



Industry 4.0: impact on Productivity, ergonomic aspects, and Workers' mental health, a literature review

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Abstract. The relationship between productivity, well-being, and mental health of the worker is a subject that has been discussed by companies in the apparel, automotive, construction, and textile industries in the search for improvements in quality of life and increased production. This paper aims to identify the impact on productivity in the apparel industry of ergonomic aspects and workers' mental health and well-being. A specific methodology (PICO) was used to convert the problem into a research question and generate the keywords to be used in the systematic review. The systematic review was conducted according to the PRISMA method. This review included searching for articles, theses, and dissertations, written in English and Portuguese, in the Web of Science and Scopus databases published between 2018 and 2023. The articles and book chapters found were reviewed according to the research objective, in which 6 articles were included in this review. The keywords used were productivity; Manufacturing industry, industry 4.0, ergonomics, and mental health. The main objective of this article is to survey studies on the relationship between ergonomic aspects, well-being, and mental health of the worker, and how these aspects can influence productivity.

Keywords: productivity, ergonomics, mental health, well-being.

1 Introduction

The new demands for the apparel industry, within the scope of Industry 4.0, reinforce the need for new studies, which involve the planning, organization, and control of production, with a focus on the worker. Analyzing the ergonomic aspects and the mental health and well-being of the worker in improving productivity and quality of work.

Like other types of industries, the textile and clothing industry is experiencing a growing lack of qualified labor and difficulty in attracting new workers to the productive sectors, due to the practice of low wages, and repetitive operations with high concentration requirements, which can result in health damage in the medium and long term [1].

In the 1930s, with the emergence of Walter A. Shewhart's control chart, it was realized that the worker was able to understand and control his production, creating a technique for industrial production. [9] From then on, two important concepts emerged: the Statistical Process Control (SPC) and the Continuous Improvement Cycle. The latter is based on the stages of problem analysis: *Plan*, planning the approach, defining the variables to be monitored and training the personnel involved; *Do*, monitoring and measuring the process; *Check*, verifying, and analyzing the data collected and the problems identified; and *Act*, acting on the causes, correcting or eliminating them, to then restart the cycle with a new planning stage. [14]

According to [9], the modern concept of Total Quality Management was developed, defending the concepts of applying quality control in all areas of the company, not as a "cake recipe", but as a set of principles to be adapted to the culture of each organization.

In the 1970s and 1980s, apparel manufacturing benefited from social transformations and the accelerated growth of the economy. The sectors that benefited most were: cutting, the monitoring of distribution and sales, using computerized systems; and quality, which gained more notoriety within the industry. [14]

The making of the garment requires the handling of various types of machinery and processes. Therefore, for production, it is essential to meet a production scale that depends on the yield of the process, both in quality and quantity required.

As of the 90s, with the opening of new markets and globalization, the need for adaptation arises, and the importance of applying quality concepts grows.

Production management involves managerial decisions about production design. The study of different physical arrangements (production systems) of a manufacturing environment may provide better conditions for higher efficiency, promoting safety, quality and productivity. [14] To perform a study strategy of the physical arrangement of a production unit, it is necessary to: improve the spatial arrangement of the workstation, update the arrangement, and allow the development of new arrangements.

As the clothing industry evolved, new concepts were introduced. In the 21st century, with the development and increase of the clothing industry, the consumer is demanding more functionality, implying greater comfort in clothing, and better wearability, with workers, looking for better quality in the development of their activities. [2]

The concept of ergonomics appeared during the second world war to optimize the interaction between man and machine, aiming to increase the efficiency and reliability of such systems. It is focused on the study of the optimization of assembly lines and prevention of muscle strain from repetitive movements, being applied to minimize the number of errors arising from the interaction of man vs machine. [4]

The basic objective of ergonomics is to study the factors that influence the performance of a worker's productive process, seeking to reduce future problems of workers, such as stress, fatigue, errors, and accidents, and to provide safety, satisfaction, and health., taking into consideration the comfort and well-being of the human being, according to the quality of life of people in their daily lives, including the working period [8].

Recognizing the relevance of the garment industry and its growing labor shortage, the overall objective of this article consists of a literature review based on scientific evidence that seeks to survey productivity, mental health and well-being, and ergonomic aspects with a focus on the garment industry worker and Industry 4.0, and their contributions to increased productivity and quality in the production process.

2 Methodology

The methodology used in the article was exploratory bibliographic research, which was based on the following question: What is the relationship between ergonomic aspects, well-being, and mental health of the worker, and how can these aspects influence productivity?

The methodology used to find the keywords followed the PICO proposal [3], which provides an evidence-based database search for a treatment or diagnosis, or strategy for evaluating the quality of a study that requires formulating the appropriate research question and searching the databases for bibliographies. [3] The search was categorized into blocks of three or more words that answered the guiding question of the study.

To find evidence to answer the guiding research question: "What is the relationship between ergonomic aspects, well-being, and mental health of the worker, and how can these aspects influence productivity?", we can use keywords in the Scopus and Web of Science systematic review databases, using the following strategies:

- 1) Productivity AND industry 4.0 AND (apparel OR textile).
- 2) Productivity AND industry 4.0 AND ergonomics.
- 3) Productivity AND "industry 4.0" AND (mental OR health OR well-being OR wellbeing).
- 4) Impact productivity OR ergonomic aspects OR employee) AND mental AND health AND (clothing AND industry OR apparel OR textile).

Table 1 shows the description of the PICO methodology used in the article according to [3].

Table 1: Definition of the components of the Systematic Review PICO.

Acronym	Definition
P	The impacts of the production process in the garment industry are related to ergonomics and the mental health and well-being of the worker.
I	Any improvement in mental health and well-being in the production of the garment industry.
C	Comparison can be the forms and methods of work in the various manufacturing industries.
O	Increased production with improved working conditions and greater worker satisfaction and quality of life.

From the application of the different keyword combinations defined above through the PICO methodology, 352 articles were found in the selected databases. As shown in Table 2.

Table 2. List of keywords used in research.

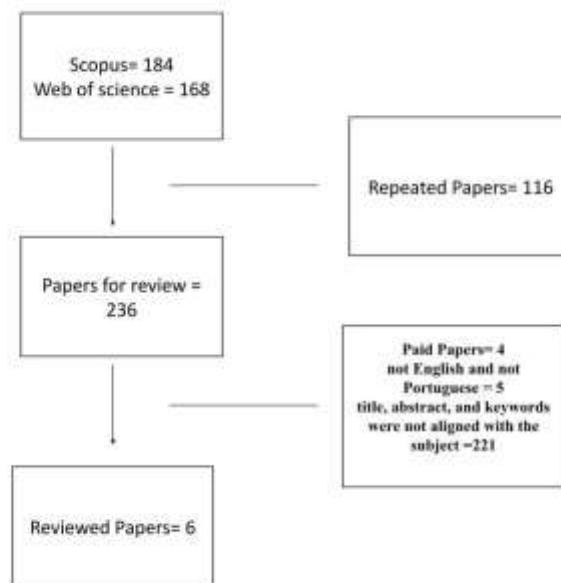
Databases	Keywords	Total
Web Of Science	<i>Productivity AND industry 4.0 AND (apparel OR textile)</i>	20
Scopus	<i>Productivity AND industry 4.0 AND (apparel OR textile)</i>	20
Web Of Science	<i>Productivity AND Industry 4.0 AND ergonomics</i>	43
Scopus	<i>Productivity AND Industry 4.0 AND ergonomics</i>	44
Web Of Science	<i>Productivity AND "industry 4.0" AND (mental OR health OR well-being OR wellbeing)</i>	100
Scopus	<i>Productivity AND "industry 4.0" AND (mental OR health OR well-being OR wellbeing)</i>	113
Web Of Science	<i>("Impact productivity" OR "ergonomic aspects" OR employee) AND "mental health" AND ("clothing industry " OR apparel OR textile)</i>	5

Scopus	<i>("Impact productivity" OR "ergonomic aspects" OR employee) AND "mental health" AND ("clothing industry" OR apparel OR textile)</i>	7
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From the methodology used for the literature review, the search was divided into four phases: identification, screening, eligibility, and inclusion of duplicate articles, articles whose title, abstract, and keywords were not aligned with the guiding question, articles in Portuguese and English and paid articles, international articles were consulted in the Web of Science and Scopus databases, published between 2018 and 2023 and removed articles that did not mention the above requirements.

3 Results

After analyzing the 352 articles in the Scopus and Web of Science databases, the PRISMA method was applied: identification, screening, eligibility, and inclusion, to identify the main articles that answer the guiding question: What is the relationship between ergonomic aspects, well-being, and mental health of the worker, and how can these aspects influence productivity?



Flowchart 1. Selected papers.

In the selected sample of 6 articles, it was observed that there are common points, namely: working conditions can impact productivity and the creation of jobs with a generic work methodology can improve the quality of life of the worker and the improvement in production.

According to [6] the use of a generic work methodology, after an ergonomic analysis (cognitive, physical, and organizational) it is possible to minimize impacts and improvements in productivity and can bring significant improvements in the workstations.

Monitoring workstations through cyber-physical production systems is capable of monitoring the human-machine relationship allowing for the improvement of well-being and productivity with the formulation of a workstation is proposed by [8].

According to [13], the level of stress can affect productivity in the textile industry, and through a study it is possible to identify the day-to-day occupational stresses that will cause impacts on production. Thus, when appropriate it can bring benefits in the standard of the quality of life of the worker and the improvement of productivity in the company.

Such findings further foster the need for studies related to the garment industry, looking for the ergonomic aspects that impact productivity.

Thus, it is suggested the execution of studies that deepen the knowledge about the impacts on productivity related to ergonomic aspects and mental health and well-being of the worker in Industry 4.0. Table 3 provides abstracts of the articles selected for the review.

Table 3. Summary of the selected papers.

Authors/ Year	Title	Methods	Findings
Meegahapola, PA; Prabodanie, RAR (2018).	<i>Impact of environmental conditions on workers' productivity and health</i>	Review	The study done in the industry shows the impacts on the productivity of environmental conditions in the shoe and automotive industries.
Newaz, MT; Giggins, H; Ranasinghe, U (2022)	<i>A Critical Analysis of Risk Factors and Strategies to Improve Mental Health Issues of Construction Workers</i>	literature review	Literature review to identify mental health risk factors in the construction industry
Krishna Siva Ravinder (2022)	MDH; RK; RP <i>Enhancement of safety and productivity all the way through function of ergonomics principles - A case study</i>	Case Study	Using the Kitting and assembly method to improve worker well-being during an assembly process and repetitive strain.

Ramos-Galarza, C., Acosta-Rodas, P. (2019). Velasco, LSF; Revilla, PER; Rodriguez, LVR; Santa Hincapie, MP; Saavedra-Robinson, LA ; Jimenez, JF (2022)	<i>Stress and productivity in workers of textile companies</i>	Review	The level of stress can negatively impact productivity
	<i>A human-centered workstation in industry 4.0 for balancing the industrial productivity and human well-being</i>	Review	Creating a generic human-centered workstation, taking into account ergonomic aspects, balancing well-being and productivity.
Pascual, Hogberg, Lamkull, Luque, Syberfeldt, Hanson, L (2022)	<i>Optimization of Productivity and Worker Well-Being by Using a Multi-Objective Optimization Framework</i>	Review	Creating a framework allowing a balance between productivity and worker well-being.

4 Conclusion

The objective of this article was to present a systematic review method on the impacts on productivity in the garment industry of ergonomic aspects, mental health, and workers' well-being. using the PICO model, which followed the guidelines for an evidence-based literature review by a guiding question that gave rise to its keywords [3].

It was observed, in the analyzed articles, that working conditions, stress levels, repetitive strain, and environmental conditions can impact productivity.

Thus, for the improvement of productivity, it is essential to improve the conditions of the physical environment and the monitoring of the worker through the Internet of Things (IoT) using sets of different types of sensors, connected directly to smartphones and/or computers, to quickly assess the productivity level of each worker, allowing the analysis of their workstations in real-time, proposing a new working methodology, aiming to improve the garment industry worker's mental health, ergonomics, and well-being.

[This work also reinforces the idea that there is a need for further studies about the relation between ergonomic improvements, of the workplace and of the task, and its effects on the productivity and the well-being of the worker.

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