of an SG, for each ISO 45001 standard certified, there are two ISO 14001 systems certified and four ISO 9001 systems certified; this demonstrates the predominance and the backbone nature of the ISO 9001 standard in this sector of industrial activity.
- The model used for the development of this integration guide considers the HSL structure that incorporates the requirements of ISO 14001:2015 and ISO 45001:2018 into the requirements of the ISO 9001:2015 standard, taking as a reference the PDCA cycle and the guidelines for integration described in the UNE 66177:2005 standard.
- Given the technological disruption, it is recommended that future research identify the implications of artificial intelligence inthe typical SG.

Limitations of the study

As this is a guide for the implementation of a GIS applicable to a generic industry in the metalworking sector and, considering that each industrial company has its own particularities, this study does not detail procedures, instructions or technical specifications related to the standards that are included.

Conflict of interest

There is no conflict of interest in relation to the submitted article.

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