Procedure for the ergonomic risks management, with a process approach, in organizations

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Abstract

Ergonomics is the science that studies the system integrated by the worker, the production means and the work environment, so that the work is efficient and appropriate to the psycho-physiological abilities of the worker, promoting their health and achieving their satisfaction (Viña, 1985). In Cuba there is an increase in the number of occupational accidents and diseases, and although there are no official data indicating a cause-effect relationship between these events and ergonomic risks, it is verified, in studies carried out, that these risks are not identified and have a high impact on the health and safety of workers. The ergonomic risk is the correlation between the probability of occurrence of adverse events and the severity of the effect on the worker, the organization and the environment, by the action of the hazards that limit the system worker-production means-labor environment (W-MP-E). Therefore, the objective of the paper is to design a procedure for the ergonomic risks management, with a process approach, in organizations. The procedure follows the logic of the management cycle, allows the detection, evaluation and control of risks in the system W-MP-E, and proposes techniques and methods for this.

Keywords
Ergonomic risks, process approach management

1. Ergonomic risks management

1.1 Critical analysis of procedures consulted aimed at investigating ergonomic risks

The critical review developed to 16 procedures aimed at the ergonomic risks investigation[1] allowed to analyze the advances in the investigation of these risks and detect methodological limitations. The study of the bibliography confirmed the validity and importance of the ergonomic risks investigation, as well as, of designing procedures that permit the investigation of the ergonomic risks in Cuban and international organizations. Through an analysis of the consulted procedures, limitations were detected, which are listed below.

1. The 75% do not adopt the systemic approach in the identification, evaluation and control of ergonomic risks, since they do not execute an analysis as a system of the interactions worker-production means-work environment in the organization processes, as well as, the relationships between each of the processes.
2. The 90% do not adopt the process approach in the ergonomic risks identification, because they do it by departments or workstations, and do not study the input and output elements, as well as, the interrelationships between the activities, aspects that may cause the appearance of ergonomic risk factors, for the process studied, and for the rest related to it.
3. The 90% do not propose a specific procedure for the ergonomic risks evaluation, taking into account the occurrence probability of occupational accidents, incidents and diseases, due to the materialization of these risks, and the severity of the consequences on the worker, the organization and the environment.
4. The 90% do not follow the logic of the management cycle in the identification, evaluation and control of these risks, because it does not establish activities for planning, organization, execution and control. They also propose insufficient identification techniques, where the ergonomic risk factors least studied are: angular velocity and acceleration, the duration and lack of adequate rest periods, stressful psychosocial factors, application of forces, mechanics, deficient work with data display screens and incorrect design of the work media and objects. Furthermore, it is not defined the creation of a work team, the responsibilities assignment for the work team, the definition of objectives, the determination of material and economic resources, and the workers participation in the identification and evaluation of ergonomic risks, that inhibits the development of a safety and prevention culture.
5. The 95% do not provide a general assessment of the ergonomic risks management status in the organization, based on the evaluation of the ergonomic risks identified.

These limitations are improvement gaps in the ergonomic risks management and laid the foundations for the design of the procedure for the ergonomic risks management, with a process approach, in organizations.

1.2 Procedure for the ergonomic risks management, with a process approach, in organizations

The procedure is structured in three stages, 8 steps and 14 tasks aimed at the identification, evaluation and control of ergonomic risks, with a process approach, in organizations. The stages and steps of the procedure are described below.

STAGE 1. Planning and organization of the identification, evaluation and control of ergonomic risks

Objectives: To prepare the conditions for the execution of the identification, evaluation and control of ergonomic risks and familiarize the work team with the organization object of study.

Responsible: Human Capital Director and Occupational Health and Safety (OHS) Specialist.

Methods and techniques: direct observation, documentary review, interviews and polls.

Below are the steps that integrate the stage, where the step two is optional if the work team has a vast professional experience in the organization.

Step 1. Establishment of the premises

Objectives: To fulfill the premises defined as indispensable for the execution of the ergonomic study.

[1] National Institute for Safety and Hygiene at Work, 2002; Department of Labor of Catalonia, 2006; Ramos, 2007; Real, 2011; Rodríguez, 2011; Torres, 2011; Jiménez, 2011; Ramírez, 2011; Moreno, 2011; Castillo Rosal y Anglés Peña, 2012; Luque, et al., 2013; Acuña, et al., 2013; Valencia Institute for Safety and Health at Work, 2013; Palacios, 2015; Águila, 2015; Montalvo, et al., consulted 2015; Villar, consulted 2015

Five premises are defined, becoming tasks in the procedure to achieve their fulfillment, essential to guarantee the commitment of the strategic apex and the workers.

1.1 Communication and approval of the ergonomic study by the board of director

Objectives: To communicate and approve the execution of the ergonomic study by the board of directors.

Method: present the ergonomic study proposal on the board of directors and explaining the ergonomic risks management procedure.

1.2 Creation of the work team and assignment of the responsibilities

Objectives: To create a work team, integrated by internal and external experts to the organization, and to assign the responsibilities of each member of the team.

Techniques: interviews, surveys to determine the coefficient of expert's competence, among others.

One of the criteria that must be taken into account for the selection of experts is that they have knowledge in OSH, Ergonomics, Psychology and Work Hygiene, among other disciplines.

1.3 Definition and approval of the ergonomic study objectives

Objectives: To define and approve the ergonomic study objectives by the work team.

Techniques: work in groups, brainstorm, weighted vote, Kendall method, among others.

1.4 Communication of the ergonomic study objective to workers

Objectives: To communicate and explain to workers about the objectives and importance of carrying out the ergonomic study in the organization.

Method: morning meetings, union meetings and newsletters.

1.5 Evaluation and acquisition of the resources for the ergonomic study

Objectives: To establish the material, economic and technological resources necessary for the ergonomic study execution.

Method: group work, brainstorming and analysis of the OHS budget.

Step 2. Characterization of the organization

Objectives: To describe the organization, from the analysis of the system W-MP-E elements, and familiarize the experts with the entity.

Responsible: work team

Techniques: documentary review, interviews and direct observation.

The description of the organization includes elements, such as, identity, subordination, location and social purpose. It must study about human capital its composition by age, sex and occupational level, also, labor satisfaction, fluctuation and productivity. In addition, work means technical condition, and it should be reviewed previous work environment studies. In more detail, the following elements should be studied:

2.1 Description of the organization processes

Objective: To describe the processes by its classification in strategic, operational and support.

Techniques: documentary review (process map, deployment and tab) and interviews.

2.2 Analysis of the legislative, regulatory and regulatory framework of the organization

Objective: To study the legal, regulatory and regulatory framework that rules the organization.

Techniques: documentary review and interviews.

The legislation and regulations effective in the organization must be analyzed in relation to Human Capital, Quality, OHS and Environment. Also know if the entity has implemented or certified a Management System of Quality, OHS

and/or Environment, or if it is a goal of the organization, among other aspects that are considered of interest by the work team.

2.3 Analysis of the documented information in OSH

Objective: To study the information in OHS, provided by the interested parties, to know the organization historical behavior in this aspect.

Techniques: documentary review and interviews.

Some of the elements to study are explained below.

- Work accidents and incidents: to review the work accidents investigations to identify if their causes are due to ergonomic risks, and in the same way, the work incidents reports.
- Previous occupational risks studies: to analyze the information coming from the application of procedures aimed at the management of occupational risks, and determine the identified risks and techniques applied.
- Occupational and common morbidity: to study the illnesses suffered by workers, specifying the work activity in which they perform, appearance date, recovery period, and if they constitute an occupational disease, according to the current legal framework, from the study of medical certificates, pre-employment and periodic medical check-ups.
- Job satisfaction: to analyze the results of studies of job satisfaction, analyzing the satisfaction with working conditions and work activity, interpersonal relationships, etc.,
- Audits and inspections: to study the OSH audits and inspections results, which will assess the historical behavior of the organization, and identify which were the remarks and know if they were eradicated, or advances achieved in this regard.

STAGE 2. Execution of the identification and evaluation of ergonomic risks

Objectives: To identify and evaluate the ergonomic risks in the processes object of study.

Responsible: work team

Techniques: to the ergonomic risks identification are proposed checklists, interviews, questionnaires, direct and photographic observation, documentary review and ergonomic evaluation methods. To the risk evaluation is proposed a procedure, adapted from Resolution 31/2002 of the Ministry of Work and Social Security of Cuba (repealed) and the methods of William T. Fine and Richard Pickers.

Below are explained each of the steps that integrate the stage.

Step 3. Selection and characterization of the process object of study

Objectives: To select and characterize the processes object of the study.

Techniques: documentary review, weighted vote and Kendall method.

The selection will be developed through the analysis of a criteria group, and the characterization considering the elements that integrate the system W-MP-E.

4.1 Selection of the processes object of study

Objective: To select the priority processes, considering the occupational accidents, incidents and diseases number, danger level, meaning for the organization mission achievement, the board of directors and/or workers interests.

Techniques: Kendall method, weighted vote, Paretto analysis, among others.

4.2 Characterization of the processes object of study

Objective: To characterize the processes considering each of the elements that integrates the system W-MP-E.

Techniques: documentary review, interviews, direct observation, among others.

The aspects to be taken into account for the characterization of the process are the following:

- Plant layout processes: to analyze the workspaces and the routes in the processes, techniques such as plan, route and thread diagrams can be used.

- Description of the workstation: taking into account the classification proposed by Marsán (2011) according to the degree of worker's participation, worker's number and their grouping, number of teams that integrates the workstation and specialization and mobility degree.
- Description of the input and output elements of the process, and the transformation, which includes the activities that are executed in it. In addition, identify in the activities the basic work components, which are divided into static and dynamic muscular work.
- Description of human capital: considering the age, occupational category, composition by gender, work experience and seniority in the organization, also job satisfaction level with working conditions, and illnesses suffered.
- Description of the production means: analyze the work media technical state, its use requirements and the effects on the environment. Also, to study of the work objects the handling requirements, physical characteristics, material safety data sheets, hazardous materials inventory (raw materials, semi-finished products, and chemical substances), and other elements.
- Description of the work environment: to measure the lighting and noise level, in addition to study the work microclimate.
- Work schedules implemented, and the distribution of work and rest times.

Step 4. Identification of ergonomic risks

Objective: To identify the ergonomic risks to which workers are exposed.

Techniques: ergonomic checklists, interviews, questionnaires, direct and photographic observation, documentary review and ergonomic evaluation methods.

It consists of studying the interactions in the system W-MP-E in the processes, and identifies ergonomic risk factors because of this.

4.1 Detection of ergonomic risk factors in the processes object of study

Objective: To identify the ergonomic risk factors, to which workers are exposed in the processes, based on the system W-MP-E analysis.

Techniques: checklists, interviews, direct and photographic observation and documentation consultation.

The work positions adopted by the workers should be studied to detect those that impose a static and dynamic overload on the worker. It is important to consider the exposure time to these charges during the working day, for the collection and analysis of information (table 1), obtained from the labor observation.

Table 1. Collection and analysis of postural information on work activity

Process/Work activity:									
No	Tasks	Job positions			Body area	Posture or movement of work	Duration (min)	Classification postures	
		Seated	Sitting up	Standing				Static (> 1min)	Dynamic

In the case that the worker develops the job in a sitting position should be analyzed the seating types adopted by workers in the positions that require it, classified in advanced, average and later position.

4.2 Application of a bipolar checkup for the musculoskeletal symptoms detection

Objective: To analyze the physical health status of workers for the musculoskeletal symptoms detection.

Techniques: questionnaire.

The bipolar check-up of Melo (2009) is a proactive tool for the musculoskeletal symptoms detection, associated with a deficient ergonomic design of the workstation, incorrect work methods, procedures and/or postures. It will be developed through the application of a questionnaire, which will study the pain intensity perceived in different parts of the human body and on both sides (right and left), in three working day moments (start, mid and final) during the work activity execution.

4.3 Application of ergonomic evaluation methods for the ergonomic risk factors identification

Objectives: To select and apply ergonomic evaluation methods for the ergonomic risk factors detection.

Method: ergonomic evaluation methods (RULA, NIOSH, LEST).

The selected ergonomic evaluation methods should be the most effective according to the work activity characteristics developed by the workers.

4.4 Elaboration of the ergonomic risks inventory

Objective: To prepare the ergonomic risks inventory of the processes object of study.

Techniques: group work, documented information analysis, among others.

A model for the elaboration of the ergonomic risks inventory is proposed in the table 2.

Table 2. Model for the elaboration of the ergonomic risks inventory

Process/Work activity:				Execution date:	
No	Description	Ergonomic risk factors	Ergonomic risks	Number of workers	Consequences

Step 5. Evaluation of ergonomic risks

Objective: To evaluate the ergonomic risks identified in the processes object of study.

Method: specific procedure for the ergonomic risks evaluation, explained below.

1. To estimate the occupational incidents, accidents and diseases occurrence probability (P) (table 3) and the consequences severity (C) in the worker, the organization and the environment (table 4).

Table 3. Criteria for estimating the occurrence probability

P	Quantitative assessment	Qualitative assessment
Low	1	Occupational accidents, incidents and diseases will seldom occur
Half	2	Occupational accidents, incidents and diseases will occasionally occur
high	3	Occupational accidents, incidents and diseases will always occur

Source: adapted Resolution 31/2002 of the Work and Social Security Ministry of Cuba (repealed)

Table 4. Criteria for estimating the consequences severity

C	Quantitative assessment	Qualitative assessment
Slightly harmful	1	Physical and mental injuries without sick leave, such as physical fatigue, discomfort, muscular pain, eyestrain and others. There is no deterioration to the environment or significant economic and material damage.
Harmful	2	Physical and mental injuries with temporary sick leave (from 1 to 5 months) and the appearance of non-fatal occupational diseases, such as intense muscular pains that last the working day, muscle disorders with transient clinical intervention, physical and mental fatigue, heat or cold stress, temporary deafness, visual fatigue (blurred vision). It does not cause damage to the environment and there is significant material and economic damage.
Extremely harmful	3	Injurious physical and mental injuries with permanent or prolonged sick leave (more than 5 months) and the appearance of fatal, invalidating or chronic occupational diseases, such as musculoskeletal disorders, hearing loss, dehydration, alterations of the internal organs, permanent visual damage with a reduction in the visual capacity, affections in the metabolism and intense physical fatigue. There are damages to the environment, and extremely significant material and economic damages that can affect the economic efficiency of the organization.

Source: adapted Resolution 31/2002 of the Work and Social Security Ministry of Cuba (repealed)

2. To determine the ergonomic risks magnitude (MR), through the expression MR= P x C
3. To evaluate the ergonomic risks, taking into account the calculated values of the MR (table 5)
4. To establish the priority level of ergonomic risks (table 6) according to their evaluation

Table 5. Evaluation of ergonomic risks

Ergonomic risks magnitude	Ergonomic risks assessment
1	Insignificant
2	Tolerable
3 y 4	Moderate
6	High
9	Very high

Table 6. Level of priority of ergonomic risks taking into account their evaluation

Ergonomic risk assessment	Priority level	Actions
Insignificant	V	Immediate control actions are not required, only the adoption of measures aimed at improving the job satisfaction of workers without economic expenses.
Tolerable	IV	It requires the implementation of measures to control or eliminate the risk, and the development of periodic controls to verify the measures effectiveness. The control actions may involve small investments.
Moderate	III	It requires control actions in the short term, and periodic supervision to ensure that the effectiveness of the implemented measures is maintained. If it is associated with extremely harmful consequences, the occurrence possibility must be estimated for the adoption of immediate control measures, or in the short term.
High	II	Requires control actions immediately to eliminate or mitigate the risk, the worker must not continue working under those conditions, to continue exposed to the risk, it must be in a time less than 8 hours of the working day, and this decision will depend on the risk type and its consequences. It may require considerable financial and material resources to control or eliminate it.
Very high	I	It should not start or continue work until the risk is eliminated. If it is not possible to reduce it, even with unlimited resources, work should be prohibited.

Source: adapted Resolution 31/2002 of the Work and Social Security Ministry of Cuba (repealed)

5. To estimate the occupational incidents, accidents and diseases occurrence possibility (PS) (table 7).

   The occurrence possibility depends on the correspondence in time and space of the hazard and the worker.

Table 7. Criteria to estimate the occurrence possibility

PS	Quantitative assessment	Qualitative assessment
Impossible	1	Occupational accidents, incidents and diseases will never happen
Low	2	Occupational accidents, incidents and diseases rarely occur
Half	3	Occupational accidents, incidents and diseases can occasionally occur
High	4	Occupational accidents, incidents and diseases are very likely to occur
Very High	5	Occupational accidents, incidents and diseases frequently occur

Source: adapted from the methods of William T. Fine and Richard Pickers (Alonso Becerra, 2011)

6. To determine the dangerousness level (DL), through the expression: DL= MR x PS

7. To establish the priority level of the ergonomic risks (table 8), according to the dangerousness level

Table 8. Evaluation of ergonomic risks according to the dangerousness level

Dangerousness level	Ergonomic risks assessment	Priority level	Actions
DL ≤ 3	Trivial	IV	The situation is not an emergency, control actions are requested aimed at improving worker's job satisfaction, without economic resources expenses.
3 < DL ≤10	Permissible	III	The situation is not an emergency, it is necessary to adopt actions in the short term to eliminate or mitigate the risk. Control actions may involve small investments and must be planned for their implementation.
10 <DL≤ 24	Harmful	II	Urgent situation, requires immediate control actions to

			eliminate or mitigate the risk, the worker must not continue working under those conditions, to continue exposed to the risk must be in a time less than 8 hours of the working day. It may require considerable financial and material resources to control or eliminate it.
DL>24	Very harmful	I	Extremely urgent, you should not start or continue work until the risk is eliminated or mitigated. If it is not possible to reduce it, even with unlimited resources, work should be prohibited.

Source: adapted from the methods of William T. Fine and Richard Pickers (Alonso Becerra, 2011)

STAGE 3. Control and follow-up

Objectives: To develop and implement the measures plan for the ergonomic risks elimination or mitigation, also, communicate, document and monitor the ergonomic risks in the processes.

Responsible: work team.

This stage provides a continuous improvement approach to the procedure. Below is exposed the tasks established for it.

Step 6. Preparation and implementation of the measures plan for the ergonomic risks control

Objectives: To generate and implement ergonomic risks control measures, considering the control hierarchy method.

Techniques: brainstorming, expert criteria and cost-benefit analysis.

The control hierarchy method (National Standardization Office, 2015) suggests adopting measures for the ergonomic risks elimination, substitution of the elements causing the risk, the engineering controls establishment, signaling, warning and/or administrative controls and the assignment of personal protective equipment to workers. The last three correspond to decisions of the organization directors, and their effectiveness depends on the workers behavior.

Step 7. Communication of the ergonomic study results to the workers

Objective: To communicate to the workers the results obtained from the ergonomic study development.

Techniques: meetings, educational talks, folding, among others.

Step 8. Documentation and continuous review of ergonomic risks

Objectives: To document and continually review the ergonomic risks in the processes object of study.

Techniques: model (table 9) and criteria for the ergonomic study execution.

Table 9. Monitoring of ergonomic risks

Process:							
Activity:				Execution date:			
Risk factors	Ergonomic risks	Workstation	Risks evaluation	Control measures	Compliance date	Review date	Compliance status / Observations

The criteria that will guide the ergonomic study execution and will contribute to the improvement of ergonomic risks management are exposed below.

- When a new project begins that involves changes in the systems W- MP- E
- When new processes, activities and/or services are introduced in the organization
- When non-conformities are detected in the OHS Management System implemented as a result of internal or external audits
- When work accidents and incidents occur and occupational diseases appear
- Changes in the legislation and norms in matter of OHS in effect in the organization
- Hiring new workers or external personnel that will remain for a certain time carrying out activities in the organization,
- Request for the workers themselves, or for deficiencies detected as a result of work satisfaction studies,

- Due to changes in ergonomic risks management procedures or the appearance of external factors, for example, emerging occupational health issues (National Standardization Office, 2015).

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