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Reduction of the rate of accidents at work through the implementation of an Occupational Safety and Health Management System (OSHS) in the industrial electromechanical industry.

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Accidents at work in industry are important factors that must be addressed. They often occur because of the lack of a management system in place. In the electromechanical industry it requires the observance of these procedures because it is an activity where many equipment and mechanical tools are employed and operators must comply with established protocols so that regrettable accidents do not happen. The research aimed to reduce the rate of occupational accidents of employees of an industrial electromechanical company through the implementation of a Management System of Safety and Health at Work. The method consisted of identifying the probable causes of accidents at work for 10 weeks. A new Occupational Safety and Health Management System was proposed and implemented taking into account 5 phases: policy, scope, planning, implementation and verification. As a result, after implementation, there was a reduction in occupational accidents of about 87.5% (from 8 accidents to 1). This also confirms the need to manage the activities in a company in order to establish normality in the productive processes and guarantee the health of workers.

* 1. Introduction

Responsible companies base their activities on a good performance of their employees and to achieve these objectives one aspect is the well-being of the people who work in it, especially those related to not suffering accidents at work resulting in delays in productive activities because of social, human and economic cost they represent to the organization (ILO, s. f.). The metal industry due to the nature of their activities has a considerable rate of accidents at work due to the failure to implement a management system for safety and health at work (SGSST). In Peru, for September 2021, it was reported 11 fatal accidents, 2184 accidents at work, 62 dangerous incidents and 8 occupational diseases to the Ministry of Labour (MTPE, 2021).

In the world, according to a study by the World Health Organization (WHO) in conjunction with the International Labour Organization (ILO), work-related diseases and injuries caused 1.9 million deaths between 2000 and 2016; the main factors are: exposure to long working hours and workplace exposure to air pollution, asthmagens, carcinogens, ergonomics risks, and noise (Diaz Dumont et al., 2020).

Many companies support the implementation of these systems because of legal, economic and benefits of a good image for the organizations (Gadea García, 2016), also the improvement of the corporate as a socially responsible company that seeks sustainable human development for the improvement of the quality of life of workers. (López, 2016). On the other hand, occupational safety management systems are implemented in many different industries such as dairy, among others (Montano Angie et al., 2020).

* 1. Methodology

The research consisted of a basic evaluation of the way as occupational safety and health activities of a company were managed in the area of industrial electromechanics making a register of accidents at work that occurred in 10 weeks. Subsequently, the same evaluation was carried out in a second phase, after the implementation of an Occupational Safety and Health Management System (OSHS) and the improvement in management was evaluated.

2.1 Indicators:

**Occupational Health**: It was evaluated with the indicator of occupational medical examinations (IEO), Eq(1) was used.

$IEO=\frac{Number of occupational medical examinations performed \* 100}{Number of occupational medical examinations scheduled in 10 weeks}$ Eq(1)

* **Planning**: Taking into account the hazard identification and risk assessment (IIPER) indicator, Eq(2) was used.

$IIPER=\frac{IPER N°made\*100}{IPER N°programmed in 10 weeks}$ Eq(2)

* **Implementation and decision-making**: The indicator training in the company was considered. Eq(3) was used .

$x=\frac{Hours of effective training\*100}{Total training hours scheduled in 10 weeks}$ Eq(3)

* **Monitoring**: It was evaluated with the indicator of inspections carried out (IM), Eq(4) was used.

$IM=\frac{Numbers of inspections\*100}{Number of inspections scheduled in 10 weeks}$ Eq(4)

* **The Audit:** The rate of audits performed was determined, Eq(5) was used.

$IA=\frac{Number of audit made\*100}{Planned audits (HODELPE) in 10 weeks}$ Eq(5)

2.2 In assessing accidents at work, the following were taken into account:

Temporary disability accidents: Determined by the number of accidents occurring after 10 weeks of evaluation.

Accident frequency (AF): measured by the accident frequency index, Eq(6) was used.

$AF=\frac{Number of registered accidents\*100}{Number of hours worked in 10 weeks}$ Eq(6)

The study population corresponded to the 20 people who work in a company of the category of industrial electromechanical service, whose main activities are to manufacture of mechanical parts, metal structures, helical threads, CNC lathe service, CNC machining center and related services for the industrial, metallurgical, mining, construction and boiler-making sector.

* 1. Results

**3.1 Occupational Safety and Health Management System (OSHS):**

The information based on the indicators collected before and after the implementation of the proposal for a new Occupational Safety and Health Management System (OSHS) is presented, taking into account the following dimensions and indicators:

* Occupational Health:

Table 1 shows the indicator of compliance of occupational medical examinations before (during the months of August, September, October and November 2017) and after the launch of the OSHS from February to April 2018) during the 10 weeks of study, with 100% compliance for the stage after the implementation of the OSHS proposal, compared to 0% before.

* Planning:

Regarding the process of identifying hazards and risks of the company’s activities through the formulation of the IPER matrix, with the application of the GSS this aspect was improved, from 39.61% to 86.54% compliance. Details for a 10 weeks period of evaluation is presented in Table 1.

Table 1 Compliance with Occupational Medical Examinations and identification of hazards and risks before and after the implementation of the OSHS

|  |  |  |
| --- | --- | --- |
|  | Before (August, September, October, November 2017) | After(February, March, April 2018) |
| Dimensions SGSST | Weeks | Made (Nro) | Planned (Nro) | Indicators | Weeks | Made (Nro) | Planned (Nro) | Indicators |
| Occupational Health:Compliance with Occupational Medical Examinations | 10 | 0 | 10 | IEO: 0% | 10 | 20 | 20 | IEO: 100% |
| Planning:Hazard Identification and Risk Assessment | 10 | 61 | 154 | IIPER:39.61% | 10 | 135 | 156 | IIPER:86.54% |

* Implementation and decision-making:

An important factor in occupational safety and health management is the training of workers to take responsibility for their work by taking care of their physical and mental integrity. In this sense, the fulfillment of hours of training before and after the implementation of a proposed new OSHS was evaluated. The results are shown in Table 2 and Table 3, where it is observed that compliance with this indicator was improved, being from 52.78% to 96.43% the increase in trained workers and from 53.66% before and 96.77% after for the number of hours spent in this activity.

Table 2 Training of personnel prior to implementation of the OSHS

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Time(August to November) | Number of partners trained | Number of partners programmed for training | Training rate | Training hours | Scheduled hours of training | Training Hours rate |
| 10 weeks | 38 | 72 | 52.78% | 88 | 164 | 53.66% |

Table 3 Staff training after OSHS implementation

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Time (February to April) | Number of partners trained | Number of partners programmed for training | Training rate | Training hours | Scheduled hours of training | Training Hours rate |
| 10 weeks | 81 | 84 | 96.43% | 180 | 186 | 96.77% |

* Inspections and Monitoring

Inspections were scheduled to verify compliance with OSHS -mandated activities. Table 4 shows the results of compliance with inspections and monitoring carried out in the 10 weeks before and then in the 10 weeks after the implementation of the OSHS. The comparison indicates that an improvement in this aspect was obtained of 59.71% before to 97.44% after.

* Audit

Internal audit is an essential activity in an OSHS. Table 4 shows the level of compliance in 10 weeks before with 33.33% and after the implementation of the SGSST with 100%.

Table 4 Comparison of inspection compliance and monitoring and Audits before and after implementation of the OSHS

|  |  |  |
| --- | --- | --- |
|  | Before (August, September, October, November 2017) | After(February, March, April 2018) |
| Dimensions del SGSST | Weeks | Made (amount) | Planned (amount) | Indicator’s compliance | Weeks | Made (amount) | Planned (amount) | Indicator’s compliance |
| Occupational Health: compliance with inspections and monitoring | 10 | 163 | 273 | IM59.71% | 10 | 266 | 273 | IM:97.44% |
| Audit: compliance with audits | 10 | 1 | 3 | IA:33.33% | 10 | 3 | 3 | IA:100% |

The Inspection and Monitoring Program after the implementation of the OSHS was shaped by the activities shown in Table 5.

*Table 5 Inspection and monitoring program after* OSHS *implementation*

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **OBJECTIVE** | **ACTIVITY** | **DETAIL** |  **STAFF INVOLVED** |  | **SCHEDULE** |  |
|  | **2017** | **2018** |  |
|  | **Aug** | **Sept** | **Oct** | **Nov** | **Dec** | **Jan** | **Feb** | **Mar** | **April** | **May** | **Jun** | **Jul** | **Total** | **REAL%** |
| Verify compliance with standards, procedures and controls required to strengthen the safety and health system and achieve the objectives set | Internal audit | Audit will be conducted | Semisa Company personnel | P |   |   |   |   |   |   | x | x | x |   |   |   | 1 | 100% |
| E |  |  |  |  |  |  | x | x | x |  |  |  | 0 | 0% |
| External audit | Audit will be conducted | OSH Supervisor and Company personnel | P |  |  |  |  |  |  | x |  |  |  |  |  | 1 | 100% |
| E |  |  |  |  |  |  |  |  |  |  |  |  | 0 | 0% |
| Physical Agent Monitoring: Noise | To carry out at the factory´s facilities | Semisa Company personnel | P |  |  |  |  |  |  |  |  |  |  |  |  | 1 | 100% |
| E |  |  |  |  |  |  |  |  |  |  |  |  | 0 | 0% |
| Physical Agent Monitoring: Luminosity | To carry out at the factory´s facilities | Semisa Company personnel | P |  |  |  |  |  |  |  |  |  |  |  |  | 1 | 100% |
| E |  |  |  |  |  |  |  |  |  |  |  |  | 0 | 0% |
| Monitoring of Chemical Agents | To be carry out at the factory´s facilities | Semisa Company personnel | P |  |  |  |  |  |  |  |  |  |  |  |  | 1 | 100% |
| E |  |  |  |  |  |  |  |  |  |  |  |  | 0 | 0% |
| Psychosocial Risk Monitoring | To carry out at the factory´s facilities | Semisa Company personnel | P |  |  |  |  |  |  |  |  |  |  |  |  | 1 | 100% |
| E |  |  |  |  |  |  |  |  |  |  |  |  | 0 | 0% |
| Monitoring of Disergonomic Risk  | To carry out at the factory´s facilities | Semisa Company personnel | P |  |  |  |  |  |  |  |  |  |  |  |  | 1 | 100% |
| E |  |  |  |  |  |  |  |  |  |  |  |  | 0 | 0% |
| Equipment Inspections, Machines, Tools | Monthly inspections  | Semisa Company personnel | P |  |  |  |  |  |  |  |  |  |  |  |  | 1 | 100% |
| E |  |  |  |  |  |  |  |  |  |  |  |  | 0 | 0% |
| Inspections of lift elements (25) | Monthly inspections  | Semisa Company personnel | P |  |  |  |  |  |  | x | x | x |  |  |  | 3 | 100% |
| E |  |  |  |  |  |  | x | x | x |  |  |  | 3 | 100% |
| Control of fire extinguishers (13) | Monthly inspections  | Semisa Company personnel | P |  |  |  |  |  |  | x | x | x |  |  |  | 3 | 100% |
| E |  |  |  |  |  |  | x | x | x |  |  |  | 3 | 100% |
| Work stations | Monthly inspections  | Maintenance personnel | P |  |  |  |  |  |  | x | x | x |  |  |  | 3 | 100% |
| E |  |  |  |  |  |  | x | x | x |  |  |  | 3 | 100% |
| Warehouse | Monthly inspections  | Maintenance personnel | P |  |  |  |  |  |  | x | x | x |  |  |  | 3 | 100% |
| E |  |  |  |  |  |  | x | x | x |  |  |  | 2 | 100% |
| Administrative Ofices | Monthly inspections  | Office Staf | P |  |  |  |  |  |  | x | x | x |  |  |  | 3 | 100% |
| E |  |  |  |  |  |  | x | x | x |  |  |  | 3 | 100% |
| Inspection of personal safety equipment (20) | Monthly inspections  | Maintenance personnel | P |  |  |  |  |  |  | x | x | x |  |  |  | 3 | 100% |
| E |   |   |   |   |   |   | x | x | x |   |   |   | 3 | 100% |

3.2 Accidents at works

The results measured around this variable were taking into account accidents with temporary disability and permanent disability.

***Accidents of temporary disability***:

Table 6 shows that before the proposed OSHS was implemented in the 10 weeks of monitoring, there were 8 accidents with temporary incapacity of workers; Also, after the implantation of the OSHS, only 1 accident occurred. The frequency that they mean is also present. It is found that an initial accident frequency of 0.0741% is reduced to 0.009% (reduction of 87.50%).

Tabla 6 Accidents with temporary disability before and after OSHS implementation

|  |  |
| --- | --- |
| Before | After |
| Time(August to November 2017) | Number of accidents with temporary incapacity | Frequency of accidents with temporary incapacity (AF) | Time(February – April 2018) | Number of accidents with temporary incapacity | Frequency of accidents with temporary incapacity (AF) |
| 10 weeks | 8 | 0.0741% | 10 Weeks | 1 | 0.009% |

3.3 Implementation of Occupational Safety and Health Management System (OSHS) proposal

The proposed improvement of the OSHS that was implemented in the company that resulted in the reduction of accidents at work, followed the guidelines of the company Homologations of Peru that can be found in its homologation platform. Table 7 shows the activities programmed in the system that were developed from August 2017 to May 2018.

Table 7 Planned and implemented activities of the GSS proposal

|  |  |
| --- | --- |
|   | **ACTIVITIES** |
|   | **POLITICS** |
| 1 | Development of occupational safety and health, quality and environmental policies |
| 2 | Communicate the policy to each of the operators and exhibit it |
|  | **SCOPE OF THE SYSTEM** |
| 3 | Develop formats to be used in the OSH Management System |
|  | **PLANNIG** |
|  | Linea Base Study |
| 4 | Conduct the baseline study of the OSH Management System |
|  | Hazard Identification and Risk Assessment |
| 5 | Develop the procedure and methodology for developing the IPER |
| 6 | Develop IPER for all jobs and work areas |
| 7 | IPER records are related to the activities carried out at the premises of the Romero Group companies |
| 8 | Develop the Risk Maps |
| 9 | Publish the Risk Maps in each area of the company |
|  | Objectives, Targets and Programmers |
| 10 | Define objectives and goals in the OSH Management System |
| 11 | Publish objectives and targets in the OSH Management System in a visible place |
| 12 | Develop an Annual Programmer for Safety and Health at Work |
|  | **IMPLEMENTATION AND OPERATION** |
|  | Resources, Functions, Responsibility and Authority |
| 13 | To elaborate an Organigram |
| 14 | Develop a Job Manual for all jobs |
| 15 | Appoint an Employer Representative for the development, implementation and monitoring of SGSST results |
| 16 | Appoint a Security Supervisor |
|  | Competence, Training and Awareness |
| 17 | Develop an Annual Training and Training Program |
| 18 | Develop an induction plan for new staff |
|  | Communication, Participation and Consultation |
| 19 | Develop a means to ensure communication between staff and management |
| 20 | Provide workers with their PPE according to the work they do |
| 21 | Provide workers with their work uniforms |
|  | Documentation |
| 22 | Develop the SGSST Handbook |
| 23 | Develop OSH Rules of Procedure |
| 24 | Prepare a Register with the charges of delivery of the Internal Regulations of SST to the workers |
|  | Operational Control |
| 25 | Developing rules governing the conduct of workers |
| 26 | Develop working procedures and instructions |
| 27 | Perform pre-use inspections on critical equipment |
| 28 | Having SCTR with both coverages |
| 29 | Develop Risk Work Analysis (ATR) and Safe Work Analysis (ATS) procedures |
| 30 | Develop a Procedure for the Safe Management of Chemical Substances |
|  | Emergency Preparedness and response |
| 31 | Define contingency plans for each potential emergency |
| 32 | Organize Brigades to address potential emergencies |
| 33 | Procure security equipment to meet a potential emergency |
|  | **VERIFICATION** |
|  | Monitoring and measurement |
| 34 | Assessing management performance against OSH objectives |
| 35 | Develop safety and health statistics |
|  | Assessment Legal compliance |
| 36 | Verify legal compliance, whether staff are on the payroll or by contract |
|  | **Inspections** |
| 37 | Conduct safety inspections |
| 38 | Record the monitoring of physical agents (noise, temperature, luminosity, humidity. Etc.) |
| 39 | Develop a chemical agent monitoring registry |
| 40 | Develop a biological agent monitoring register |
| 41 | Develop a psychosocial risk factor monitoring registry |
| 42 | Develop a monitoring record of Risk Factor Disergonomic |
| 43 | Have the Calibration Certificates of the work equipment |
|  | Occupational Medical Evaluations (EMO) |
| 44 | Conduct an occupational health screening programme |
| 45 | Perform occupational medical examinations |
| 46 | Handing out occupational medical exams to workers |
| 47 | Prepare aptitude reports |
| 48 | Take into account aptitude reports for assigning tasks to staff |
|  | **Audit** |
| 49 | Develop an audit procedure |
| 50 | Run an External Audit |
|  | Accidents investigation |
| 51 | Prepare Register of Occupational Accidents and Diseases |

4. Discussion

The results of the evaluation before and after the implementation of a System of Safety and Health at Work (SGSST) allowed to improve the indicators of training of workers in personal safety issues within their work and operation of the company, which led to improving the productivity of the company, in addition to complying with the country’s regulations (Law 29783 and amending Law 30222). This is a strategy of companies to improve their visibility and confidence to their potential consumers, selling the image of responsible company with their collaborators and that in practice brings benefits in improving their processes and compliance with standards such as ISO 45001 (Castiblanco et al., 2020). For a proper implementation of a SGSST, the managerial commitment, participation of all the staff of the organization, diagnosis and planning, continuous improvement and monitoring and measurement must be taken into account (Lopez, 2016).

The study identified that compliance with planned programs within a management system is very important, the commitment of those administering the system is fundamental to the success of a management system for the safety and health of workers; Also descriptive retrospective studies-Analytic help to realize an efficient baseline to then implement the management system with the relevant improvements that result in a significant decrease of occupational access, problems are overcome by ergonomic and mechanical factors, among others (Karimi et al., 2020)

The most important aspect of the study was the decrease in the cases of accidents with work incapacity of the workers of this company in the category of industrial metallurgy, reducing this indicator from 8 cases to a single case for the same evaluation period (10 weeks) before and after the introduction of a new Occupational Safety and Health System. This is due to the continuous improvement of the way in which activities related to work and working conditions were managed, such as the use of protective equipment, awareness of hazards and risks when promptly identified, training, inspections and monitoring of compliance with safety standards. Thus, in Korea, a study showed similar results in companies that implemented the KOSHA 18001 system by lowering their accident rate compared to companies that did not (Kim, 2021).

* 1. Conclusion

The implementation of a Management System for Safety and Health at Work allowed to the company to reduce the frequency rate of accidents with work incapacity by 87.5%. In addition, a good management reduces the absenteeism of workers due to illnesses acquired in the course of their activities, avoids financial penalties for non-compliance with legal standards and generating economic benefits and responsible corporate image.

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