Ergonom+IA
In-depth insight into ergonomics and human factors

Ergonomics and IA

Human Factors and Ergonomics in Low-Income Countries

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The use of the information, models, and concepts that form an integral part of this document assumes that the professional is certified or has undergone the training and education required to understand the principles of ergonomics. Similarly, they must understand the nature of the processes used, their application, and the interpretation of the results.

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Ergonomics:

Context

In Colombia, occupational health and safety practitioners and professionals who carry out ergonomic analyses in companies have developed a preference for checklists and questionnaires for occupational health and safety prevention. It should also be mentioned that this behavior stems from training processes, sometimes academic and sometimes unregulated by institutes of dubious scientific quality, where these types of resources are openly promoted as the only means of working on ergonomic studies. Added to this is confirmation bias, where these experts associate ergonomics with posture.

It should be borne in mind that the exclusive use of and reliance on checklists and questionnaires to carry out interventions in the field of ergonomics, occupational health and safety (HSQ) in Latin America is a fundamentally flawed and very limited approach, especially when pseudo-institutes and commercial companies proliferate, selling training focused on checklists to train ergonomics experts in a matter of hours who, according to their commercial advertisements, solve companies' problems and can provide solutions (specifically chairs or tools with an ergonomic seal).

While these checklists could be assigned some value as informational resources in a comprehensive strategy, relying exclusively on them creates significant problems for workers and companies. Below, we will mention some of them:

1. The illusion of completeness and false security:
   For occupational health and safety professionals in companies and for workers in Colombia, these lists and questionnaires create a false sense of security that risks are "covered." They imply that if all the boxes are checked or all the questions are answered, safety is achieved. This type of reasoning overlooks the dynamic, complex, and often unpredictable nature of work systems.

   What is the consequence? Organizations may neglect deeper risks (e.g., production pressure that takes precedence over safety protocols, a culture of inadequate maintenance, a flawed safety culture) because the checklist is "complete." It should be remembered that serious accidents often result from latent failures that are invisible to standard checklists.

2. Passivity and lack of proactivity:
   Checklists and questionnaires are inherently reactive and passive tools. They mainly capture known hazards or solicit reported perceptions or experiences. They are deficient in identifying emerging risks, novel hazards, or subtle degradations in safety margins.

   What is the consequence? Prevention becomes retrospective, addressing past issues or easily identifiable problems. Truly forward-looking and predictive prevention (anticipating future failures, analyzing near misses and accidents in depth, understanding performance variability) is stifled. Ergonomic interventions become substitute patches rather than increasingly complex improvements.

3. Superficiality and lack of contextual depth:
   From the perspective of the complexity of work-derived data, checklists impose binary (yes/no) or simplistic categorizations. Questionnaires often reduce complex experiences

(pain, stress, perceptions of safety culture) to numerical scales or limited options. They eliminate nuance, context, and rich qualitative understanding of how work is actually performed (versus how it is prescribed).

What is the consequence? Interventions designed based on this superficial data tend to be superficial as well, for example, providing a new chair based on a pain scale, without understanding ergonomic interactions, work pace, or individual variability. As a result, the root causes remain and will continue to remain unaddressed.

4. **Subjectivity, bias, and limited perspective:**
   This is a critical flaw in questionnaires: Responses obtained using questionnaires and checklists are heavily influenced by social desirability bias (giving "correct" answers), recall bias, fear of repercussions, language barriers, and different interpretations of questions. They represent perceptions, not necessarily objective reality.

   The critical flaw in implementing checklists: Their effectiveness depends entirely on the knowledge, experience, vigilance, and honesty of the user. A rushed or untrained professional can easily overlook critical elements. Checklists also reflect the biases and blind spots of their creators.

   What is the consequence? The data used for any type of intervention may be misleading or incomplete. Interventions may focus on perceived problems that are not critical to the company and the worker, or overlook serious hazards hidden by biased reports. The voice of workers may be distorted or silenced.

5. **Undermining worker expertise and engagement:**
   There is strong evidence that relying exclusively on questionnaires and checklists can disempower workers. Questionnaires solicit opinions, but within a rigid framework; checklists imply that safety is based on inspection, rather than collective responsibility and experience.

   What is the consequence? The deep practical knowledge that workers have about their tasks and the risks involved is lost. Genuine participation in safety responsibility and problem solving is not encouraged. Interventions defined remotely based on data from lists and questionnaires lack worker support and may be impractical (the harmlessness of active breaks, for example).

In summary:
In Latin America, traditional ergonomic assessments are often based on observational methods and surveys, which can be inconsistent due to the subjectivity of the assessors. These methods continue to be widely used in low- and middle-income countries because of their cost and ease of implementation [6]-[7].

In our countries, this approach has given rise to what we call "Pseudo-Ergonomics." Pseudo-ergonomics refers to the superficial, fragmented, or erroneous application of ergonomic principles that creates an illusion of safety and comfort without addressing the root causes of work within a work system. It is characterized by a disconnect from the specific work context, a lack of participatory design with end users, and an overreliance on isolated, product-based "solutions" rather than an integrated redesign of processes. As evidenced by persistently high rates of work-related musculoskeletal disorders, pseudo-ergonomics produces suboptimal

results for both human well-being and overall system performance, despite the appearance of ergonomic compliance.

The impact of pseudo-ergonomics and the use of checklists in low-income countries poses a significant challenge, which revolves mainly around inadequate technology transfer from high-income countries and a widespread lack of awareness, which together contribute to a high work-related health and safety burden. Addressing these challenges requires going beyond the simple transfer of tools and knowledge. Research and practice point to several key changes in approach:

1. Adapt, don't adopt: Ergonomic technology and principles from high-income countries must be critically evaluated and adapted to local conditions, environments, and people before use. This includes taking into account local anthropometry, common postures, and work practices.
2. Develop local capacity: There is an urgent need to improve ergonomic knowledge and practices in industry, the healthcare sector, and other areas. This involves introducing ergonomic education in schools and universities and increasing its presence in industry.
3. Contextualize tools: Checklists and other safety interventions should be designed or adapted to take into account the specific political, social, and professional contexts of low- and middle-income countries, rather than being applied based on paradigms from developed countries.

Today, various technologies such as robotics, IoT, AI, computer vision, augmented and virtual reality can help reduce subjectivity in assessments, reduce exposure to hazardous environments, prevent workplace injuries, and generally improve working conditions [8]. There is a trend toward combining subjective and objective methods to obtain a more comprehensive and accurate ergonomic assessment [9]-[10].

By its very nature, an accurate assessment goes beyond traditional disciplinary fields of assessment, requiring integrated and technological work. Multi-criteria decision-making methods allow for a more effective analysis of ergonomic risks, adapting to the specific limitations and needs of the work environment [11].

Promoting and using only this type of resource to define ergonomic OSH interventions is highly deficient and potentially dangerous. This logic promotes a superficial, reactive, bureaucratic, and compliance-focused approach that fails to understand the complexity of work systems, ignores the physical reality and experience of workers, and is blind to emerging risks at work and structural failures in work systems. In short, it violates the ethical codes of ergonomics and is dishonest about the needs and expectations of the company and its workers.

What would be the way forward?

Effective prevention and application of ergonomics in OSH requires a multidimensional approach: direct observation (work as it is performed), rigorous physical and environmental monitoring, in-depth investigation of incidents and near misses (beyond checklists), proactive risk assessment techniques, robust worker participation mechanisms (beyond surveys), safety culture assessments, and analysis of objective data derived from the work, the worker, and the work situation (retrospective and prospective indicators).

Main thesis: In a semi-industrial society with underdeveloped professional critical analysis, moving away from checklist-based ergonomics is a high-risk, high-reward strategy. Its primary function shifts from simple compliance to being a catalyst for systemic cultural and cognitive

change, but it requires carefully structured implementation. The role of non-checklist ergonomic analysis in this challenging context is transformative rather than transactional. It is not just a different tool for the same job, but a tool for a completely different job: developing the fundamental critical thinking skills necessary to evolve the safety culture from a reactive, compliance-based model to a proactive, adaptable, and resilient one. Its success depends entirely on recognizing the skills gap and implementing robust support structures to bridge it.

Some elements of this proposal to reflect on

Hybrid intelligence (HI) is the combination of human intelligence and artificial intelligence (which is why we write Ergonom+AI), as it extends human intellect rather than replacing it. HI takes into account human experience and intentionality when making meaningful decisions and taking appropriate actions, along with ethical, legal, and social values. [1]

The goal in designing hybrid intelligence systems is to place humans at the center, changing the course of the AI revolution, always remembering that AI systems tend to be "wise idiots," matching or exceeding the performance of human experts in limited areas. [1]

In this vein, hybrid intelligence ergonomics (HIE) will start from the understanding that humans and workers in general have extensive knowledge about their world, have a strong sense of common sense that they implement in their spheres of activity, and routinely develop skills of collaboration, adaptability, and responsibility in terms of shared social and collective norms, values, and explanations.

In many fields of science, it has been concluded that humans possess great flexibility in the face of changing circumstances during the execution of a task. There, they operate in environments in which knowledge, norms, and values (often implicit) define which goals and actions are desirable or even permissible. These elements have been extensively and thoroughly studied and demonstrated by ergonomics focused on human activity. Here we can quickly reference some of the principles of this theory, which is widely known by researchers in ergonomics:

a. Activity theory seeks to identify six key components: subject (worker or group of workers); object (purpose of the activity); tools (physical and psychological instruments); community (workers or teams that interact with the subject); rules (formal and informal norms that regulate work); division of labor (how tasks and responsibilities are distributed).

b. Analyze contradictions and problems. Points of tension that manifest as problems in work activity: conflicts between tools and rules; conflicts between the object and the division of labor; conflicts between the subject and tools.

c. Analyze the difference between how the work is supposed to be done and how workers actually do it: detailed observation (record and analyze worker activity); interviews with workers (understand their experiences and subjective view of problems); documentary analysis (review procedure manuals, production records, and incident reports)

d. Design a vision for improving the system, which corrects and transforms the activity system: participatory design (involve workers in the design of solutions); evaluation of alternatives (for redesign of the job, tools, and procedures, analysis of impacts); redefinition of the system (solution that resolves the main contradiction).

e. Implement and analyze the impact (monitor whether the change resolved the original contradictions or generated new tensions).

In the age of AI, low-income economies face a paradox:
How can we take advantage of technological progress without eroding human dignity?

Hybrid intelligence ergonomics (HIE) aims to find a solution to this problem by anchoring innovation not in silicon, but in humanity, transforming AI from a tool of extraction to a partner for flourishing.

Conventional ergonomics asks: How can humans adapt to technology? HIE demands: "How can technology emerge from human lives?" Hybrid intelligence ergonomics will develop as a transformative framework for sustainable work in low-income economies.

It has long been proven that traditional ergonomics often fails in low-income economies due to cost constraints, infrastructure deficiencies, and cultural mismatches, in addition to the promotion and misguided use of questionnaires as the sole means of analysis. The conventional ergonomics approach ignores that low-income economies face interrelated challenges:

1. Physical: 89% of informal workers are at high risk of injury (ILO, 2024).
2. Technological: The adoption of AI often exacerbates inequality through "digital colonialism."
3. Economic: Productivity losses from work-related injuries cost between 1.8% and 5.5% of GDP (World Bank).

Hybrid intelligence ergonomics rethinks this paradigm by seeking to integrate human contextual intelligence fused with principles of anthropotechnologies, macro-ergonomics, and activity theory, turning AI into a symbiotic partner rather than a replacement.

Core philosophy of hybrid intelligence in ergonomics

The essential quest of hybrid intelligence (HI) ergonomics is to merge human contextual wisdom (e.g., tacit knowledge, cultural adaptability) with the computational power of AI (e.g., pattern detection, predictive analytics) to create solutions that are:

1. Sober (low cost, locally repairable),
2. Inclusive (usable by illiterate or digitally illiterate users),
3. Adaptive (learn from real-world feedback loops).

Hybrid intelligence ergonomics is the intentional design of work systems, where human contextual intelligence and the computational intelligence of machines enhance each other, creating capabilities that neither possesses on its own, prioritizing dignity, adaptability, and justice.

Hybrid Intelligence, framed by Activity Theory, transforms the ergonomics of static interaction between humans and tools into dynamic systems of socio-technical activity. AI becomes a co-evolutionary mediator that integrates into local historical and cultural practices, transforming limitations into spaces for innovation. This is crucial in low-resource environments where technology must contribute to human development in community terms.

Role and Impact (The "Why")

1. Primary Role: Function as a "Critical Thinking Engine"

- It Forces Diagnosis over Judgment: Instead of "Is the chair adjusted? (Y/N)," the question becomes "Why is the worker constantly leaning forward?" This will force a search for systemic causes.

- Develops systemic thinking: professionals must analyze the interaction between the worker, the task, the tools/technology, the environment, and the organization (a simplified socio-technical system).

- Develop empirical reasoning: professionals learn to collect data (observation, quotes) and formulate conclusions based on evidence, rather than opinions based on norms.

2. Secondary function: improving the effectiveness of the intervention

- Logical flow: Deeper analysis → identification of root causes → more effective and sustainable solutions.

Here is an example:

- Conclusion of the checklist: "Hunching over when lifting weights." → Intervention: "Training on lifting techniques." (Often ineffective).

- Conclusion of the analysis: "The worker avoids using the mechanical lift because retrieving it from a cluttered warehouse adds 5 minutes to a 2-minute task, and management encourages speed." → Intervention: 1. Relocate the lift. 2. Review production incentives with management. 3. Then reinforce training. (Effective from a systemic point of view).

3. Tertiary function: foster a participatory safety culture

- Involving workers in the analysis process (e.g., through interviews or workshops) validates their expertise, builds trust, and encourages acceptance of solutions.
- In this way, safety moves from being a top-down imposition to a shared problem-solving exercise.

To achieve true ergonomic development, a strategy is needed to mitigate the consequences of the spread of pseudo-ergonomics. Today, in low-income countries, professionals do not know how to begin or complete an ergonomic analysis. They feel overwhelmed.

Simple, step-by-step frameworks need to be provided, and it must be understood that tools such as checklists should not be used to comply with regulations, but as a guide to know what to look for. Appropriate qualification processes will make it possible to move beyond superficial analysis, where ergonomics professionals arrive at the first obvious conclusion ("bad posture") without delving deeper. This highlights their inability to synthesize: as a result, they devote themselves to collecting data, but are unable to convert it into coherent conclusions or practical recommendations.

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