

Health and Safety Management System in Methalmechanic Sector

Jeniffer Gracia^{a*}, Paola Acevedo^b, Ivan Cabeza^{c*}

^aUniversidad Distrital "Francisco José de Caldas", Bogotá, Carrera 7 No. 40B-53, Colombia

^bDepartment of Industrial Engineering, Universidad Cooperativa de Colombia, Bogotá, Avenida Caracas 37-63, Colombia

^cDepartment of Chemical Engineering, Km. 7, Autopista Norte de Bogotá. Chía, Cundinamarca, Colombia

ivan.cabeza@unisabana.edu.co; jgraciar@udistrital.edu.co

The health and safety in the industry integrate procedures, techniques, and elements that can be applied to an organization to identify, evaluate, and control dangerous agents used in processes and activities. In addition, it is used to measure and propose actions for the prevention of incidents or health diseases. The main objective is to save the lives and health of the workers and avoid any possible damage to the company's actives. (Arellano y Rodríguez, 2013). For example, the Colombian company in the metal-mechanic sector studied counts with operational and administrative workers with a Risk Level of three (medium). The company supplies services for the oil sector, specifically in producing and maintaining steel pieces. The main risks in the company are work incidents, extern property damage, and professional diseases.

In consequence, they have a goal to establish procedures for the health preservation of workers and improve corporate image and competitiveness. All the mentioned above is because their clients are essential Colombian companies like CASAVAL and ECOPETROL. Therefore, the main objective of the present research was to design the safety and health management system for an essential Colombian company in the metal-mechanic sector. The aim was to guarantee a healthy team worker with safe work conditions. For it, we used a four steps methodology: the first step consists of SWOT (strengths, weaknesses, opportunities, and threats) analysis, followed by the five forces diagram by Porter, then, we identified the intervention needs for risk prevention using the Colombian Technical Guide CTG 45 norm, and finally, the study established the control, following and evaluation measures for the management system.

The workforce in the company develops their activities under constant noise, vibrations, low luminary, and the exposure of inorganic dust. Additionally, they have contact with shavings, solvents, metals, and daily they work in prolonged postures or make repetitive motions. Also, workers deal with decision-making processes and mental charges (Mancera, et al, 2018; Gracia, et al., 2018). According to the process developed in the company, the present work established different programs for monitoring different aspects: epidemiologic, wellness, auto care, and risk prevention. Furthermore, process, structure, and result indicators were developed to measure the efficiency of the safety management system. These indicators can also identify and execute corrective actions and continuous improvement strategies for no conformity found.

Keywords: Health and safety management systems, Risk management, Risk assessment, Risks prevention.

1. Introduction

The management of occupational safety and health as embodied in ISO 45001:2018 is based on the systems thinking approach applicable to organizations, as assessed by Karanikas et al (2022). According to Çalış and Büyükkakıncı (2019), there is evidence that occupational safety and health management systems for accreditation purposes have been increasing worldwide in response to the large number of occupational accidents occurring in companies. Nowadays, enterprises must take care not only to satisfy and accomplish the clients' requirements but also to be encouraged to fulfill their employees' expectations. There is increasing interest in occupational health and safety management systems in companies and a higher level of training in quality systems (ISO 9001) and the application of environmental management systems (ISO 14001).

Implementing these management systems has shown considerable savings in all types of organizations (Redinger & Levine, 2010). For this purpose, it is crucial to implement management systems to continuously improve the work conditions, safety, risk reduction, and compliance with the norms related to these aspects to avoid penalties and fines (Delvika & Mustafa, 2019). As Stefana and Paltrinieri (2020) point out, in the industry, it is crucial to analyze the risks from the people, the processes, and the physical plant, to detect the dangers and thus recognize the risks and their consequences. According to the study carried out by Santos et al. (2013) and consistent with Vinodkumar y Bhasi (2011), there are different benefits for small companies that implement Occupational Health and Safety Management Systems, among which the following stand out: improvement of working conditions, compliance with regulations and the generation of better internal communication for the worker about occupational risks. In this way, the number of accidents and their associated costs is reduced, thus improving the internal and external corporate image, and increasing the profitability of the companies. There are also other benefits, such as reducing absenteeism and the rate of reported occupational illnesses. (Santos et al, 2013). In addition, the prevention and mitigation of labor diseases and accidents are the responsibilities of the management and employees in an enterprise. That is why enterprises must create, implement, and maintain health and safety management systems to show continuous improvement according to the actual norms for safety and health and contribute to keeping the employers with the best conditions in terms of health and safety.

Furthermore, it is mandatory to implement control measures in each one of the processes in the company that intern, and external organizations will audit to validate the system (Cruz & Mercado, 2015). The case study of this paper is about a company in the metal-mechanic sector in Colombia. The company does not have a health and safety management system implemented. Because of it, it is under vulnerability to risk and safety incidents, damage to the own property, damage to external properties, and present labor diseases. To solve this situation, the company established procedures for maintaining and preserving the worker's health. Also, they want to improve the corporative image and competitiveness to reach new clients like CASAVAL and ECOPETROL, big Colombian enterprises that choose their providers with management systems implemented. For this reason, the objective of this contribution is to illustrate some elements that are part of the design of the Occupational Health and Safety Management System carried out in the metal-mechanical company of the study, which, through its implementation, will allow the company to have a healthy human team in a safe workplace, following current regulations.

2. Materials and methods

The methodology used in the present work has four main steps. The first step is related to the initial diagnostic where the activities developed are: a) Checklist elaboration due visits to the company where it was possible to determine the specific situation in the risk and safety issues. b) Brainstorming to determine the measures for the risk and safe intervention. c) Pareto diagram elaboration to identify the compliance of the requirements for risk and safety issues. d) Interviews with workers of the company to measure the knowledge about the company structure. e) SWOT analysis. f) Porter's five forces analysis. g) Causes tree for the incidents presented in the company. h) Analysis of the documents about risk and safe aspects reviewing the accomplishment with the Colombian norms and laws. The second step consists of formulating the intervention acts for risk and safety management based on the Colombian methodology CTG 45 Icontec. For this purpose, a risk overview and a risk matrix were elaborated to determine the company's level of risk and establish the intervention acts for each risk and safety issue found. In addition, using a cause-and-effect diagram and the 5W2H method was possible to explore the cause-effect issues due to the risks found in the first step and analyze the selection criteria for the interventions proposed. According to the actual norms, the third step was to establish the documentation needed in the risk and safety management system for the case study company. Finally, the fourth step was defining the control measures, the following methods, and the risk and safety management system's evaluation using a matrix with structure, process, and result indicators.

3. Results and Analysis

3.1 Risk and safety diagnostic

After developing the activities for the diagnostic, the results show that the accomplishment level in the metal-mechanical company was 74%. However, regarding the requirements of the norm, the accomplishment percent calculated was 26%.

3.1.1 SWOT analysis

Thanks to the interviews to each one of the employees, the elaboration of a check list and a SWOT analysis was possible to establish and to identify the condition of the enterprise regarding the accomplishment of the

requirements of the norms. Table 1 show the results found in the metal-mechanical company of the study (Górny, 2020).

Table 1 SWOT analysis of the occupational health and safety management system Inducast

<p style="text-align: center;">IFAS</p> <p style="text-align: center;">EFAS</p>	STRENGTHS (S)	WEAKNESSES (W)
	<p>The company has an adequate infrastructure to carry out productive activities.</p> <p>Employees have the necessary protection elements to carry out their work.</p> <p>They have security standards in each of the organization's areas of operations.</p> <p>Employees are trained to carry out their work, as well as in the use of personal protection elements.</p> <p>Willingness and commitment by the organization for the implementation of the occupational health and safety management system.</p>	<p>Personnel not very committed to the use of security elements.</p> <p>Personnel poorly trained in the occupational health and safety management system.</p> <p>Lack of knowledge regarding occupational health and safety issues.</p> <p>Little culture related to safety and health at work.</p> <p>Lack of activities and programs that encourage self-care.</p> <p>Full compliance with the requirements established in the regulations is not evidenced.</p> <p>There is no adequate monitoring of the existing risks in the company, since there are no human resources personnel.</p> <p>Lack of control of occupational risk factors. Bad financial situation.</p>
OPPORTUNITIES (O)	STRATEGIES SO	STRATEGIES WO
<p>To design and implementation of the management system for occupational health and safety.</p> <p>Easy access to information for the implementation of the occupational health and safety management system.</p> <p>The company is on time to improve the safety and health of its workers, and thus reduce costs and gain greater competitiveness.</p> <p>Continuous improvement of the system once it is implemented. Provide quality of working life to company workers.</p> <p>To implement programs that encourage self-care with the help of the Occupational Risk Insurer.</p>	<p>To implement effective and truthful information channels.</p> <p>To carry out preventive maintenance to lathes and machines used daily by workers.</p> <p>To verify that the safety equipment used by the workers is in optimal conditions for its use and protection.</p> <p>To provide elements that can be helpful when taking active breaks such as stress balls.</p> <p>To provide training on safety and health at work.</p>	<p>To carry out workplace inspections at least once a month to keep workers informed of the risks to which they may be exposed.</p> <p>Make employees aware of the importance of the occupational health and safety management system.</p> <p>To start a training program related to safety and health at work.</p> <p>To choose the occupational health and safety watch.</p> <p>Review plan by the watchman that the regulations are being complied with and also the constant and adequate use of PPE.</p>
THREATS	STRATEGIES ST	STRATEGIES WT
<p>Exposure of the worker to occupational hazards.</p> <p>Possible work accidents that can have a high cost for the company.</p> <p>Fine by the entities in charge of controlling the HSMS, after carrying out the respective inspection and surveillance.</p>	<p>Design and implementation of the occupational health and safety management system.</p> <p>Manage hazards and risks, identifying, evaluating and seeking due control over them.</p> <p>Take prevention and control measures.</p> <p>To take actions so that the HSMS is executed and fully comply with the requirements established in the regulations.</p>	<p>To design and implement an emergency plan.</p> <p>To design methods for hazard identification and risk assessment.</p> <p>To train workers regarding the risks to which they are subjected on a daily basis in the area where they work.</p>

3.2 Labor risk analysis and formulation of control measures

Using the results obtained by a risk identification and risk evaluation matrix regarding to the company's activities it was possible to establish the intervention measures to control and minimize the risk type I (non-acceptable) and II (acceptable under specific control) evaluated. With these intervention measures, the company can prevent incidents and labor diseases affecting the workers and the organization. Figures 1 and 2 show the graphic resume of the qualitative evaluation performed according to the CTG 45 norm and classified by productive processes and administrative procedures (Walker, D. Tait, R., 2004).

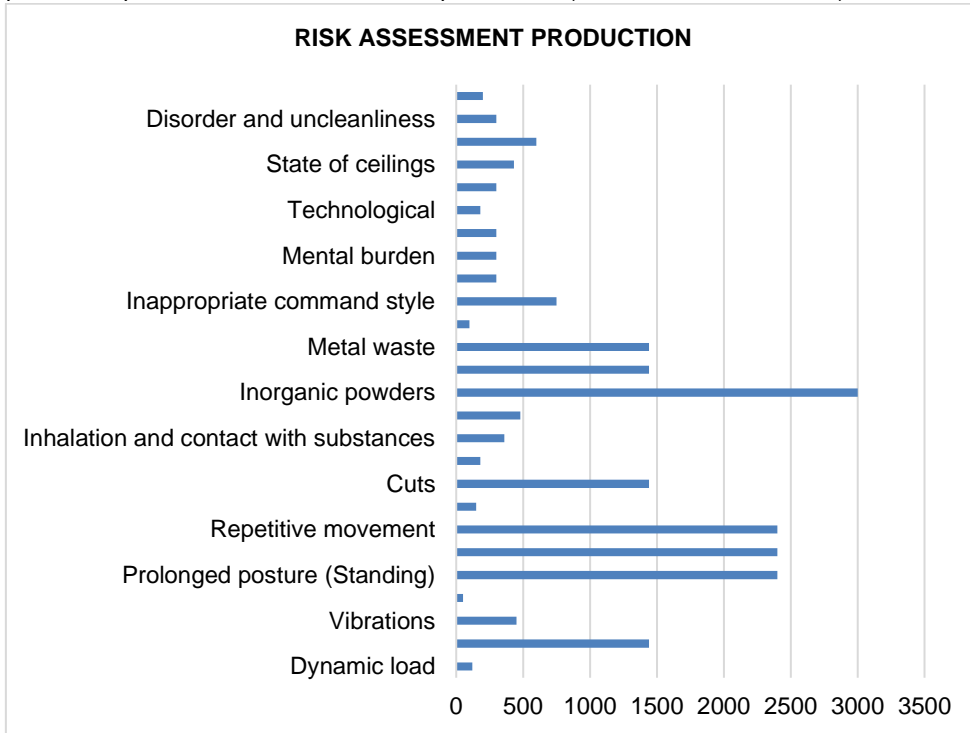


Figure 1 Risk Analysis in Inducast's production process using CTG 45 methodology

The workers of the operative area are under exposition to continuous noise, vibrations, and inorganic dust generated by the equipment. Also, they work without enough light and contact residues, solvents from the cleaning operations, and metals. In addition, they expressed that the head of the area generates stress in labor (Zhang, et al., 2010).

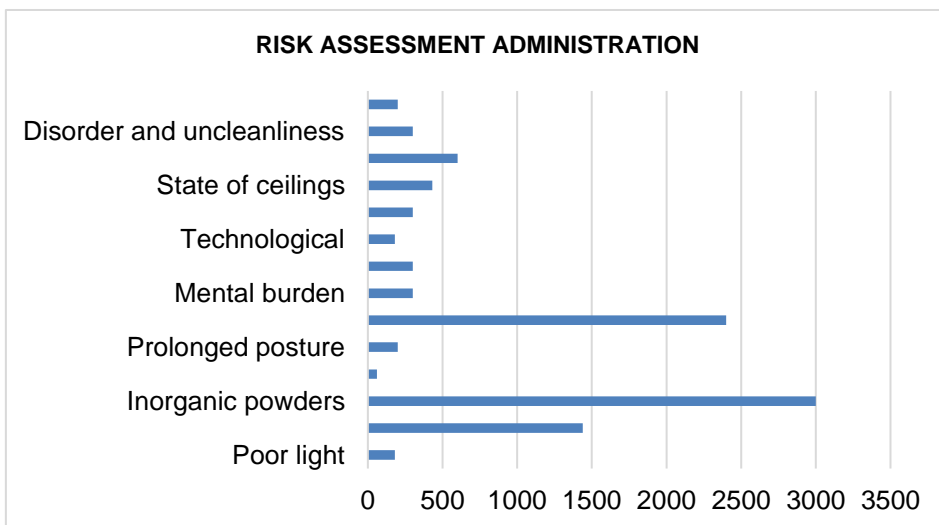


Figure 2 Risk Analysis in Inducast's administration process using CTG 45 methodology

Regarding the administrative area, the light is insufficient, and there is continuous noise and expositions to organic dust. The workers in the area are in the same posture for a long time and must do repetitive movements. In addition, the activities developed by them are for decision-making and with a high load of mental activities, representing psychological risk. Once the main labor risk in the company was determined, it was possible to carry a cause-effect analysis using Ishikawa methodology.

3.3 Analysis of the continuous improvement plan

The number of items regarding the risk for safety and health care in the company found were eight: constant noise exposition, prolonged postures, physic effort, repetitive movements, cuttings, inorganic dust presence, inadequate management of the task and, stairs without maintenance. Since all these items cause damage to the health of the workers was necessary to formulate improvements for each one (Tudoran, et al., 2020) considering the 5W2H methodology.

The production area is higher risk because the main items are related to the machinery used in the manufacturing processes: manual lathe, CNC lathe, cutter, etc. Using these types of equipment produces discomfort to the workers that can cause diseases in the long term if there is no control in the operational activities. For the item of constant noise, the development of an auditive program where the employers receive capacitation to create conscience about the risk and how to prevent it. In the case of prologued posture at the operative area, the solution proposed is the creation of programs for wellness and active pauses for the management, measure, and control of the risk associated with this item.

In the production area, the workers require to make physical efforts to manage the raw materials and products. To do this movement, it is necessary that workers conserve a good posture and that they have the equipment required to do these operations. The production in the company is continuous, so the procedures to elaborate the different pieces are almost the same, and the workers must do repetitive movements that generate pain, diseases, and some accidents. To decrease the risk level, the company must reserve enough space and pause active programs to reduce the health issues.

The machines and tools used by the workers can be dangerous if safety measures are not considered and workers do not use the protection elements needed. To avoid cuttings and hits is mandatory to give workers all the tools needed. Due to the type of operations developed in the company, the production area generates inorganic dust that affects workers' health. To reduce this risk, the company organizes informative talks to teach all the people how they can avoid the exposition and the importance of using masks to prevent diseases. The stairs located in the company's production area are not in good condition, so in the action plan, the suggestion to repair it was included.

The company is looking to have a safe and healthy environment for the workers and better work wellness for operative and administrative. That is why they have the compromise to do all the necessary stuff to solve all the items identified following educational programs and the continuous improving thinking.

4. Conclusions

The study used different tools and techniques to identify, solve and monitor the health, risk, and safety issues in a company in the metal-mechanical sector. The results of the risk panorama elaborated using the CTG 45 methodology, the Ikishawa diagrams, and the 5W2H analysis helps us to conclude that the health risk is less acceptable and the ones that generate severe health and safety risks are the ones related to continuous noise exposition (by the machinery employed in the production area). This situation is due to the lack of a preventive maintenance program and the raw materials used in the production process like metals that need machinery highly dangerous and with a high probability of generating cuts in arms and legs.

Furthermore, the risk of losing an arm or a leg is high due to the direct contact with the residual streams like shavings. The programs developed are epidemiologic care, hearing loss, active pauses, solid management, stress management, protection elements, wellness, personal care, prevention of accidents and incidents, procedures, formats, and instructions for health, risk, and health. All the documents consider the activities developed in the company to demonstrate the existence of HSMS and the accomplishment of law requirements. Finally, for the company, it is essential to give a safe and healthy work environment, and because of that, it is committed to implementing the operative and administrative changes included in the continuous improvement plan developed. The plan contains the measures, reduction, and following steps of the issues found.

Acknowledgments

Authors acknowledge to managers and employees of the metal-mechanical company in this study.

References

- Arellano D.J., Rodríguez C. R., 2013, Salud en el trabajo y seguridad industrial, Alfaomega.
- Çalış S., Büyükkakıncı B., 2019, Occupational Health and Safety Management Systems Applications and A System Planning Model, *Procedia Computer Science*, 158,1058-1066
- Cruz I., Mercado R., 2015, Occupational Safety and Health in Peru, *Annals of Global Health*, 81, 4, 568-575.
- Delvika J., Mustafa K., 2019, Evaluate the Implementation of Occupational Health and Safety (OHS) Management System Performance Measurement at PT. XYZ Medan to minimize Extreme Risks, *IOP Conf. Series: Materials Science and Engineering*, 505.
- Górny A., 2020, Guidelines for the Use of Quality Engineering Tools to Improve Occupational Safety. The Case of Polish Construction Companies, *Occupational and Environmental Safety and Health II*, 277, 31-39
- Gracia J., Lara L., Quintero P., Santis A., 2018, Formulation of Strategies for the Implementation of Integral Management System Based on ISO 9001:2015 and 14001:2015 in the Company Surtiapiques (Bogotá-Colombia), *Chemical Engineering Transactions*, 67, 559-564.
- Karanikas N., Weber D., Bruschi K., Brown S., 2022 Identification of systems thinking aspects in ISO 45001:2018 on occupational health & safety management, *Safety Science*, 148, 1-12
- Mancera F.M., Mancera R.M., Mancera R.R., Mancera R.J., 2018, Seguridad y salud en el trabajo. Gestión de Riesgos., Alfaomega production, *Journal of Cleaner Production*, Vol 247,20
- Santos G., Barros S., Mendes F., Lopez N., 2013, The main benefits associated with health and safety management systems certification in Portuguese small and medium enterprises post quality management system certification, *Safety Science*, Vol 51,1, 29-36.
- Stefana E., Paltrinieri N., 2020, Integration Between Occupational and Process Safety: Existing Approaches and Challenges for an Enhanced Framework, *Chemical Engineering Transactions*, 82, 31-36.
- Redinger Ch., Levine S., 2010, Development and Evaluation of The Michigan Occupational Health and Safety Management System Assessment Instrument: A Universal OHSMS Performance Measurement Tool, *American Industrial Hygiene Association Journal*, 59,8, 572-581.
- Vinodkumar M., Bhasi M., 2011, A study on the impact of management system certification on safety management, *Safety Science*, Vol 49,3, 498-507
- Walker D., Tait R., 2004, Health and safety management in small enterprises: an effective low-cost approach, *Safety Science*, Vol 42,1, 69-83
- Zhang M., Qi C., Chen W., Lu Y., Du X., Li W, Meng C., 2010, Re-analysis of occupational hazards in foundry, *Chinese Journal of Industrial Hygiene and Occupational Diseases*, Vol 28,4, 280-285.
- Tudoran V., Marin C., Condrea E., 2020, Corrections and corrective actions – instruments for the continuous improvement of a management system, *Management and Leadership, Strategica*, 275-287