

Investigation of the Brazilian academic production in Ergonomics, from 1987 to 2017

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Abstract

Paper aims: To shed light on the state of the art of the academic production in Ergonomics.

Originality: There is no study on the Brazilian academic production in Ergonomics for the last 30 years.

Research method: Based on the Capes database, the abstracts of 1471 theses/dissertations from 2007 to 2017 were classified by approach and focus.

Main findings: 58.9% of the studies are diagnoses and only 1.4% presents complete projects for work optimization, what might indicate a difficulty of implementing ergonomic interventions in Brazilian companies. 52% of the publications are from national meeting proceedings and only 5.4% from international journals.

Implications for theory and practice: The lack of clear objectives, main results and applications in the abstracts reduces the potential interest in the studies. This, and the low number of intellectual production (less than one publication/study) impact the dissemination of knowledge.

Keywords

Ergonomics. Academic production. Intellectual production. Investigation.

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1. Introduction

“Ergonomics (or human factors) is the scientific discipline concerned with the understanding of interactions among humans and other elements of a system, in order to optimize human well-being and overall system performance” (International Ergonomics Association, 2019). It “promotes a holistic approach in which considerations of physical, cognitive, social, organizational, environmental and other relevant factors are taken into account” (International Ergonomics Association, 2019). Ergonomics was developed at the outbreak of World War II, being officially founded in July 12, 1949, in England.

In Brazil (see Moraes & Soares, 1989; Moraes, 1999; Soares, 2006 for a historical overview), the Ergonomics seed was planted in the Industrial Engineering course at the Escola Politécnica of the Universidade de São Paulo (USP), when Prof. Sergio Penna Kehl supervised the first masters dissertation entitled “Ergonomia do Manejo”, presented in 1971 by Itiro Iida. The latter was responsible for introducing the discipline in the graduate course of Industrial Engineering at COPPE/Universidade do Rio de Janeiro (UFRJ). In the same period, Ergonomics was also introduced in Psychology departments by prof. Paul Stephaneek and prof. Reiner Rozestraten (USP Campus Ribeirão Preto), and prof. Franco Lo Presti Seminério (Instituto Superior de Estudos e Pesquisas Psicossociais of the Fundação Getúlio Vargas, Rio de Janeiro - ISOP/FGV-RJ). Prof. Alberto Mibielli de Carvalho introduced



Ergonomics in the department of Medicine of the two most important universities in Rio de Janeiro: Nacional (UFRJ) and Ciências Médicas (UEG, later Universidade do Estado do Rio de Janeiro - UERJ). Prof. Karl Heinz Bergmiller introduced the discipline in the Design course of the Escola Superior de Desenho Industrial (ESDI/UERJ).

In 1974, in Rio de Janeiro, prof. Franco Lo Presti Seminário promoted the first Brazilian Seminar in Ergonomics and, in 1975, set up the first specialization course in Ergonomics (a partnership ISOP/FGV-RJ and COPPE/UFRJ), which ended in 1990 when ISOP was extinguished by the Collor government. Since then, many Higher Education Institutions (HEI) in different Brazilian regions offer *lato sensu* courses in Ergonomics (Soares, 2004) and, in 2012, the Centro de Artes e Comunicação of the Universidade Federal de Pernambuco (UFPE) launched the first *stricto sensu* course (professional masters), the first class initiating in March 2013 (Universidade Federal de Pernambuco, 2013). Both *lato* and *stricto sensu* courses may be accredited by the Associação Brasileira de Ergonomia (2019a), which was founded in August 1983 and is affiliated to the International Ergonomics Association (IEA). ABERGO also provides professional certification for ergonomics practitioners, holds the journal *Ação Ergonômica*, launched in 2002 (Associação Brasileira de Ergonomia, 2019b) and, since 1984, organizes the biennial Congresso Brasileiro de Ergonomia. Lucio et al. (2010) evaluated the contents of the ABERGO congresses from 1999 to 2008.

The spreading of Ergonomics in Brazil may also be noted by the increasing number of research groups. In 2001, Soares (2004) found 101 Ergonomics research groups listed in the directory published by the Conselho Nacional de Desenvolvimento Científico e Tecnológico – CNPq, of the Ministério de Ciência, Tecnologia e Inovação (MCTI), while Lucio et al. (2010) found 165 groups in 2008. In June 2018, a search in the same directory (Conselho Nacional de Desenvolvimento Científico e Tecnológico, 2018) showed 321 Ergonomics research groups acting in various institutions.

Since the first initiatives in the 1970s, many doctorate (DT) theses, as well as academic masters (AM) and professional masters (PM) dissertations have been produced in graduate programs from several HEIs across Brazil. Considering that depending on the modality and course area, as well as the ergonomic approach, the studies might differ, this paper aimed at contributing to the field of Ergonomics, by analyzing this academic production. Research started during the revision of the second edition of the book “Ergonomia, Projeto e Produção” (Iida, 2005) with the objective of identifying Brazilian case studies for substituting, in the third edition (Iida & Guimarães, 2016), the old and international ones used in the previous edition. Although it was not found as many cases as needed to illustrate the three areas (physical, cognitive and organizational) of the Ergonomics domain (International Ergonomics Association, 2019; Associação Brasileira de Ergonomia, 2019c) presented in the third edition, written between 2012 and 2015, the search ended up with important information about the Ergonomics academic production since 1987, which was later updated to 2017, as presented in the following sections.

2. Method

Survey was based on the keyword “ergonomics” in any part of the registration form of the documents available at the Capes Theses Database of the Portal de Periódicos Capes/MEC (since 2016 denominated Theses and Dissertations Catalog) (Coordenação de Aperfeiçoamento de Pessoal de Nível Superior, 2018). Survey was done in three steps: 1) in April 2012 (Coordenação de Aperfeiçoamento de Pessoal de Nível Superior, 2012); 2) in November 2013 (Coordenação de Aperfeiçoamento de Pessoal de Nível Superior, 2013) and; 3) in May 2018 (Coordenação de Aperfeiçoamento de Pessoal de Nível Superior, 2018), due to the changes made by Capes regarding the collection of information, analyzes and evaluation of the National Graduate System (SNPG) in the past years. Until March 2014, information was collected through the Capes collection system (Coleta Capes) when it was replaced by the Sucupira Platform, “an online tool to collect information, perform analyzes, assessments and serve as a reference base” (Coordenação de Aperfeiçoamento de Pessoal de Nível Superior, 2014). However, only in 2016, it was integrated into the Sucupira Platform, being regularly updated since September 2016.

In April 2012, the Capes database returned 1336 theses and dissertations under the keyword ergonomics, from 1987 to 2010, therefore a second search was done when the Capes website became accessible in October 2013, providing complete information only about the studies from 2005 to 2012. The third search, in May 2018, retrieved the documents from 2013 to 2017. Thus, 1883 documents from 1987 to 2012 were retrieved in the first and second searches, and 834, from 2013 to 2017, were collected in the third search, totalizing 2717 documents from 1987 to 2017. In the third step, the Capes database, already integrated into the Sucupira platform, provided complete information (including abstract) of the academic production only from 2013 onwards. All documents prior to 2013 were listed with title, author and HEI, but there were no more abstracts available and no link to access the complete documents. Therefore, since the Capes database no longer made

available the abstracts from the studies before 2013, it was decided to evaluate a ten-year period, using the 906 records from 2007-2012 (identified in steps 1 and 2) and the 834 records from 2013-2017 (identified in step 3), totaling 1740 theses and dissertations.

Because the Capes database does not allow for data exportation, they were copied to a word editor for further analysis and transfer to an electronic spreadsheet. From the 906 records (period 2007-2012), 83 were eliminated because did no refer to Ergonomics: they were filtered because the research line of the program or department informed the term “ergonomics”; other 23 had no abstract and four have abstracts with insufficient information for analysis. From the 834 studies (period 2013-2017), 128 were eliminated because did not refer to Ergonomics, 23 had no abstract, two had abstracts with insufficient information for analysis and six could not be accessed due to system failure. Therefore, the universe considered 796 studies from 2007-2012 and 675 studies from 2013-2017, totaling 1471 studies from 2007 to 2017 (329 DT theses, 882 AM dissertations and 260 PM dissertations). Table 1 shows a summary of the number of studies retrieved and excluded in the three steps of the survey.

Table 1. Summary of the number of studies retrieved and selected in the survey.

Source	N° of studies	Exclusion criteria				Total valid	
		Not Ergonomics	Lack of abstract	Abstract with insufficient information	Not accessible		
Step 1							
April 2012	Capes Catalog (2012)	1336					
(1987-2010)	Coleta platform						
Step 2							
November 2013	Capes Catalog (2013)	+547 (2005-2006)					
(2005-2012)	Coleta platform						
Period 1987-2012	Coleta platform	1883 (977 were from 1987-2006)					
Period 2007-2012	Coleta platform	906	83	23	4	0	796
Step 3							
May 2018	Capes Catalog (2018)	834					
(2013-2017)	Sucupira platform						
Total N° of studies (1987-2017)		2717					
Total N° of studies (2007-2017)		1740	211	46	6	6	1471

The abstracts of the 1471 selected documents were read by two researches with doctorate in Industrial Engineering/emphasis on Ergonomics and classified by:

- a) approach type: (1) “diagnosis” with no recommendations or with generic recommendations such as “changes are needed”, without pointing out how these changes could be made; (2) “diagnosis with recommendations” involving analysis of a situation with clear proposals for improvement; (3) “complete project”, which presents an analysis, proposal for improvement (of interface, product or process), its application and validation; (4) “production of basic data” (in anthropometry, biomechanics, physiology, psychology) from laboratory experiments; (5) “comparison or proposal of method”; (6) “professional profile”, which evaluates the role of professionals working in Ergonomics and; (7) “literature review”.

With the exception of type 6 (“professional profile”) studies, they were also classified by:

- b) focus: human factors (anthropometry, biomechanics, physiology, psychology), interface (human-computer interaction, signs, warnings, labels), process (production and service) or product (including architecture, urban space, computational equipment, but excluding interface).

Due to lack of abstract clarity, 20 out of the 1471 documents generated disagreement or doubt about their classification according the “approach”, the only one that involves subjective judgment, what could give margin for some bias. Conflicts were solved after debate and consensus among the two evaluators and a third researcher, also author of this article. Therefore, considering that for most of the documents this classification was easily performed, and that the other classifications were objective, we believe bias is minimal and negligible in this particular study.

Descriptive statistical analysis was carried out considering the HEI, department, year, course modality (DT, AM and PM), course area, study approach and focus. For inferential statistical analysis, and considering the large number of department names in various HEIs, they were grouped into six major areas: Architecture, Design, Engineering (Aeronautical, Agricultural, Agronomic, Automotive, Biomedical, Civil, Electrical, Environmental, Forestry and Mechanical), Industrial Engineering (Process, Production, Management Systems), Health (Biology, Collective Health, Health Sciences, Medicine, Nursing, Odontology, Physical Education, Physiotherapy, Psychology and Public Health), and “Others” (Administration, Arts, Communication, Computation, Economy, Education, Linguistics, Music, Social Sciences, Sociology and Tourism). Industrial Engineering (which has a predominantly managerial focus) was separated from the other Engineering (which have a predominantly technical focus) in order to better evaluate the area concentrating the largest number of studies.

Considering the six major areas, chi- square statistics was used to evaluate the frequency and dependency between variables: course area, course modality, study approach and focus of study. This test allows for verifying dependence between two variables, through a double entry table, also known as contingency table. In addition to the chi-square test, when it indicated significant difference, the standardized residuals were analyzed for characterizing the nature of dependency between variables.

In order to evaluate the repercussion of the academic production, a search was performed for the publications associated to the theses and dissertations from the five HEIs with largest academic production (50 or more theses and dissertations), in the period 2007-2012. These institutions were the Universidade Federal Fluminense (UFF), Universidade Federal de São Carlos (UFSCar), Universidade Federal de Santa Catarina (UFSC), Universidade de São Paulo (USP) and Universidade Federal do Rio Grande do Sul (UFRGS). Search was performed by five students of prof. Dr. Raimundo Lopes Diniz, from the Design course of the Universidade Federal do Maranhão (UFMA), in the authors’ curricula, available on the CNPq Lattes platform, updated until the end of May 2016, when the 2007 to 2012 survey was closed. The survey for the period 2013- 2017, done in May 2018, considered the publications, from all HEIs, listed as “associated intellectual production” to the theses and dissertations in the Sucupira platform.

3. Results

Figure 1 shows the historical evolution of the annual academic *stricto sensu* production from 1987 to 2017, summing up 2717 theses and dissertations over the years. It is noted that this number represents all the studies available in the Capes database, filtered by the keyword “ergonomics”, but they have not been treated yet. Therefore, it incorporates the studies that were later eliminated from analysis because they were not studies on Ergonomics, had no abstract or the abstract had not enough information for analysis. We can see an increase in production over the years.

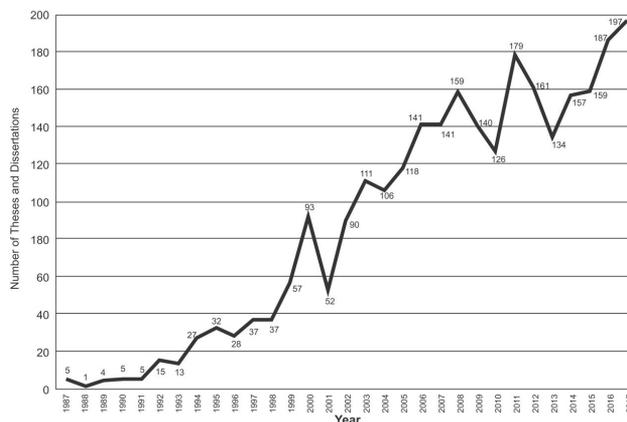


Figure 1. Historical evolution of the annual production of theses and dissertations from 1987 to 2017, before data treatment.

Figure 2 shows the academic production, per year, from 2007 to 2017, period selected for detailed analysis, since information was available in the Capes Catalog and on the Sucupira platform. Note that the Figure shows data already treated, eliminating the studies that were not on Ergonomics, those without abstract or with abstracts with insufficient information. They summed up 1471 theses and dissertations, an average of 147 studies per year, with peaks in 2011 and 2017. As per Table 2, the academic production in the period 2007-2017, distributed by major course area and course modality, was 329 DT theses (22.4%), 882 (59.9%) AM dissertations and 260 (17.7%) PM dissertations.

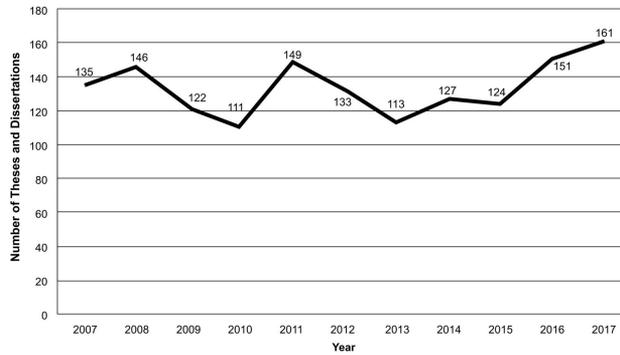


Figure 2. Academic production in Ergonomics, per year, from 2007 to 2017, considering data already treated (studies submitted to statistical analysis).

Table 2. Academic production (period 2007-2017) according to course modality and major course area.

Course Area	Architecture	Design	Engineering	Industrial Engineering	Health	Others	Total	%
Course Modality								
Doctorate (DT)	15	42	44	121	64	43	329	22.4
Academic Masters (AM)	54	219	121	208	165	115	882	59.9
Professional Masters (PM)	2	56	35	124	23	20	260	17.7
Total	71	317	200	453	252	178	1471	100
%	4.8	21.6	13.6	30.8	17.1	12.1	100	

Figure 3 presents the results from the HEIs with largest academic production in Ergonomics (50 or more theses and dissertations) in the period 2007-2017, and Figure 4, the distribution by course modality. It is important to note that, from 2007 to 2012, the top five HEIs were UFF, UFSCar, UFSC, USP and UFRGS, but in the period 2013-2017, the academic production of UFPE surpassed that of UFRGS, in view of the inauguration, in 2013, of its professional master's program in Ergonomics.

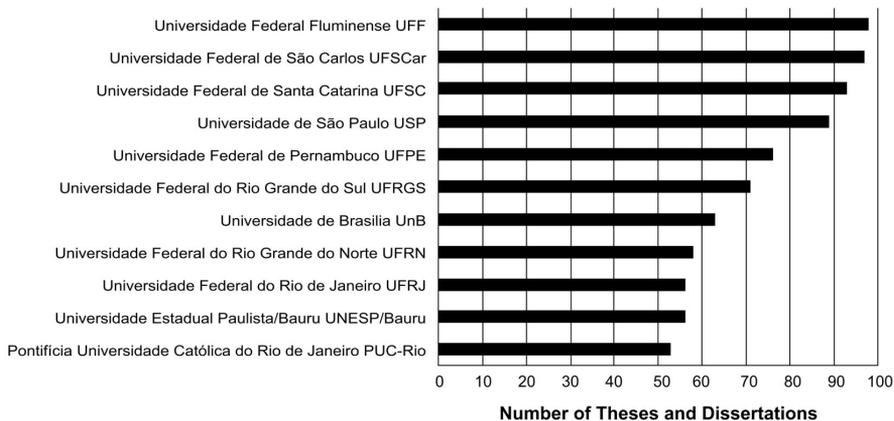


Figure 3. Academic production in Ergonomics, of the HEIs with 50 or more theses and dissertations in the period 2007-2017.

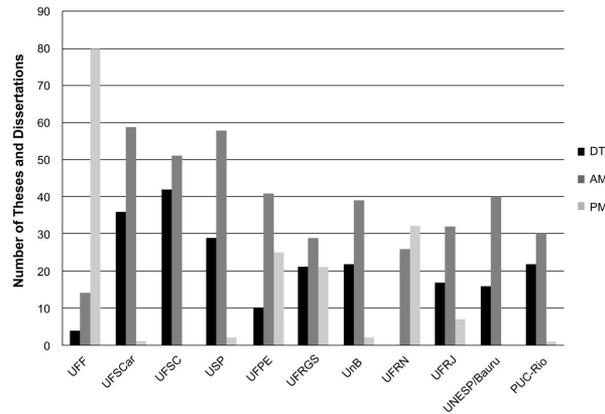


Figure 4. Academic production in Ergonomics, by course modality, of the HEIs with 50 or more theses and dissertations in the period 2007-2017.

Based on data in Figures 3 and 4, among 136 HEIs, UFF has the largest academic production (98), followed by UFSCar (97), UFSC (93), USP (89), UFPE (76), UFRGS (71), Universidade de Brasília (UnB) (63), Universidade Federal do Rio Grande do Norte (UFRN) (58), Universidade Federal do Rio de Janeiro (56), Universidade Estadual Paulista/Campus Bauru (UNESP/Bauru) (56) and Pontifícia Universidade Católica do Rio de Janeiro (PUC-Rio) (53). These 11 HEIs are responsible for 55% of the academic production, and six of them (UFF, UFSCar, UFSC, UFRGS, UFRN and UFRJ) concentrate Ergonomics in Industrial Engineering programs, what justifies the higher incidence of studies in this course area (see Table 2). USP concentrates the studies in the areas of Architecture/Urbanism (43), Industrial Engineering (10) and Physical Education (10); UFPE, UNESP/Bauru and PUC-Rio concentrate the studies in the area of Design; and UnB in the area of Psychology (40). These HEIs have research groups registered in the CNPq directory (Conselho Nacional de Desenvolvimento Científico e Tecnológico, 2018).

Table 2 shows a higher incidence of AM dissertations (882 or 59.9%) than DT theses (329 or 22.4%) and PM dissertations (260 or 17.7%), what was expected since it reflects the annual entry of students in the courses: there are less candidates for doctorate programs and few HEIs offer professional masters programs, a modality created by Capes in 1998.

The area of Industrial Engineering concentrates the largest number of studies (453 or 30.8% of the total) in all course modalities: 26.7% DT thesis, 45.9% AM dissertations and 27.4% PM dissertations. Out of these 453 studies, 87 are from UFSCar, 81 from UFF, 65 from UFSC, 54 from UFRGS, 42 from UFRJ, 25 from UFRN, 19 from the Universidade Tecnológica Federal do Paraná (UTFPR), 15 from the Universidade Federal da Paraíba (UFPB) and 12 from USP.

The Design area concentrates 317 studies (21.6% of the total): 13.2% DT thesis, 69.1% AM dissertations and 17.7% PM dissertations. They are mainly from UFPE (68), UNESP/Bauru (52) and UNESP/Araraquara (18), PUC-Rio (49), USP/Ribeirão Preto (13), USP/São Carlos (11). 13 studies, from the Pontifícia Universidade Católica de São Paulo (PUC-SP), are in digital design.

The Health area comprises 252 studies (17.1% of the total) from ten courses, the majority (65.5%) being AM dissertations.

The Engineering area groups the studies (200 or 13.6% of the total) from Agricultural Engineering (mainly from the Universidade Federal de Santa Maria - UFSM), Forestry Engineering (mainly from the Universidade Federal de Viçosa - UFV), Civil Engineering (mainly from UFF), Biomedical (Universidade do Vale do Paraíba - UNIVAP, Universidade de Mogi das Cruzes - UMC and Universidade Camilo Castelo Branco - UNICASTELO), Automotive (USP), Environmental (UFRJ), Aeronautical and Mechanical (mainly from the Universidade Federal do Paraná - UFPR and the Instituto Tecnológico de Aeronáutica - ITA). This confirms the relevance of Ergonomics for different professional segments.

Considering the 71 studies (4.8%) grouped into the Architecture area, 44 (62%) belong to the Architecture/Urbanism course of USP.

178 studies (12.1%) correspond to 11 areas grouped under the generic classification “Others”.

Table 3 presents the academic production organized according to study approach and course modality.

It was expected an association between study approach and course modality, i.e., that DT theses were either “complete projects” (with diagnosis, proposals of solutions, validation, and recommendations for implementation) or “comparison or proposal of method” with the modeling of complex systems; that AM studies were “diagnosis with recommendations”; and PM dissertations were less complex (diagnosis). However, the majority of DT theses are “diagnosis” (53.5%), 28.6% are “comparison or proposal of method”, 5.2% are “diagnosis with recommendations” while “complete projects” are only 7.0% of the DT production. The majority of AM dissertations are “diagnosis” (61.8%) followed by “comparison or proposal of method” (16.1%), “diagnosis with recommendations” (7.7%) and 7.8% are “complete projects”. The majority of PM dissertations are also “diagnosis” (56.2%), followed by “comparison or proposal of method” (23.8%) and “diagnosis with recommendations” (6.9%).

Table 3. Academic production organized according to study approach and course modality.

Course Modality	Doctorate (DT)	Academic Masters (AM)	Professional Masters (PM)	Total	%
1. Diagnosis	176	545	146	867	58.9
2. Diagnosis with recommendations	17	68	18	103	7.0
3. Complete project	23	69	20	112	7.6
4. Production of basic data	19	45	10	74	5.0
5. Comparison or proposal of method	94	142	62	298	20.3
6. Professional profile	0	5	1	6	0.4
7. Literature review	0	8	3	11	0.7
Total	329	882	260	1471	100
%	22.3	60.0	17.7	100	

Statistical chi-square test showed significant association (associated probability = 0.0016) between study approach and course modality and the standardized residuals test confirmed that “diagnosis” (type 1) is relatively more frequent in AM dissertations and relatively less frequent in DT theses. “Comparison or proposal of method” (type 5) is relatively more frequent in DT theses and less frequent in AM dissertations.

Table 4 presents the distribution by study approach and course area. The majority of studies (867 or 58.9% of the total) are “diagnosis” (type 1), 235 (27.1%) being from Industrial Engineering and 188 (21.7%) from Health courses.

Table 4. Academic production organized by study approach and course area.

Course Area	Architecture	Design	Engineering	Industrial Engineering	Health	Others	Total	%
1. Diagnosis	32	174	101	235	188	137	867	58.9
2. Diagnosis with recommendations	11	30	16	33	6	7	103	7.0
3. Complete project	11	28	26	23	14	10	112	7.6
4. Production of basic data	1	23	12	24	11	3	74	5.0
5. Comparison or proposal of method	15	60	45	130	29	19	298	20.3
6. Professional profile	0	1	0	5	0	0	6	0.4
7. Literature review	1	1	0	3	4	2	11	0.7
Total	71	317	200	453	252	178	1471	100
%	4.8	21.5	13.6	30.8	17.1	12.1	100	

“Comparison or proposal of method” (type 5) is the second incidence (298 or 20.3% of the total), 130 (43.6%) being from Industrial Engineering, mainly from AM dissertations and DT theses.

112 studies (7.6%) are “complete projects” (type 3), 28 (25%) from Design, 26 (23.2%) from Engineering and 23 (20.5%) from Industrial Engineering courses. The projects are mainly from AM dissertations (61.6%).

103 studies (7%) are type (2) “diagnosis with recommendations”, 33 (32%) from Industrial Engineering and 30 (29.1%) from Design courses, mainly from AM dissertations.

74 (5%) type (4) studies are “production of basic data” in anthropometry and biomechanics, mainly proposed in Design AM dissertations from UNESP/Araraquara and UNESP/Bauru.

Type (6) “professional profile” studies (six or 0.4%) and type (7) “literature review” (11 or 0.7%) are minority, summing up 1.1% of the total.

The chi-square test showed significant association (associated probability <0.0001) between study approach and course area: “diagnosis” (type 1) is relatively more frequent in Health courses (evaluating postural risks) and in the courses grouped as “Others”, while relatively less frequent in Architecture, Engineering and Industrial Engineering courses. “Diagnosis with recommendations” (type 2) is relatively more frequent in Architecture (diagnosis of built environment and urban space) and Design courses (diagnosis of consumer products, workstations and interfaces) while relatively less frequent in Health courses. “Complete project” (type 3) is relatively more frequent in Architecture (projects of built environment and urban space) and Engineering courses (mainly projects of built environment) but relatively less frequent in Industrial Engineering courses. Studies on “production of basic data” (type 4) are relatively more frequent in Design courses while relatively less frequent in the courses grouped as “Others”. Studies of “comparison or proposal of method” (type 5) are relatively more frequent in Industrial Engineering (methods for production management and risk assessment) and relatively less frequent in Health and “Others” courses. Studies on “professional profile” (type 6) are relatively more frequent in Industrial Engineering courses.

Table 5 shows the distribution according to study focus (human factors, interface, process or product) and course area of 1465 studies, because six studies out of the 1471 were on “professional profile”, and were not classified by focus.

Table 5. Academic production organized by focus of study and course area.

Course Area	Architecture	Design	Engineering	Industrial Engineering	Health	Others	Total	%
Human Factors	0	24	14	38	40	10	126	8.6
Interface	1	110	15	15	8	26	175	11.9
Process	3	41	70	320	182	124	740	50.5
Product	67	141	101	75	22	18	424	28.9
Total	71	316	200	448	252	178	1465	100
%	4.8	21.6	13.7	30.6	17.2	12.2	100	

Note: Six studies were classified as type 6 (professional profile) and were not classified by study focus

There is significant association (associated probability < 0.0001) between course area and focus of study: the analysis of the standardized residuals showed that studies on human factors are relatively more frequent in Health and relatively less frequent in Architecture courses. Studies focusing on interface are relatively more frequent in Design and “Others” courses and relatively less frequent in the other course areas. Studies with focus on process are relatively more frequent in Industrial Engineering, Health and in “Others” courses, while relatively less frequent in Architecture, Design and Engineering. Studies on products are relatively more frequent in Architecture (urban space), Engineering (electrical/mechanical products) and in Design (workstations and consumer products) but are relatively less frequent in the other course areas.

4. Discussion

From 1987 to 2017, there was a significant increase in Brazilian academic production in Ergonomics. A detailed analysis of the last ten years (2007-2017) shows regularity in this production with an average of 147 studies/year, with peaks in 2011 and 2017. Six HEIs with 70 or more theses/dissertations (UFF, UFSCAR UFSC, USP, UFPE and UFRGS) account for 35.6% of the academic production, the largest number (37%) being AM dissertations with type (1) approach (diagnosis). Industrial Engineering is the area with the largest number of studies (30.8%, mainly focusing on process), followed by Design (21.5%, mainly focusing on product and interface) and Health (17.1%, mainly focusing on process). Based on the analysis, it is possible to summarize the results as per Table 6.

The largest number of studies, in all course modalities, is concentrated in the area of Industrial Engineering, which responds for the majority of studies with focus on process. Design has the second concentration of studies, which tend to focus on product and interface. Health is the third largest area, mainly producing diagnosis with focus on process.

Table 6. Distribution of the studies according to course area, study approach and focus.

Approach	Course Area	Architecture	Design	Engineering	Industrial	Health	Others	Total	%
	Focus				Engineering				
1. Diagnosis	Human Factors	0	5	2	14	17	4	42	4.8
	Interface	1	67	8	5	1	12	94	10.8
	Process	0	27	50	189	158	109	533	61.5
	Product	31	75	41	27	12	12	198	22.8
2. Diagnosis with recommendations	Human Factors	0	0	0	0	0	0	0	0
	Interface	0	7	0	1	1	1	10	9.7
	Process	0	3	6	20	5	5	39	37.9
	Product	11	20	10	12	0	1	54	52.4
3. Complete project	Human Factors	0	0	0	0	0	0	0	0
	Interface	0	15	2	4	3	7	31	27.7
	Process	0	2	3	10	6	0	21	18.7
	Product	11	11	21	9	5	3	60	53.6
4. Production of basic data	Human Factors	0	11	8	16	9	2	46	62.2
	Interface	0	2	0	0	0	0	2	2.7
	Process	0	0	1	5	2	0	8	10.8
	Product	1	10	3	3	0	1	18	24.3
5. Comparison or proposal of method	Human Factors	0	8	4	6	13	3	34	11.4
	Interface	0	19	5	5	3	6	38	12.7
	Process	0	8	10	95	9	9	131	43.9
	Product	15	25	26	24	4	1	95	31.9
6. Professional profile			1		5			6	
	Human Factors	0	0	0	2	1	1	4	36.4
7. Literature review	Interface	0	0	0	0	1	0	1	9.1
	Process	0	1	0	1	2	1	5	45.4
	Product	1	0	0	0	0	0	1	9.1
	Total		71	317	200	453	252	178	1471

The largest number of “diagnosis” (type 1) (867 or 58.9% of the total), 61.5% with focus on process, 22.8% on product, 10.8% on interface and 4.8% on human factors, are studies from Industrial Engineering (27.1%) and Health (21.7%) courses which tend to evaluate ergonomics risk, mainly in AM dissertations. Most “diagnosis” are presented in AM dissertations (62.9%) followed by DT theses (20.3%). Although good solutions arrive from a good diagnosis, i.e., from the understanding of work conditions, it was expected that most theses were more complete studies. Maybe the authors are spending too much time in the diagnosis phase, and do not have enough time for reflecting on the research, for generating alternative solutions, and for implementing and validating them, or at least, for generating recommendations for future implementation. It is also possible that recommendations/solutions were proposed, although they were not expressed in the abstracts.

Only 103 studies (7% of the total academic production) are “diagnosis with recommendations” (type 2), 52.4% of them with focus on products, 37.9% on process and 9.7% on interface. The majority of type 2 studies derive from AM dissertations (66%), mainly developed in Industrial Engineering courses (32%), which tend to focus on process, and in Design courses (29.1%), which tend to evaluate consumer products, workstations and interfaces, which are tested with users. Recommendations focus on improvement of product usability and accessibility. The studies from Architecture courses are often diagnosis and recommendations for the built environment and urban space.

The second largest academic production (298 or 20.3% of the total) is “comparison or proposal of method” (type 4) mainly from Industrial Engineering courses (43.6%), focusing on processes (43.9%). The studies in Industrial Engineering courses, mainly from DT theses, propose models for process optimization or risk management in complex systems. AM and PM dissertations tend to evaluate/compare tools for postural risk assessment.

“Complete projects” (type 3) are rare (112 studies or 7.6% of the total), and mainly from AM dissertations (61.6%) in Design, Engineering and Industrial Engineering. 53.6% of them focus on products (workstations, computerized products, and also built environment and urban space from Architecture courses) and 27.7% on interface. Out of these 112 “complete projects”, 21 (18.7%) have focus on process, i.e., on work optimization, representing only 1.4% of the 1471 studies in 10 years.

It is not possible to precise the reasons for this low number of studies, but one possibility might be the difficulty of implementing Ergonomics in most Brazilian companies, which often complain that the intervention disturbs their production (e.g., Guimarães, 2009; Guimarães et al., 2012, 2014). They might consider that there is no need for research in order to comply with legislation, relying on consulting services with practices with immediate utility (i.e., fixing the workstation and not improving the work). If a company does not value Ergonomics, it is not easy to develop a diagnosis, and a complete project is even more difficult to carry out. Some ergonomics academic studies are held in companies that give access as “a favor” to the researcher, and not necessarily because there is an interest in work optimization. The local of these studies is often selected by convenience (“where is possible”), because the researcher works there or knows someone who gives access to the company. Therefore, considering that a company had not commissioned the research, probably it is not prepared for accepting proposals that question the status quo. At most, it might accept changes in the workstation (a product/physical ergonomics) that do not change the sociotechnical system (the process/organizational ergonomics). In some cases, even when a cost-benefit analysis shows the positive impacts of the ergonomic intervention, the company may be reluctant to implement non-conservative proposals (e.g., Guimarães et al., 2012). The international literature shows how difficult it is to promote changes (e.g., Vink et al., 2008; Scott, 2009), although the contemporary Ergonomics is claiming for the integration between ergonomics and production (Westgaard & Winkel, 2011; Zink, 2014) and emphasizing the need for multidisciplinary teamwork to perform interventions with positive social, economic and natural impact, i.e., focusing on sustainability and decent work (e.g., Bolis et al., 2014; Lange-Morales et al., 2014; Thatcher & Yeow, 2016, 2018; Bonfatti et al., 2017; Thatcher, 2017; Fostervold et al., 2018).

Besides a lack of interest (or credit) in Ergonomics, another motive for the few complete projects on process might be the tradition of Brazilian researchers on keeping distance from the companies and relying on public investment, which is considered more important than building partnerships with the private sector (Nature Index Global, 2015).

One finding of this study is the poor quality of many abstracts, what hampered their analysis. Perhaps this is due to the fact that the abstract is often the last written part, usually produced in the last minute of the final deadline for submitting the document. Therefore, it ends up being neglected, although an abstract is mandatory in the databases, which use it to indexing a study in order to make it searchable. The students have to give (and the supervisors have to demand for) more attention to the abstract, understanding that a good abstract (with clear objectives, method, main results and applications) should reveal what the study is about and also its relevance. It is the key to raise the interest in the reading of the whole study, therefore, to the dissemination of knowledge and the development of Ergonomics.

Regarding the reading of the documents in full, it is important to highlight that most ones from the 2007-2012 survey were not easily available. Some HEIs do not provide the documents in any database, and when the abstract did not provide sufficient information for evaluation, it was necessary to call the course secretariat or to directly contact the author to get additional data. In 2014, in order to facilitate this access, the Capes system made it mandatory the upload of the full document, which then could be retrieved through a link in the database, already integrated into the Sucupira platform. Even so, 212 out of 675 (31.4%) records from the period 2013-2017 did not have the document attached.

The search for publications related to the theses and dissertations from the five HEIs with largest academic production (50 or more studies) in the period 2007-2012, was done based on the curriculum Lattes of the authors. Table 7 presents the intellectual production of these five HEIs (UFF, UFSCar, UFSC, USP and UFRGS) and Table 8, the type of the publications, by course modality.

As can be depicted from Table 7, USP has the largest intellectual production (29.4% of the publications) followed by UFSC (26.5%). Although UFF has the largest academic production, it is responsible for 16.9% of the publications, mainly in national proceedings, what might be expected since its academic production is mainly PM dissertations. PM is a course modality that does not demand as many qualified publication, as it is expected from AM and mainly DT courses. Table 7 also shows that 52% of the publications are in national proceedings and 31.3% in national journals. Only 24 articles (8.7%) were published in international proceedings and 15 (5.4%) articles (nine from UFSC and six from USP) in international journals, what might imply the reduced contribution of Brazilian researchers in the international scene. No doubt language is a barrier and having an article accepted for publication in journals with high impact factor demands a lot of work. Nevertheless, it is expected that a DT thesis should produce at least one international article, which is not the case, as can be depicted from Table 8.

As per Table 8, DT courses have the largest intellectual production, with 0.8 publication/thesis. When evaluating the type of publication, each thesis generated 0.08 article in international journals; 0.32 article in national journals; 0.06 article in international proceedings; 0.31 article in national proceedings and 0.02 book

Table 7. Publications from the five HEIs with largest academic production, in the period 2007-2012.

Type of Publication	International	National	International	National	Book	Total Intellectual	Total Academic
	Journal	Journal	Proceedings	Proceedings	Chapter	Production	Production
HEI							
USP	6	26	11	34	3	80	89
UFSC	9	14	5	42	2	72	93
UFSCAR	0	30	1	20	2	53	96
UFF	0	11	4	31	0	46	98
UFRGS	0	5	3	13	0	21	71
Total	15	86	24	140	7	272	447
%	5.5	31.6	8.8	51.5	2.6	100	

Table 8. Publications from the five HEIs with largest academic production, in the period 2007-2012, organized by course modality.

Type of Publication	International Journal	National Journal	International Proceedings	National Proceedings	Book Chapter	Total Intellectual Production	Total Academic Production
Doctorate (DT)	11	43	8	41	3	106	132
Academic Masters (AM)	4	36	12	69	4	125	211
Professional Masters (PM)	0	7	4	33	0	44	104
Total	15	86	24	143	7	275	447

chapter. AM studies generated 0.6 publication/dissertation: 0.02 article in international journals; 0.17 in national journals; 0.06 article in international proceedings; 0.32 article in national proceedings and 0.02 book chapter. PM studies generated 0.42 publication/dissertation: no article in international journals; 0.07 article in national journals; 0.04 article in international proceedings; 0.32 article in national proceedings and no book chapter.

The search for the period 2013–2017 was done, for all HEIs, through the item “associated intellectual production” on the Sucupira platform. However, it was available for only 131 (19.4%) out of 675 records, and only ten of these 131 studies, all PM dissertations, have an intellectual production different from zero, totaling 15 publications:

- five articles in national journals (one from Environmental Engineering –UFRJ; one from Biomedical Engineering –UTFPR; one from Industrial Engineering- Centro Universitário SOCIESC; one from Industrial Engineering -Universidade Federal do Pará –UFPA; and one from Industrial Engineering - Universidade Federal da Bahia);
- eight articles in national proceedings (three from the same Industrial Engineering-UFF dissertation; one from another Industrial Engineering dissertation –UFF; two from a same Industrial Engineering dissertation -Centro Universitário SOCIESC; one from an Industrial Engineering dissertation – UFF; and one from an Environmental Engineering dissertation - UFRJ);
- one expanded abstract in international proceedings and one book chapter from an Electrical Engineering dissertation - Universidade do Estado de Santa Catarina- UDESC.

It is reasonable to assume that the number of publications from 675 studies, in the period 2013-2017, is larger and more qualified, but they are not being associated to the academic production on the Sucupira platform, which is an important vehicle for accessing academic material. Without the effort of the HEIs in fulfilling all information requested, and attaching the full thesis/dissertation in the platform, the content of the studies and their publications will not be available for research, what is an obstacle for the development of Ergonomics in the country. Another issue is that the reduced number of publications in international vehicles does not allow Brazilian researchers to excel in the scientific community.

It is important to note that the obtained results give just a glimpse of the intellectual production, since data are far from accurate due to the difficulty in getting information on the publications: only a few, from all HEIs, were found in the Sucupira platform, for the period 2013–2017. Most publications are from the 2007–2013 search, based on the authors’ curricula Lattes, but some of them were not updated and others were missing on the CNPq database. In some cases, the publications were found in the curriculum Lattes of the supervisor.

Part of the results of this study (the academic and intellectual production in Ergonomics from 1987 to 2012, obtained in steps 1 and 2) was presented and discussed with the Brazilian academic community during the 18^o Congresso Brasileiro de Ergonomia in 2016, and during the Encontro de Pós-Graduação em Design/ESPM-Rio in 2017, when it was stressed the importance of disseminating and building on the experience accumulated over more than 40 years since the submission of the first masters dissertation in Ergonomics. The resources for research in Brazil are scarce, the country is large, with a great diversity of problems that require solutions, and research done in the country is indispensable to stimulate other studies that could contribute to social, cultural, environmental and economic development, that is, to the sustainable development of Brazil. Some reflections about the discussions held in these meetings and a few proposals for improving knowledge dissemination and cooperative work can be found in Guimarães (2018).

5. Conclusion

This article presented an investigation on the Ergonomics academic production (theses and dissertations) from 1987 to 2017, available at the Capes Theses and Dissertations Catalog. For the period 2007-2017, 1471 documents (329 DT theses, 882 AM dissertations and 260 PM dissertations) were analyzed and classified according to approach: (1) diagnosis, (2) diagnosis with recommendations, (3) complete project, (4) production of basic data, (5) comparison or proposal of method, (6) professional profile, and (7) literature review. With the exception of studies on “professional profile”, they were also classified by focus: human factors, interface, process or product. In order to enable for statistical analysis, the studies were grouped into six major course areas: Architecture, Design, Engineering, Industrial Engineering, Health and “Others”.

The majority of studies (58.9%) are “diagnosis”, 27.1% being from Industrial Engineering and 21.7% from Health courses, generally as a result of AM dissertations, most of them (61.5%) focusing on process. “Diagnosis with recommendation” accounts for 7% of the studies (52.4% with focus on product) mainly from Industrial Engineering and Design AM dissertations. Studies on “comparison or proposal of method” (20.3%) tend to be either management models, from DT theses, or comparison of ergonomic risk tools from AM dissertations developed in Industrial Engineering courses. 7.6% of the studies are “complete projects”, mainly from AM dissertations (61.6%), 53.6% of them about products, mainly developed in the courses of Design, Engineering and Industrial Engineering. Only 18.7% of these “complete projects” (1.4% of the total of 1471 studies) focus on process, that is, on work optimization, what may be reflecting the difficulty of implementing organizational changes in Brazilian companies, or the lack of partnership between HEIs and the companies. 5% of the studies are “production of basic data” mainly as a result of AM dissertations from Industrial Engineering and Design courses. “Literature review” accounts for 0.7% of the studies and 0.4% is on “professional profile”.

A search for the intellectual production related to the studies of the period 2007-2012, done in the curriculum Lattes of the authors from the top five HEIs, showed 447 publications. DT courses have the largest intellectual production, with 0.8 publication/thesis; AM generates an average of 0.6 publication/ dissertation and PM generates 0.42 publication/dissertation. Both theses and dissertations tend to generate publications preferably in national meetings (52% of publications), followed by national journals (31.3% of the intellectual production); 8.7% are articles published in proceedings of international meetings and only 5.4% in international journals. DT courses have the largest production in international journals with an average of 0.08 article/thesis. The association between academic and intellectual production from all HEIs, in the period 2013-2017, showed 15 publications, mostly in national proceedings and national journals, listed in the Sucupira platform. These low figures for a ten-year period might indicate that either most researchers are not publishing their studies or their publications are not being associated to the academic production on the Sucupira platform.

The main objective of this study was to verify the state of the art of the academic production in Ergonomics, but it should be understood as a preliminary investigation, since evaluation was based on the abstracts, what does not allow for in-depth analysis. Besides, the main core of the theses and dissertations was not clear in many abstracts, what probably impacted on the results and, undoubtedly, reduces the interest that prospective readers could have in these studies. The diffusion of both academic and intellectual production is crucial for the development of Ergonomics, a discipline that deals with people, with the work done by people, and the quality of working life, therefore, can contribute to the sustainable development of Brazil.

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