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The Prevention of Industrial Manual Tool Accidents Considering Occupational Health and Safety

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Abstract: The industrial sector is improving its management systems and designing healthy workspaces by focusing on selecting the best ways to reduce accidents and optimize financial and human resources. Hand tools represent the general equipment used in a significant range of industrial jobs. This research aims to develop a tool selection method to help users, managers, and tool designers ensure awareness and care regarding ergonomics based on the anthropometrics of employees, considering the main risk factors for tool selection. The information, which relates to hand security risk factors and the established parameters set by official international institutions, is evaluated during the study. This paper also presents a safety risk assessment framework based on criteria collected through a survey from 10 experts to rate the initial risk value and determine its importance using the analytical hierarchy process (AHP). As a result, the analysis identified the possibility of injury (with 73.06% accuracy) as the biggest concern for companies due to its immediate effects on workers' health. It provides a decision regimen—a tool for decision-makers to design and plan prevention activities to reduce accidents, injuries, and possible illnesses. It further lays out a methodical and analytical model to be used by managers to ensure correct hand tool selection. This model can be used to reduce the possibility of illnesses or injuries for workers and tailor the ergonomic design of each workstation according to specific hand anthropometric data for the worker.

Keywords: industrial risk; tools selection; hand tools; workers' risk; discomfort: occupational safety; tool size; safety engineering; decision-making tools; occupational health and safety

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1. Introduction

The industrial sector is improving its management systems and designing robust, fit, and healthy workspaces, focusing on selecting the best way to reduce accidents and optimize resources [1–3]. In the current tendency, hand tools are the principal equipment in a significant range of industrial jobs. The large number of injuries on a yearly basis is causing huge problems for that kind of business [4]. In industry, one of the most significant control points focuses on the requirements in specific fields. Ergonomic and safety requirements are correlated since both contribute to creating a safe and healthy work environment. Ergonomic requirements constitute designing workspaces, tools, and equipment to reduce the physical strain on workers and promote their well-being, whereas safety requirements address identifying and mitigating hazards that can lead to accidents, injuries, or illnesses. Organizations can prevent ergonomic dangers and reduce the risk of musculoskeletal disorders by considering ergonomic factors such as body positioning, equipment design, and better task organization. Integrating ergonomic principles into safety practices ensures that workers are trained to recognize and address ergonomic risks. This results in a comprehensive approach to occupational health and safety management that improves worker safety, comfort, and productivity [1,4].

For ergonomic managers, one of the biggest concerns is the methods used for tool selection. In trying to reduce the probability of a worker's future illnesses, it is necessary to analyze the repetitiveness and the elemental force during work and then after applying the methodological selection for tools, whereby the workstation is implemented. In this case, the dependence of tool size on the market shall be the restrictive factor since the companies that are producing tools are focusing on designing them for all, not for individual or special needs, and this could cause a problem for specific workers [5].

The requirements for managers are established by a process composed of two levels. The objective of the first level is to divide the tasks into groups based on the needs of the project and the application. The activities that serve to direct the process make up the second level. For instance, each task's specification and validation relate to the tools involved during the activity. Figure 1 shows managers' processes during evaluation and selection [6–8].

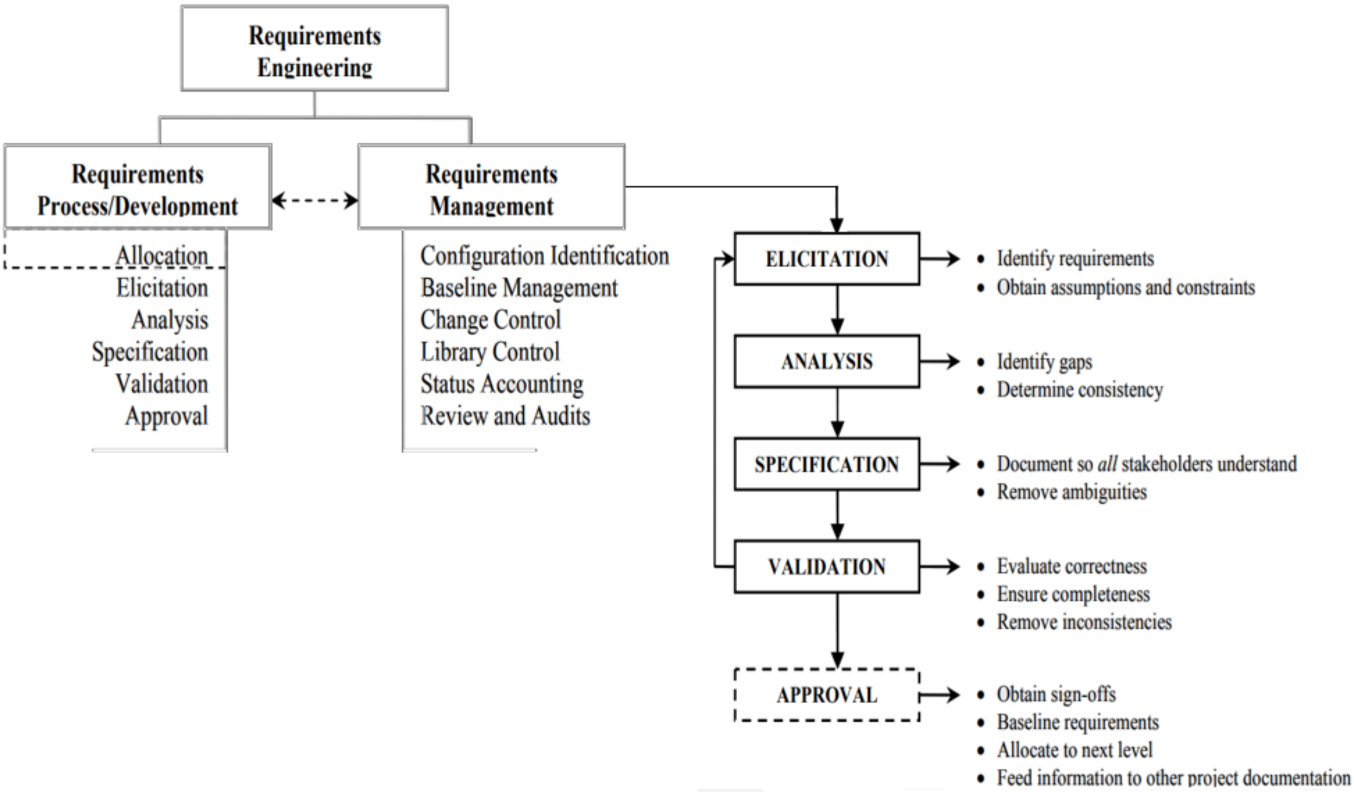

Figure 1. Managers requirements and process evaluation.

Industrial tool risk assessments are concerned with identifying occupational diseases relevant to different aspects of the human body. They are continuously improving by using a range of methods, from survey evaluations to virtual reality simulations, to identify and reproduce the causes of accidents to minimize them [1,9–11].

Musculoskeletal disorders are monitored through different methods based on the observation and organization of the workstation; due to this reason, the tool selection method is an essential part of the designing or organizational part of workplaces [12]. The repetitive work of the manual task, which requires excessive muscle effort, represents a significant problem from an ergonomic point of view since it involves wrist flexion and extension [13]. Each factory's ergonomics managers must acknowledge extreme cumulative trauma disorders as an important ergonomic hazard.

The US Bureau of Labor Statistics shares information about non-fatal occupational injuries and illnesses, and it has shown that 100,000 accidents happen per year that are related to using hand tools, as indicated in Table 1, demonstrating the high number of accidents in the industry in this field and the need to define possible solution strategies. The presented data refer to the machinery driven by hand and hand tool accidents.

Table 1. Work-related injuries; rate of and average days off work; US 2015–2021 [14–16].

Source of Injury or Illness	Incident Quantity Per Year							Average Days off Work
	2015	2016	2017	2018	2019	2020	2021	
Equipment	59,830	95,800	116,202	116,416	118,074	124,462	125,297	7
Hand tools	52,030	83,275	100,998	101,184	102,626	108,177	108,903	5
Total accidents related to hand	111,860	179,075	217,200	217,600	220,700	232,640	234,200	/

The search for increasing efficiency in the globalized market includes all organizational systems being standardized in response to a similar task in several countries [17]. In this sense, when considering operators as the center of a cognitive process that leads to decisions, a "human reliability analysis" is applied, with their dependability influencing overall device usage safety [18]. The ideal condition for ensuring high safety standards is to monitor using different methods and manage both components of this binomial to manage the "human factors" in the manufacturing process, evidencing the need for risk prevention methods focused on specific hand tools.

Related Works

Typically, industrial employees utilize hand tools based on their availability in the workplace; however, before beginning operations in the industry, managers and ergonomics specialists conduct research and pick the appropriate tool size. For the appropriate data collection, a systematic literature review was conducted.

In 2005, Raymond G Hart [19] presented Hand Injury Prevention, which identified high-risk populations and common mechanisms of injury and proposed a future prevention program.

In 2007, training was conducted using the Prevention of Hand Injuries: Evaluation of Knowledge, Attitude, and Behavior [20]. Then, CE de Putter, M [21] presented Health-Care Costs and Productivity Losses Due to Hand and Wrist Injuries: A Population-Based Study (2012), finding that hand injuries cost USD 740 million, which is the most expensive medical treatment for companies.

In 2013, Gregor Harih and Bojan Dolšak [22] developed a tool handle design based on a digital human hand model, providing a better comfort rating than cylindrical handles as a result. Besides, in 2013, Leixnering M [23] presented the prevention of hand injuries. The current situation in Europe was analyzed after 10 years of using different programs with the specific objective of reducing the number of hand injuries, showing that 41% of total injuries are related to using manual tools.

Sohrabi [24] explains how the diameter of non-powered hand tools affects comfort and hand torque (2015), estimating that better comfort would be achieved by optimizing the diameter of hand tools to demonstrate the effect of the optimization process. In addition, in 2015, an example of the Principle of Ergonomics Being Integrated Into Hand Tool Design by Aptel, Claudon, and Marsot [25] for preventing potential illnesses in workers in the future and understanding the characteristics of hand tools relevant to the task and the interaction between implementation and the human operator was used. In addition, Szabo [26] presents an evaluation of the usability of machinery (2017), identifying the main factor of accidents involving workers to be incorrect behavior during tasks in the industrial workplace.

When considering the works cited above, it is reasonable to conclude that hand injury prevention and correct tool selection are the main aspects of the current industrial trends. Nonetheless, hand tool selection is carried out without a frame to prevent and reduce hand injury risk. In this sense, most previous works do not provide a mechanism for selecting an adequate non-powered hand tool. In order to satisfy the absence of this requirement, a rigorous hand tool selection method is recommended by a guided frame in industrial security.

The available standardized industrial documents guide the management of different variables and methods of data collection to determine their influence on workers' behavior [27]. It is also vital to note that some of the key parameters that might significantly impact the final tool selection are not mentioned in the papers. As a result, a guide for non-powered tool selection that meets industrial security principles and prevents workers' injury risk has been developed.

The rest of the document is structured as follows: Section 2: Tool selection method. Section 3: Results. Section 4: Discussion. Finally, Section 5: Conclusions.

2. Generalized Framework for Tool Selection

The methodological development of this research covers the execution of various stages. In principle, the revision of the methods from the collected data is used to assess the information that has been obtained. In order to support the selection of the appropriate instrument, the gathered data are structured and displayed in various tables, phases, and sections.

The research continues with an *assessment* of the usefulness of hand tools to determine the necessary steps during hand implementation evaluation. This step is necessary to decide if the device fulfills the characteristics of the completion of the activity in which each hand tool shall be applied and used.

The next step is *Tool Characteristics*, in which we determine if the contact shape of the tool can be a possible cause of injury and any capacity to minimize it. The results of this evaluation activity and the tasks that can be performed with numerous common tool types are explained during this process.

Then, we analyze *Handling the tool* to understand correct tool usage based on the ergonomics positions during the task and the related activity.

Finally, a *Risk assessment* is used when understanding the usefulness of the hand tools to measure the risk level. In this step, the criteria collected from 10 experts were used to rate the initial risk value and determine its measured importance using a mathematical method. The responses were collected through an online survey. Each participant explicitly agreed to the use of the data to identify the perceived risk; the data were collected anonymously as per the relevant European GDPR laws.

The criteria for the selected information were centralized in order to be able to form groups of the main industrial security characteristics for hand tools. In this way, the possible injury risk could be reduced and could be focused on non-powered tools (as a safety device) to carry out the required industrial task.

By performing an industrial task involving a hand tool, there is a latent injury risk. Table 2 shows the relationship between the sources and the consequences of the injury to clarify the causes or risks to be prevented during the activity.

Table 2. Worker injury and possible causes [28].

Wound Possibility	Cause
Total or partial body parts cuts	The main causes include improper tool handling, sharp blades or edges, a lack of safety precautions, and inadequate training or experience. Designed tools with sharp edges could easily cut body parts if they interact directly.
Muscular and ligaments stress, atherosclerosis.	The main causes include repetitive motions, poor ergonomics, excessive force or pressure, and inadequate rest or recovery periods.
Corneal abrasion	The main causes include failure to wear appropriate eye protection, maintain a clean workspace, and handle tools with care. It can produce flying chips of wood or metal into the eye, causing injuries.
Bones fractures	Neglecting safety protocols, inadequate training, neglecting personal protective equipment, and refraining from handling tools carelessly or imprecisely can create "Stroke or slip with tools".
Syndromes or permanent diseases	Ergonomic lack during work activities and repetitive tasks/long-term work with mismatched tools.

The injuries produced by hammers, chisels, pliers, screwdrivers, and other hand tools during typical job tasks can be considered and divided into different groups according to the severity and the necessary medical treatment, starting from a mild level (level I) to a severe level (level IV), as Table 3 shows. The main consequence related to hand tools is a skin cut, which represents a high percentage in each level of injury.

Table 3. Levels of hand trauma [29].

Level of Trauma	Machine (%)	Cut (%)	Other
Level I	11.61	28.02	60.37
Level II	45.4	30.08	24.52
Level III	56.4	38.39	5.21
Level IV	88.2	4.22	7.58

In order to prevent possible accidents, several standards give the necessary guidelines for good work practices. The international standard ISO 691 [30] establishes the tolerance in hand tools for their operation to prevent accidents produced by incorrect hand tool use or wrong tool size. The standard OHSAS 18001 [31] specifies the principles for health and security given by Occupational Health and Safety Management Systems (OHSAs). In connection with this, ISO 45001 [32] adds further requirements and concepts, providing a focus on understanding the organization's context:

- stronger leadership commitment and worker participation;
- a risk-based approach to occupational health and safety;
- integration with business processes;
- enhanced worker consultation and participation;
- supply chain management consideration;
- an emphasis on emergency preparedness and response [32].

In order to reduce injuries related to work activity, the European Union directive 89/391/EEC [33] recommends implementing measures to encourage improvements in worker safety and health at work. Table 4 shows that despite implementing the principles established by different international standards, hand and wrist injuries represent almost 17% (740 million) of the total medical and production annual expenses caused by the mentioned reasons.

Table 4. The most expensive accident types and related healthcare and productivity costs in 2007 [21].

	Injuries (Thousands)	Cases/per 100,000	Costs (Millions)	Costs per Case	Costs in Millions (Productivity)	Costs Per Case (Productivity)	Total Costs (Millions)
Wrist and hand lesions	260	1575	329	1265	411	1580	740
All injuries	920	5600	2467	2680	1919	2086	4386

Besides the right tool selection process, the following stages should be considered: knowing your job, looking around your workspace, adjusting your posture during work, and choosing the right tool are among the first four. Job activity, tool features, and ergonomic worker positions are all highlighted in this context to generate the appropriate tool selection.

2.1. Work Activity

The first step of the selection process was to examine job activity. Tools must be used for certain activities, and when they are used for inappropriate tasks, they degrade and may cause damage, pain, or injury. The evaluation process is displayed in Figure 2, which is used to assess the usefulness of hand tools for each activity.

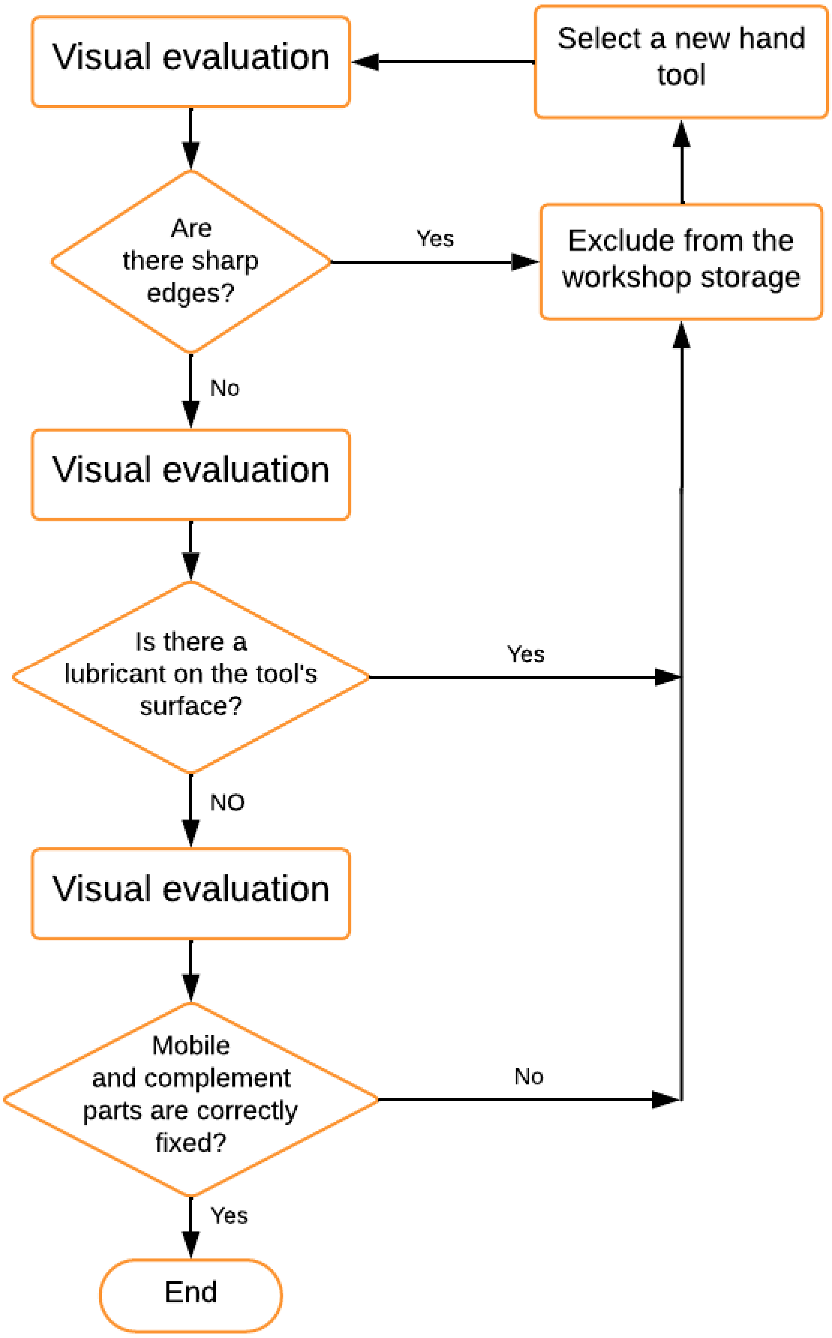

Figure 2. Assessment of the usefulness of hand tools.

When choosing the right tool size, one of the decisive factors can be the workspace for moving the hand tool. The appropriate space needed for the length of the body should be provided if a particular tool is needed for the job.

2.2. *Tool Characteristics*

An injury could result from the tool's dangerous contact shape; therefore, it is important to be aware of this feature. The main tool characteristics of the assessment criteria are displayed in Table 5.

Table 5. Tool Characteristics [34].

Eligibility Parameter	Shape Device	Tool Characteristic	Handle Grip Material
Features	Flexible moldable form	Lightweight tool	High-friction surface
	Not a sharp edge	Dimensions ratio to task	Handle surface-congruent force distribution

Besides, the hand tool's material and texture should be carefully addressed before beginning any tasks at each workstation to ensure proper handling and secure the attachment of the device [35–37]. ISO 45001 validates the systems for managing a company's health and safety at work [38]. It focuses on the scope near different standards, like OSHA18001, to consider the different requirements for managers. These behests are displayed in Table 6, showing non-powered hand tool evaluation before selection and the possible task related to each tool.

Table 6. Safety rules for hand tool assessment [38].

TOOL NAME	INSPECTION ACTIVITY	FORBIDDEN TASK	TASK TO BE CARRIED OUT FOR INJURY RISK REDUCTION
Hammers	Visual and manual evaluation of clamping handle to exclude those hammers that have any defect	Do not try to repair the damaged or fissured clamping handle.	Shall be applied to hit only with the metal head
	Evaluate the correct fit between the metal head and the clamping handle. Do not use a hammer with a gap between these parts	Do not use hammers with loose nuts	When there is an existing need to share the hammer with another worker, it should be carried out by gripping the metal head.
	Check the metal head of the hammer and whether it has a burr		The worker must use protective glasses
			Inside flammable environments, must use special hammers.
Pliers	Visual and manual evaluation of clamping handle to exclude the pliers that have any defects	Do not use pliers with loose screws	To cut thick wires, the plier shall be located perpendicular to the wire.
	Evaluate the correct fit between the parts of the clamping handle	Do not use pliers as a hammer	For activities with pliers, the worker must use protective glasses
	Do not use pliers with a gap between these parts	Do not use small particles fitted between the pliers' parts during drill activities	
Metal file	Visual and manual evaluation of clamping handle to exclude the metal file that has any defects	Do not hit the metal file during cleaning activities	Fit the small parts before grinding activities with the metal file
	Clean the metal surface	Do not clamp the metal file by the free extreme	
Wrench	Clean the wrench surface of the existing grease	Do not use a wrench as a hammer	Use the correct wrench size according to each nut size
		Do not use a wrench as a lever	For squeezing or loosening activities, the wrench must be pulled
		Do not use a tube as a lever to extend the wrench	

Table 6. *Cont.*

TOOL NAME	INSPECTION ACTIVITY	FORBIDDEN TASK	TASK TO BE CARRIED OUT FOR INJURY RISK REDUCTION
Screwdriver	Visual and manual evaluation of the clamping handle to exclude the screwdriver that has any defects	Do not use pliers to fit the clamping handle during the squeeze or loosen activities.	The screwdriver shall be transported in a proper bag
	Clean the wrench surface of the existing grease	Do not support the body parts over the screwdriver	The metal shank shall be perpendicular to the screw head.
	Evaluate the correct fit between the metal shank and the clamping handle. Do not use a screwdriver with a gap between these parts.		
Chisel	Visual and manual evaluation of the head to exclude the screwdriver that has any defects like fissures or burr	Do not sharpen the edges of the chisel by yourself	The chisel shall be transported in a proper bag
			The sharpened edge should be operated in the opposite way to the worker
		Do not use a chisel as a lever	Fit the small parts with another tool when you need to conduct chisel activities over them

2.3. *Way of Handling the Tool*

The next step in the selection process is choosing the work approach for the activity. In order to determine tool size, the applications of the tool and its handle are analyzed in relation to the anthropometrics of the workers' hands [34]. The inherent design features that promote safer tool operation and minimize the risk of accidents or injuries may be evaluated from two fronts: the intrinsic safety of non-powered hand tools and the ergonomic way of handling the device.

2.3.1. Intrinsic Safety of Non-Powered Hand Tools

In order to mitigate the risk of accidents and promote safer working conditions when selecting non-powered hand tools, intrinsic safety features play an important role in connection with all the safety protocols for promoting productivity, ensuring regulatory compliance, and contributing to overall operational efficiency and cost-effectiveness. Table 7 presents the main prudent characteristics of hand tools related to intrinsic safety features.

Table 7. Intrinsic safety aspects in non-powered hand tools [39].

Non-Powered Hand Tool Characteristics	Intrinsic Safety Features
Ergonomic	- Ergonomic handle design for comfortable grip and reduced strain. - Non-slip handle surface for improved control. - Magnetic tip to securely hold screws and prevent slipping. - Insulated handle for electrical safety.

Table 7. *Cont.*

Non-Powered Hand Tool Characteristics	Intrinsic Safety Features
Non-Slip	- Textured grips for non-slip handling and enhanced control. - Built-in wire cutter guard to prevent accidental cuts. - Anti-pinch design to minimize the risk of finger injuries. - Joint locking mechanism for secure grip and stability.
Retractable Utility	- Retractable blade mechanism for safe storage and reduced accidental cuts. - Blade locking feature to prevent unintentional blade movement. - Durable construction with impact-resistant materials.

2.3.2. Ergonomic Way of Handling the Tool

Most companies continuously invest in ergonomic tools and promote proper handling techniques. It not only prevents workplace injuries and disorders but also promotes a healthier and more productive work environment, and by doing so, contributes to overall workplace success and well-being. The ergonomic grip of each hand tool has great significance during an industrial task, helping workers reach their work goals.

The power grip shown in Figure 3 is the handling method used for both small and large hammers to generate the required force when striking the materials. In this method of holding a tool, the entire palm is used to support the object, and the fingers and thumb apply the forces [40].

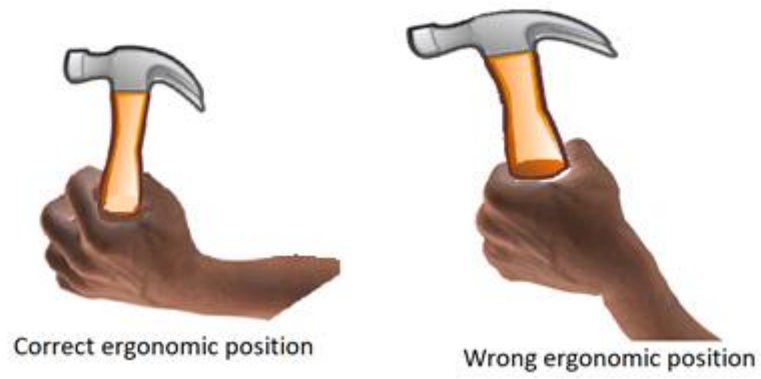

Figure 3. Power grip.

The handling method of a tube-like tool is conducted according to handle length and diameter, as shown in Figure 4. In this method of holding a device, the entire palm is used, while the fingers and thumb are used to apply force.

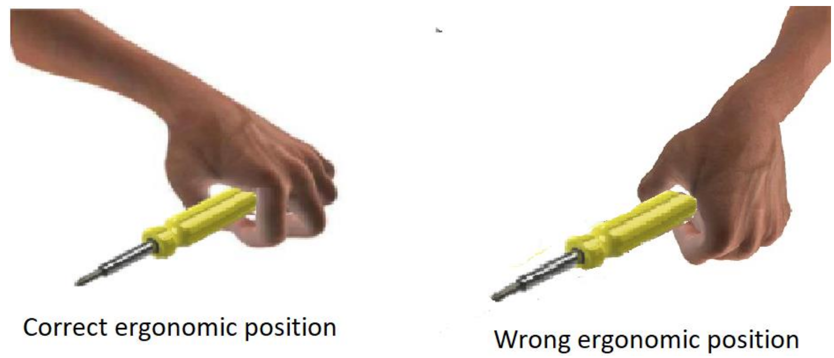

Figure 4. Single handling of a tool.

The instrument is handled with a pinch grip (see Figure 5) for control, precision, and accuracy. In order to apply the necessary force for the task, the tools are held between the thumb, index fingers, and middle finger when using this method of gripping. Contact pressure is another handling style, conveniently illustrated in Figure 6. It differs from other handling styles, as it uses the palm to exert force to hold the device against the component that must be fixed.

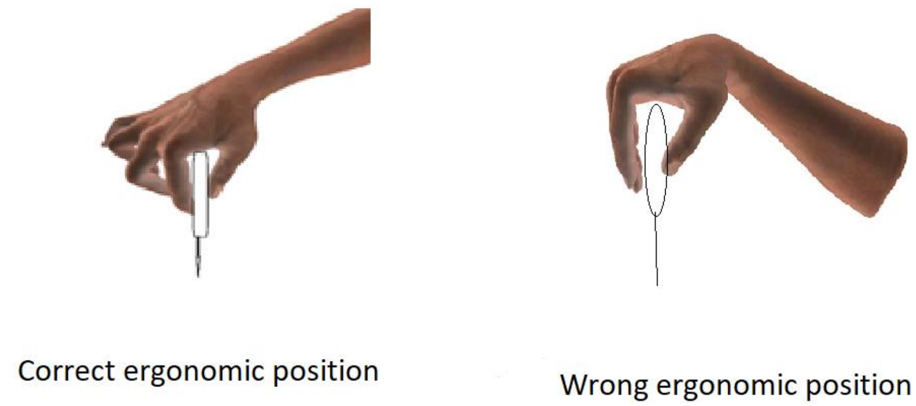

Figure 5. Pinch grip tool handling.

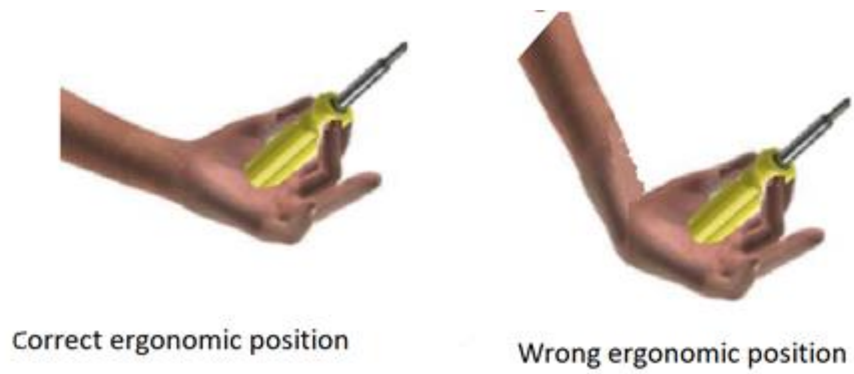

Figure 6. Contact pressure tool handling.

Double-handle tools, as illustrated in Figure 7, are commonly handled using total hand force. The handling method of the tool is shown in Figure 7. In order to apply the appropriate force for the work, the pliers or pincers are held in this grip between the thumb, index finger, and middle finger [41].

Figure 7. Double-handle tool.

2.4. Assessment of Risk during the Usefulness of Hand Tools

A comprehensive evaluation and categorization of the risks was carried out. We used the Analytic Hierarchy Process (AHP) evaluation method for the numerical evaluation, which was proposed by Thomas L Saaty, and was used in a paired comparison to evaluate the degree of risk importance during the assessment of the usefulness of hand tools [42,43].

Using the scale guide method, the experts gave the rating based on how significant the risk was according to the direct consequence for a worker's health and the indication of it for future illness.

Table 8 shows matrix A, representing the relationship between each risk and the relevant scale to compare and calculate the necessary steps to continue the calculation. The next step is to calculate the normalization of matrix A using Equation (1).

Table 8. Matrix A = risk evaluation ratio.

Matrix		Physical Injuries	Ergonomic Risk	Tool Damage	Wi	Ci	LAMDAi
		1	**2**	**3**			
Physical Injuries	1	1	5	7	3.27	0.73	0.98
Ergonomic risk	2	1/5	1	3	0.84	0.19	1.19
Tool damage	3	1/7	1/3	1	0.36	0.08	0.89

$$p_i = r_i * l \sum_{i=1}^{N} r_i \quad (1)$$

where

p_i = normalized value for each position;

r_i = value for each position.

To calculate each r_i value for each position in the normalized matrix, Equation (2) is used:

$$r_i = exp\left[\frac{1}{N} \sum_{J=1}^{N} \ln(a_{ij})\right] \quad (2)$$

In the equation, each value is calculated related to matrix A in the order $N \times N$, and the value a_{ij} represents the value for each position in the summary; the values are represented in the matrix of normalization, as shown in Table 9. Normalization ensures that the values reflect the relative importance or preference while maintaining consistency and mathematical coherence in the matrix, which represents comparisons between pairs of criteria.

Table 9. Normalized matrix.

0.74	0.79	0.64
0.15	0.16	0.27
0.11	0.05	0.09

The consistency ratio (CI) and the random consistency ratio (RCI) are calculated using Equations (3) and (4), respectively. As a result, if the value is lower than 0.1, the consistency of a specialist evaluation through Equation (5) is determined, and these results are shown in Table 10. The consistency ratio (CR) indicates the consistency of the judgments made in the pairwise comparisons, while the CI measures the extent of inconsistency observed in the pairwise comparisons, and the RCI represents the expected inconsistency for random judgments of the same size.

Table 10. Results.

$$Ci = \frac{\lambda max \ - N}{N-1} \quad (3)$$

Ci =	0.03244379	

$$Rci = \frac{1.98^{\circ} \ * \ (N-2)}{N} \quad (4)$$

Rci =	0.66	

$$CR = Ci/Rci \quad (5)$$

CR =	0.0492	Consistent

In order to determine these results, it is necessary to use λmax, which represents the principal eigenvalue of the pairwise comparison matrix used in calculating the consistency index. Besides, the N value represents the value of independent variables in the comparison method.

3. Results

When considering all activities that involve hand tools, ergonomic managers need to start with the selection activities focused on safety by considering the correct hand tool. The main result is the identification of the different stages necessary for ergonomics managers to be able to select tools to ensure the safety of workers' hands during the relevant activity. Figure 8 shows the sequence to follow during tool selection.

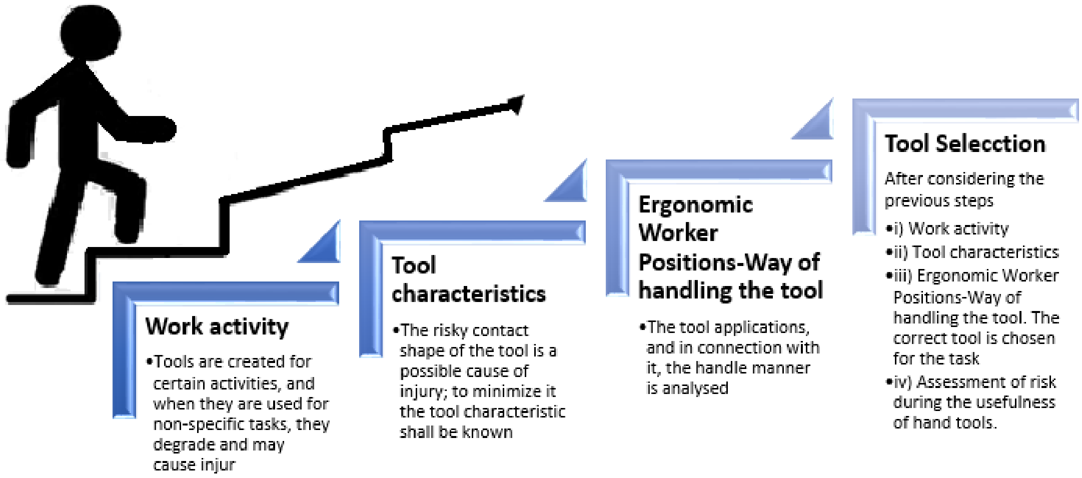

Figure 8. Sequence to follow during tool selection.

The first step in the hand tool selection process is understanding the activity to determine the necessary conditions to go through; the next step is to identify the characteristics of the tool needed. When the device is selected according to the evaluation of each part, advancing to the next level of tool handling is where the main important aspect is: identifying the correct ergonomic posture during the task. After fulfilling all the security requirements and meeting the correct requirements, the adequate tool shall be chosen, or else the evaluated tool shall be rejected, and the process will restart with a new one.

Finally, after solving Equation (6) to determine the risk level S^*, this value establishes the highest risk to consider during tool selection. The consensus indicator S^* quantifies the overall level of agreement among the decision criteria. It is calculated by comparing the individual judgments with the average judgments of the group to define the incidence of each criterion [44].

$$s^* = [M - \exp(H_{\alpha min}) / \exp(H_{\gamma max})] / [1 - \exp(H_{\alpha min}) / \exp(H_{\gamma max})] \quad (6)$$

where

$M = 1 - H_\beta$;
s^* = consensus indicator;
H_α = Shannon alpha entropy;
H_α = $(1/(1 - \alpha)) * \log(\text{sum}(p_i \hat{} \alpha))$
p_i = is the probability of the i-th outcome in the distribution;
α = is the parameter that controls the sensitivity of the entropy calculation;
H_γ = Shannon gamma entropy;
H_γ = $-\Sigma(p_i \hat{} \gamma * \log(p_i))$;
p_i = is the alpha probability assigned to the i-th state;
γ = is a parameter that controls the level of emphasis on the probabilities;
H_β = Shannon beta entropy;
H_β = $H_\gamma - H_\alpha$.

Solving the AHP consensus is calculated based on the row geometric mean method RGMM results by employing Shannon A and B. These values are shown in Table 11 and evaluate the importance of each risk, being organized on a rising scale. The maximum displayed value is related to physical injuries. In this sense, the manager needs to evaluate these factors during hand tool selection [44].

Table 11. Risk evaluation results.

Criterion		Weights	+/−
1	Physical injuries	73.1%	18.4%
2	Ergonomic risk	18.8%	4.7%
3	Tool damage	8.1%	2.0%

The results illustrated in Figure 9 present physical injuries as the highest, with 73%, ergonomics risk as second highest, with 18.8% and finally, tool damage, with an incidence of 8.1%.

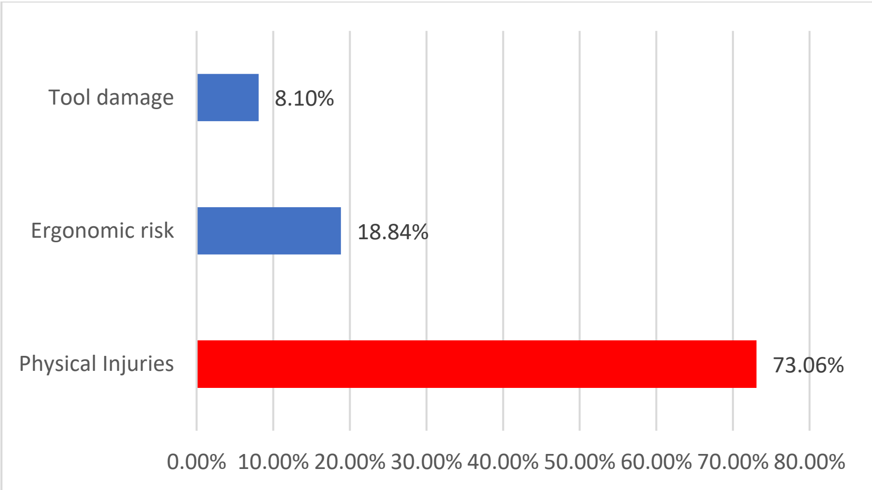

Figure 9. Risk evaluation results.

4. Discussion

The first principle of a company is to manage the resources correctly and to receive better incomes. In this approach, safeguarding workers from illnesses is essential to enhancing production. For this reason, selecting the right tools requires careful consideration [45]. This study identified the primary components employed during the operations that require hand tools to reduce the potential danger. The present research indicates that injuries pose the most significant concern for companies, accounting for an average percentage of 73.06%. It also reflects the immediate effects that injuries can have on worker health, making them the top priority for organizations. Workplace injuries, often resulting from accidents or hazardous conditions, can lead to physical harm and impairments, causing employee downtime, increased healthcare costs, and reduced productivity.

This study is a contribution related to the stages and the evaluation of hand tools. It reflects the necessity to identify the main characteristics of all gadgets and to check them before the selection. We classified the aspects that determined the usefulness of a tool and related this to the context of previous research where the hand parts and dimensions were identified. In order to achieve the best and safest practices for activities related to contact pressure subjection, the chosen instrument must be between 10.19 centimeters and a maximum dimension of 11.71 centimeters, considering the demographics of each location and nation. The required tool for pinch grip submission must have a dimension ranging from 6.19 centimeters to 7.71 centimeters, according to the OSHA international standard, which suggests the values between these limits. The specified tool for activities requiring single-handle tools and power grip applications should be between 4.46 centimeters and a maximum size of 5.74 centimeters, and for activities involving double-handle tools, the recommended tool should be lower than 7.11 centimeters [46,47]. In this study, the researchers identified the correct ergonomic position for each task that involves hand tools to avoid wrong positions and reduce the possibility of injuries. Because ergonomics is the second largest concern, with a percentage of 18.8%, and considering that ergonomics does not have immediate effects, like repetitive motions and poor posture, this factor can result in long-term health issues and future illnesses.

The international bodies that set standards recommend that hand tools be measured solely in terms of task characteristics [48–50]. As a result, the processes required for making the right tool selection are described in this project. Before choosing a tool, each stage should be considered, including certain steps for tool evaluation.

The relevant literature review also supports the correct risk categorization and classification to apply during hand activities; Marie-ÈveChiasson et al. [51] and Paulien M Bongers and Anja M Kremer et al. [52] note that management help tools are crucial for evaluating and minimizing risk to provide a work environment where trust and physical and psychological safety is enhanced. In this study, risk classification and risk level evaluation were analyzed during tool selection. Thus, it is likely that when managers ensure correct hand tool selection using the support material, their work environment will be healthier and safer. This, in turn, may be associated with reducing future work illness, as indicated in this study. Conversely, based on market availability, hand tools are not selected based on a risk evaluation; rather, their production is based on material and shape design. This study indicated a strong association between physical injuries and incorrect tool selection, which should be noted in order to reduce work-related hand injuries.

5. Conclusions

Hand tool selection is a basic and critical part of industrial and non-industrial activity; it should be performed carefully to prevent future work illness and accidents. In order to ensure correct tool selection, a strict evaluation is needed to be performed to fulfill all steps specified in the method.

If, during the compilation of the tool evaluation, any hand tools do not meet the security and usefulness evaluation parameters at any stages of the evaluation method, the gadget must be replaced, and the evaluation for the new one must be restarted.

The most critical issue in the evaluation is the definition of the criteria. Through AHP, the requirement for consistent or near-consistent matrices is determined. Our evaluation showed that the consistency and validation criteria are under the limit of 0.1 for the consistency ratio CR; for the risk evaluation, it was 0.0492, determining the correct setting criteria.

The results also show that injuries, which can cause direct risk, have the highest average percentage at 73.06% and represent the biggest concern for companies due to their immediate effects on worker health. This is followed by ergonomic risk, with a percentage of 18.8%, which can provoke future illness.

The importance levels and risk classes in the suggested methodology help the workers to interpret the risk analysts' work. AHP is recommended for each workplace based on the hazards specific to each situation.

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