



ERGONOMICS IN PRODUCTION ENGINEERING: AN OVERVIEW OF THE PRACTICE AND TEACHING IN UNDERGRADUATE COURSES IN BRAZIL

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Abstract

Production Engineering has contributed to improving the quality of products and processes, and one of its areas of study is ergonomics. However, despite the importance of this science for the professional practice of engineers, not all consider it in their projects. The objective of this study is to present an overview of the practice and teaching of ergonomics in production engineering courses in Brazil. To this end, the research was divided into two parts: i) a survey of ergonomics applied in production engineering projects; and ii) a survey of ergonomics disciplines in production engineering courses at Brazilian universities. The scope was limited to federal universities and those that made information available online. The results indicated that, among the study participants, none considered the cognitive and organizational aspects of ergonomics in their projects. Regarding the survey of ergonomics disciplines, 212 disciplines from 69 universities were investigated. The results revealed that ergonomics is not a mandatory subject in 29.24% of the courses and is taught in a workload of less than 50 hours and in conjunction with other subjects in 33.81% of the courses. Another finding is that none of the courses where ergonomics is mandatory have any indications in the syllabus that the specialization domain "Organizational Ergonomics" is addressed. Based on these results, a gap in ergonomics teaching is observed. It is recommended that this study be continued, including private universities and other variables that contribute to a better understanding of this reality.

Keywords: Ergonomics; Production Engineering; Teaching.

1. INTRODUCTION

The crisis experienced in Brazil is reflected in different economic areas, impacting both the industrial and service sectors (BARBOSA FILHO, 2017). In this context, in the search for companies to become, or remain, competitive, some of the elements used in the practice of organizations have been the minimization of labor costs and the maximization of productivity. However, the search for reduction

of costs when done without due concern for ergonomic issues can lead to an increase in the workload of workers and consequences related to human costs; in addition to costs for the work system with increased rework, errors and accidents (GUIMARÃES, 2004).

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Situations like these contribute to a drop in productivity and an increase in costs, instead of the desired cost reduction. It is, therefore, a cycle that is not virtuous and must be fought. On the other hand, ergonomics can contribute to breaking this cycle in a way that is compatible with the reality faced by companies.

Ergonomics is a discipline that has a systemic approach to all aspects of human activity (IEA, 2000). According to the Brazilian Association of Ergonomics, ergonomics is a science that seeks to understand the interactions between human beings and other elements or systems in order to optimize human well-being and the overall performance of this system (ABERGO, 2001).

It should be noted that the scope of Ergonomics has expanded in recent decades, no longer focusing only on the physical and incorporating the cognitive and organizational into its domains of specialization (ABERGO, 2021). According to Hendrick (1995), in order to account for the breadth of these three dimensions and to be able to intervene in work activities, ergonomics must be applied in a holistic approach to the entire field of action of the discipline, both in its physical and cognitive aspects, as well as organizational, social and environmental, among others. Also according to Hendrick, it is necessary to promote good ergonomics, that is, the one that is committed to the results, also generating good savings.

In this context, it is understood that professional training in strategic areas for the improvement of processes and new projects such as production engineering, for example, still needs to have a better developed human focus. The importance of promoting this change is reinforced by the new National Curriculum Guidelines for the Undergraduate Engineering Course - DCN, according to Resolution No. 2, of April 24, 2019 (DCN, 2019). In them, the competencies and the expected profile in the training of the graduate are established. Among the characteristics of the graduate's profile are: having a holistic and humanistic view, being critical, reflective, creative, cooperative and ethical and with a strong technical background; be able to recognize the needs of users, formulate, analyze and solve engineering problems in a creative way; adopt multidisciplinary and transdisciplinary perspectives in their practice; consider global, political, economic, social, environmental, cultural, and occupational health and safety aspects; To act with impartiality and commitment to social responsibility and sustainable development.

Also, the performance of engineers is subordinated to compliance with a code of ethics. According to the Code of Professional Ethics for Engineering, Agronomy, Geology, Geography and Meteorology, developed by the Federal Council of Engineering and Agronomy -



CONFEA/CREA (2019), violations of this code can lead to the loss of professional registration. In its Article 10, item II, some of the positions vetoed to professionals are presented, among which the following can be mentioned: neglecting the occupational safety and health measures under their coordination and imposing an excessive pace of work or exerting psychological pressure or moral harassment on employees.

In addition to these justifications, others can be added in order to contribute to demonstrating the importance of the discipline of ergonomics and related disciplines in professional training, such as, for example, for future production engineers, such as: the high number of sick leaves of workers and accidents at work, according to the Yearbook on Occupational Accidents (2019). It is understood that in many of these contexts, production engineering professionals can also contribute in a positive and preventive way, as long as they have the appropriate skills.

Although the need to consider human factors is established, there is no specification of how these competencies can be developed or, at least, what would be the minimum acceptable in the training of these professionals so that such competencies can be considered minimally developed. It is also unknown how the discipline of ergonomics has been taught to these graduates in Brazil. That is, which aspects of ergonomics are considered in the respective disciplines and whether these are limited to the theoretical part or involve the development of skills based on practice.

Thus, the present study seeks to understand how ergonomics disciplines are taught in production engineering courses in Brazilian universities, in addition to identifying an overview of how production engineering professionals have applied ergonomics in practice in their projects. It is believed that with this understanding, numerous other actions can be initiated in order to contribute to the training of these and other graduates who will use ergonomics in their professional practice.

2. GOAL

The objective of this study is to present an overview of the practice and teaching of ergonomics in production engineering courses in Brazilian universities. Due to time constraints, it was decided to delimit the scope of this research to federal universities with production engineering courses and that made the information available online.

3. MATERIALS AND METHOD



To meet the proposed objective, this research was divided into two parts:

i) survey of ergonomics practice by production engineering professionals and; ii) survey of ergonomics and related disciplines in production engineering courses in Brazilian universities.

In the first part of the research, as a method to improve the understanding of the content, interviews were conducted with production engineers in order to identify their experiences and their point of view on the practical application of ergonomics. The initial idea was to apply this form to all professionals in the area of production engineering affiliated with ABEPRO. However, after different attempts to contact them, the researchers did not get a response from the association. Thus, a convenience sample composed of professionals from the area of Production Engineering was used. Thus, the questionnaires were distributed in contact networks of professors in the area of engineering. In all, 18 professionals returned to the survey. It should be noted that this sample does not represent the population and the analyses presented describe only the experience of the professionals who participated in this research.

In the second part, with the delimitation of the scope to federal universities with production engineering courses and that made information available online, a total of 212 disciplines from 69 universities in all states were investigated. Also, in this scope of analysis, it was limited to the survey of the following information: content, workload and obligation. It should be noted that, for this project, no mechanisms for checking and validating the information obtained were implemented.

In this survey, the following information from the ergonomics disciplines was considered: workload, obligation and content based on the course syllabus. Study topics, prerequisites and other information were not addressed in this scope of the research due to the difficulty of accessing this information. It should be noted that in addition to this information, others can contribute to the survey of an overview of the teaching of ergonomics, however, it was decided to address the other universities, courses and information in future research.

4. FINDINGS

The first part of the results presents the survey that sought to understand how production engineering professionals perceive the importance of ergonomics in their professional performance and how they use it in practice. To this end, a questionnaire was developed in the Google Forms® tool. The details of this form are presented below.

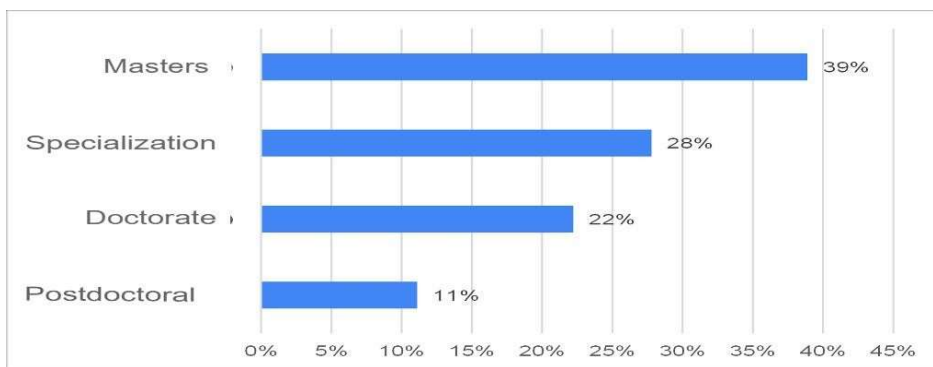


4.1. Survey of how ergonomics is considered in practice

This form, in addition to seeking the characterization of the respondents, also sought answers to the following questions: What level of training is the respondent at, what is his time working in the area of Production Engineering, how important the participant considers ergonomics, how many projects he has carried out in the area of Production Engineering, how many of these projects were carried out using ergonomics and were these aspects considered in the projects.

Fig.1 represents the level of education of the professionals who participated in the research, all of whom graduated in production engineering at the undergraduate level. Of the total number of respondents, all had at least specialization training, 27.8% with specialization; 38.9% with a master's degree; 22.2% with a doctorate and 11.1% with a post-doctorate.

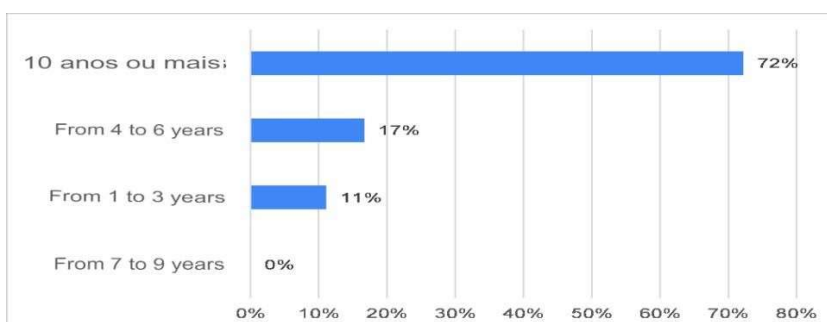
Figure 1 - Level of training of Production Engineers.



Source: the authors, 2020.

In Fig.2 it is shown the time of work participants in the area of Production Engineering. Among the people evaluated, most have been working in the profession for more than 10 years, with 72.2% with 10 or more years of experience; 16.7% aged 4 to 6 years; 11.1% work from 1 to 3 years in the area of production engineering.

Figure 2 - Time of experience of Production Engineers in practice.

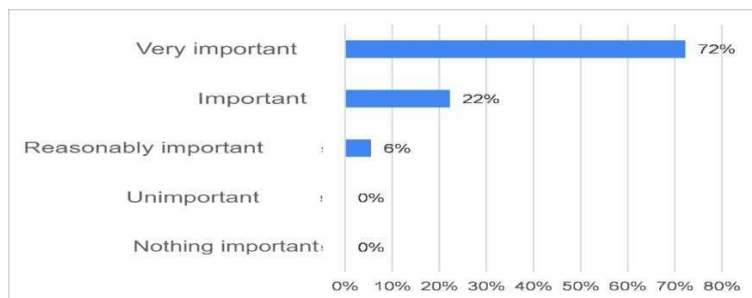


Source: the authors, 2020.



Fig. 3 addresses the importance of ergonomics in the professional practice of the engineers who participated in the study. In the perception of most respondents, the application of ergonomics in the practical performance of the production engineer is considered very important, specifically: 72.2% consider it very important, 22.2% consider it important and 5.6% of people consider it reasonably important.

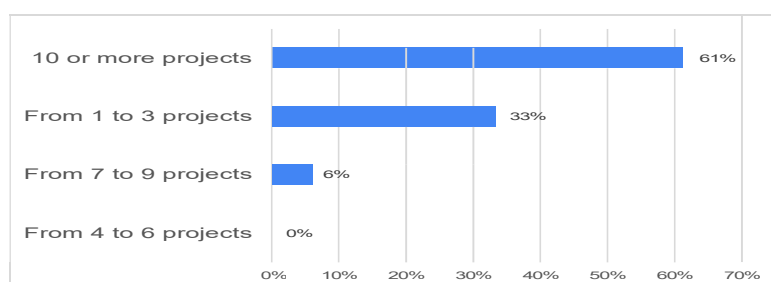
Figure 3 - Graph of the importance of ergonomics in practice for Production Engineers.



Source: the authors, 2020.

Fig. 4 represents the number of projects carried out in professional practice by participants in the area of Production Engineering. All professionals who participated in the survey reported having already participated in some project in the area of production engineering, and 61.1% had already carried out 10 or more projects; 33.3% carried out between 1 and 3 projects and; 5.6% performed between 7 and 9.

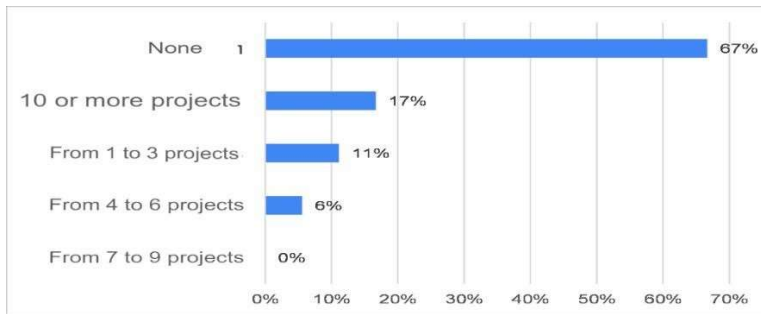
Figure 4 - Projects carried out in the area of Production Engineering



Source: the authors, 2020.

Among the projects developed by the professionals, Fig. 5 represents the percentage of projects that considered ergonomics. In most of the projects applied, the respondents reported not having applied ergonomics in practice, and: 66.7% had never applied ergonomics in their projects; 11.1% applied ergonomics in 1 to 3 projects, 5.6% applied ergonomics in 4 to 6 projects, and 16.7% applied ergonomics in 10 projects or more.

Figure 5 - Number of production engineering projects in which Ergonomics was applied



Source: the authors, 2020.

Participants were also asked about which aspects of ergonomics were addressed in the projects. Table 1 presents these results, and in 100% of the projects in which ergonomics was applied, only the domain of specialization of physical ergonomics was considered. It should be noted that one of the respondents pointed out the application of the Time and Methods Study as being ergonomics, however it was not clear in the answer which human factors would have been considered in this study.

Table 1 - Ways of Approaching Ergonomics in Projects

Requirements considered in the projects	Ergonomics
Posture and labor gymnastics practices: in 5s implementation projects	Physics
Chair / notebook stand for home office work	Physics
Posture and work station	Physics
Work station: in Kaizen Program Implementation Project	Physics
Worker comfort	Physics
Study of times and methods	It is not clear what human factors which were considered in the study

Source: the authors, 2021.

It should be noted that there is a possible contradiction in the answers, because while most professionals say that ergonomics is very important, they do not actually apply it in their projects or apply only a partial view, limited to the physical aspects of ergonomics.

The results of this first part of the research contribute to justify the importance of conducting a survey on how ergonomics disciplines have been taught in production engineering courses in Brazil.

4.2. Ergonomics in Federal Universities in Brazil

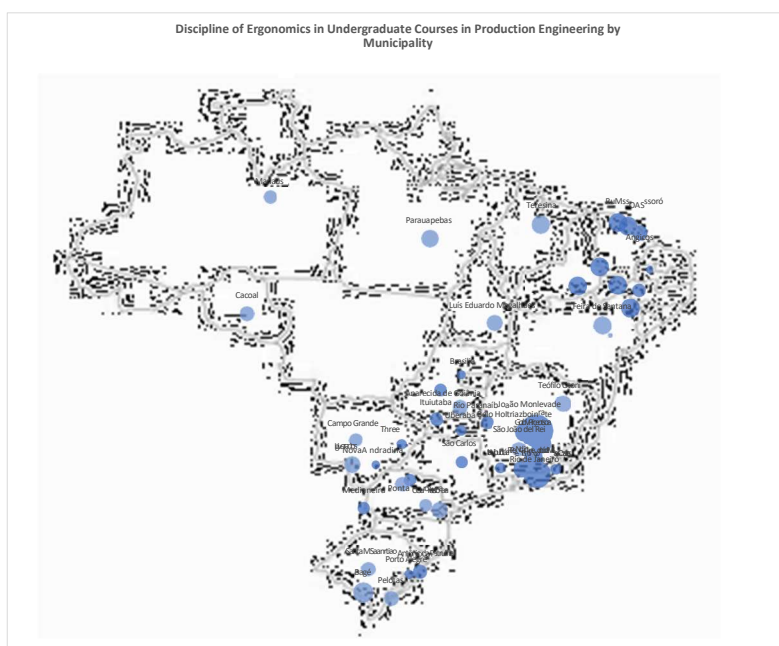
The results of the second part of the research are presented below, and reflect an overview of the ergonomics disciplines in the production engineering courses of federal universities in the country that make the information available online.

Fig. 6 represents the ergonomics disciplines in production engineering courses in Brazilian states. In this Figure it is possible to identify in the colors of lighter green, the states that received indicator 0 (zero) and in dark green the states that received indicator 3 (three), which was the highest score among the states. States such as Sergipe, Rio Grande do Sul, Rio Grande do Norte, Rondônia and Piauí appear as positive highlights in this survey.

Fig. 7 shows the proportion of ergonomics disciplines in production engineering courses by municipalities in Brazil, by means of bubbles. With this graph it is possible to identify a highlight for the number of municipalities in the northeast, southeast and south regions that have the largest number of ergonomics disciplines in production engineering courses.



Figure 7 - Ergonomics Map in Production Engineering



Source: the authors, 2021.

Fig. 8 shows the states with universities that present ergonomics disciplines in production engineering courses where it was possible to verify, through reading the syllabus, the existence of indications that the specialization domain of organizational ergonomics is part of the teaching scope. It is possible to verify that the following regions apply this domain: Amazonas, Piauí, Ceará, Rio Grande do Norte, Rio Grande do Sul, Paraíba and Pernambuco. Also noteworthy are the states of Pará, Minas Gerais and Rio de Janeiro, where there are courses with disciplines that address macroergonomics and the socio-technical view.

Figure 8 - Organizational Ergonomics Map in Production Engineering



Source: the authors, 2021.

With the results, it was possible to identify that the discipline of ergonomics is not mandatory in 29.24% of the courses and is taught in a workload of less than 50 hours and together with other subjects in 33.81% of the courses. Another finding is that in none of the courses where the discipline of ergonomics is mandatory (70.76%) there is evidence in the syllabus that the specialization domain of "Organizational Ergonomics" is addressed.

Although this is a preliminary research, these results reiterate the importance of more surveys like this and reflections on how ergonomics disciplines have been taught in production engineering courses. It is emphasized that the practical performance of ergonomics also occurs through the training of professionals from other areas and that the ideal would be a joint effort in investigations in all areas of training in which the discipline of ergonomics is taught.

In addition, the present research focused on theoretical training and not on practical training, but it can be mentioned that in terms of the syllabus of the disciplines studied, the practical training of the students was not made explicit.

The results, so far, show a gap in the teaching of ergonomics, which can impact the training of future production engineers. Therefore, it is recommended that this study continue including private universities, different means of accessing/checking the data and the consideration of other variables that contribute to a better visualization of the reality of professional training in courses that have the discipline of ergonomics. Studies that seek



successful experiences in internationally recognized educational institutions are also recommended so that the most relevant aspects are considered in the analyses.

5. CONCLUSION

This research aimed to present an overview of the practice and teaching of ergonomics in production engineering courses in Brazil. To this end, the research was divided into two parts: i) survey of the practice in ergonomics by the professionals and; ii) survey of ergonomics and related disciplines in production engineering courses in Brazilian universities. Due to time constraints, it was decided to limit this research to federal universities that made information available online.

The results of the first part of the survey showed the importance of ergonomics from the point of view of production engineers, and 72.2% of the participants understand that it is very important to consider ergonomic aspects in projects in the area of production engineering. On the other hand, only 33.4% apply ergonomics in their projects. Of the total number of professionals who have already applied ergonomics in their projects in practice, most consider only the physical aspect of ergonomics and none of them have applied the domains of specialization of cognitive and organizational ergonomics. It is understood that these results present a possible contradiction, because at the same time that professionals understand the importance of ergonomics, they do not consider it in practice.

In the second part of the survey, the survey of ergonomics disciplines in engineering courses covered 212 disciplines from 69 Brazilian federal universities. These were evaluated taking into account the content, the workload and the obligation. With the results, it was possible to identify that the discipline of ergonomics is not mandatory in 29.24% of the courses and is taught in a workload of less than 50 hours and together with other subjects in 33.81% of the courses. Another finding is that in none of the courses where the discipline of ergonomics is mandatory, there is evidence in the syllabus that the specialization domain "Organizational Ergonomics" is addressed.

It is concluded based on the information provided by these universities that there is a gap in the teaching of ergonomics, which may impact the training of future production engineers. Therefore, it is recommended that this study be continued, including private universities, different means of accessing and checking the data, and the consideration of other variables that contribute to a better visualization of this reality.



THANKS

The present work was carried out with financial support from the National Council for Scientific and Technological Development – CNPq, through a Scientific Initiation scholarship.

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