Anxiety, Depression and Quality of Life in Industry 4.0: A literature review

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Abstract—With an increasingly competitive labor market and rising unemployment rates, inadequate working conditions such as: low wages, unhealthy environments, excessive noise and heat, accumulation of functions, excess working hours and regime in different shifts, are factors that may contribute to the emergence of mental and behavioral disorders. In order to carry out this study, a systematic literature review was carried out using the Methodi Ordinatio method, through the following steps: selection of databases; definition of keywords and their combinations; definition of search criteria; extraction of searches from databases; elimination of duplicate articles; definition and application criteria for the exclusion of articles that are not compatible with the proposed theme. It was possible to identify that there is a low number of scientific productions that address the themes of quality of life, anxiety and depression, and industry 4.0, which is an opportunity for future studies.

Keywords— Industry 4.0, Depression, Anxiety, Quality of Life.

I. INTRODUCTION

The absence of workers at their place of work is converted into reduced productivity, such data, known as absenteeism, is associated with delays, reduced individual performance and turnover (JOHNS, 2010). The employee, when presenting at work affected by a disease, and with a drop in performance due to health problems, is related to presenteeism (SCHULTZ, 2007).

According to Harnois & Gabriel (2000) the weight of mental health disorders on health and productivity has been underestimated over time. According to researchers from the UK Department of Health and the British Industrial Confederation, they estimated that between 15-30% of workers will experience some form of mental health problem throughout their careers. Mental health problems are the leading cause of illness and disability, among the main disorders are depressive disorders, which predominate in the United States workforce.

The science that investigates mental health in the industrial environment is called industrial psychology, and the entire development of industrial psychology and industrial sociology Elton Mayo (1945), initially studied the effects of workers' physical conditions on productivity, and the reason for constant conflicts between workers and employers that impacted productivity.

Human relations, whether man to man, or man with machine and material, occupy a complex space in the industrial enterprise. Regardless of mechanization, machines must be designed, operated, and supervised by man, and the study of this human behavior, aims to provide support for increasing efficiency and reducing production and distribution costs (VITELES, 1955; MYERS, 1922).

In order to remain competitive, companies demand beyond the human capacity, the fulfillment of previously established goals, which lead them to the search for survival, in this way, employees and managers enter an immersive state at work, feeling the limit of their own abilities at face new goals, which end up generating more anxiety, fear and anguish (DOWNS, 2000; MOTTA, 2012).

When analyzing the industrial transition scenario that takes place in the 21st century, it is necessary to investigate the mental health and quality of life of the

worker, who is the main affected by the changes. Therefore, for the preparation of the literature review work, the *Methodi Ordinatio* method proposed by Pagani et al. (2015) in the Scopus, Web of Science, PubMed and MedLine databases.

The present work is structured as follows: after this introduction, the theoretical basis is carried out regarding the concepts that underpin the research, followed by the methodological procedures used in carrying out the research. Finally, the analysis and discussion of the data is presented, ending with the final considerations of the work, its limitations and suggestions for future research.

II. BIBLIOGRAPHY REVIEW

2.1 Industry 4.0

Industry is a part of the economy that produces material goods, which are highly mechanized and automated, and since the beginning of industrialization technological advances have led to changes in paradigms, known as "industrial revolutions". The first industrial revolution was due to the use of mechanics, while the second industrial revolution was due to the intensive use of electric energy, while the third industrial revolution was due to the widespread use of digitalization, and finally, in the 21st century the era in which we combine internet technology and "smart" objects with manufacturing, known as Industry 4.0 (LASI, 2014).

Industry 4.0 includes a variety of technologies, methods and principles, with the aim of increasing the autonomy and dynamics of systems, developing new opportunities. To adapt to the concept of industry 4.0, there is a need to develop technology transfer processes with its suppliers (SILVA & KOVALESKI, 2018).

Understood as a new industrial stage, industry 4.0 integrates manufacturing operating systems and information and communication technologies, especially the Internet-of-Things (IoT), a cloud system, forming the concept Cyber-Physical Systems for industry 4.0 (WANG, 2015). Cyber-Physical Systems are considered as physical artifacts controlled, monitored, coordinated and integrated into networks by an embedded system. This embedded system is a combination of hardware and software components, connected in an environment through sensors, to perform predefined tasks in real time, assembling a specific data (STOCK, 2018).

For Frank et al. (2019) technologies in industry 4.0 can be separated into at least two different layers according to their main objective, according to Figure 1.
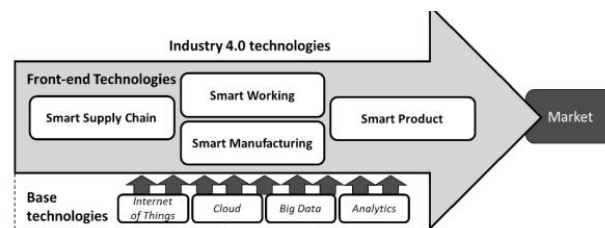

Fig 1: Theoretical scheme of Industry 4.0 technologies

Source: Frank et al. (2019).

The front-end technologies of Industry 4.0 conceptualize emerging technologies (Smart Manufacturing), that is, the way the product is offered (Smart Products), how the raw material and products are delivered (Smart Supply Chain), and the new working models supported by new technologies (Smart Working) (FRANK, 2019).

Manufacturing jobs are facing a risk of being automated, in this way, human beings will be affected by increased knowledge at work and task uncertainties (STOCK, 2018). Therefore, human resource management has been defined as an effective employment strategy and the development of a highly committed and qualified workforce to achieve the company's objectives (HECKLAU, 2016).

2.2 Anxiety

According to Spielberger (1966), the discriminatory use of the term anxiety refers to different constructions. The most commonly used denotation is a complex emotional reaction or state that varies in intensity and fluctuates over time due to stressful situations that affect an individual. While, for the American Psychiatric Society (2019), anxiety is a normal reaction to stress and can be beneficial in some situations, such as serving as a warning to identify a danger, however, it differs from anxiety disorders that involve fear or excessive anxiety.

The term "anxiety" also refers to individual differences in anxious tendency as a personality trait, people prone to anxiety as a personality trait are more willing to manifest anxious states than non-anxious people, while neurotic individuals have high traits of anxious personality and are more likely to respond to situations involving threats to self-esteem with greater increases in intensity of anxious state than people with lesser traces of anxiety (SPIELBERGER, 1966).

Anxiety is due to a concern, which is capable of ruining extensions of human life, be it the idea of the danger of falling into conformity with the ideals of success that are imposed by society and that as a result, says

goodbye to dignity and respect. And it is caused by, among other elements: recession, redundancy, promotion, retirement, conversations with colleagues in the same industry, and / or news of great successes of friends (DE BOTTON, 2004).

According to the United States Department of Health and Humanitarian Services (HHS, 2019), there are five major categories of anxiety disorders, namely: generalized anxiety disorder, obsessive-compulsive disorder, panic disorder, post-stress disorder traumatic, and social phobia (or social anxiety disorder). Generalized Anxious Disorder is characterized by chronic anxiety, exaggerated worry and tension, even though there is nothing to cause it. Obsessive-Compulsive Disorder is characterized by recurring unwanted thoughts, given as obsessions, and / or repetitive behaviors, called compulsives. Panic Disorder is characterized by repeated and unexpected episodes of intense fear, accompanied by physical symptoms that can include chest pain, heart palpitations, short breaths, dizziness, and abdominal pain (HHS, 2019). Also, according to HHS (2019), Posttraumatic Stress Disorder is characterized by the development after exposure to a frightening event or the result of a serious physical injury that occurred or was threatened. Finally, Social Phobia or Social Anxiety Disorder is characterized by enormous anxiety in daily social situations.

According to Linden (2007), the evidence that the work environment can play an important role in the development of anxiety problems and disorders has increased, and it is discussed as "bullying", "work stress", "burnout", or "overwork". In the results found by Halsam et. al (2005), it was identified that the uncontrollable workload contributed to anxiety. The post-traumatic stress disorder related to the work environment has been highlighted. According to Laposa et. al (2003), work-related anxiety disorders can manifest themselves in the form of phobia, social anxiety, or generalized anxiety and fears of insufficiency.

The lack of treatment, according to Halsam et. al (2005), has the potential to become a problem for employees who suffer from anxiety or depression, as they may experience symptoms of fatigue, or low concentration, which implies performance. According to Jones et. al (2015), organizations have emphasized the importance of improving employee psychological health, absenteeism, turnover and presenteeism, as mechanisms that affect the company's performance.

The relationship between anxiety and depression remains unknown, as shown by the study by Dealy et al. (1981), who investigate patients with symptoms of anxiety and depression, traditionally diagnosed based on their rates

of depressive symptoms and anxiety symptoms. These authors found that there was no clear link between patients with anxiety and depressive disorders.

2.3 Depression

Depression, according to the American Psychological Association (2020), is the most common mental disorder, people with depression may experience a lack of interest and pleasure in daily activities, in addition to significant weight loss, insomnia or excessive sleep, lack of energy, lack of concentration, feelings of devaluation or excessive guilt and focused thoughts of death or suicide. According to Mousa (2016), in the United States, severe depression affects 14.8 million adults every year.

The difference, for Lewinsohn et al. (2000), between mood swings between degrees of significant and clinical depression, such as severe depression, and those that occur normally remains a problem. However, for the National Clinical Practice Guideline 90 (2010), the identification of severe depression is based not only on its severity, but also on the permanence, presence of other symptoms, and the functional and social severity.

Although the degrees of normal and clinically significant depression do not have clear, easy differences, the greater the severity of the depression, the greater the morbidity and adverse consequences. When considering other aspects, such as duration, stage of the disease and history of treatment, there are problems found in the classification of depression in categories (KESSING, 2007; LEWINSOHN, 2000).

Because of the complexity in identifying the severity of the depressive disorder, the literature recommends the use of a depression scale for the initial assessment. For this, there is a preference for the use of short scales with a "yes / no" answer format, such as the GDS with 30 items, or the Brief Depression Scale (BDS) with 11 items (BECK, 1998).

III. METHODOLOGY

3.1 Review principles

In order to carry out this study, a systematic literature review was carried out using the following steps to exclude articles that are not compatible with the proposed theme. The scheme of the steps is illustrated in Table 1.

Table 1: Systematic review steps

Step	Definition	Activity
i)	Selection of databases	Four databases were selected: Scopus, Web of Science, PubMed and MedLine.
ii)	Definition of keywords and their combinations	The keywords defined were "industry 4.0", "anxiety", "depression", "quality of life", "HADS" and "WHOQOL", their combinations are detailed below.
iii)	Defining the search criteria	Research without time limit, works inserted as articles in the area of Psychology, Engineering, Social Science and Medicine. Containing in your title any of the keywords mentioned in step ii.
iv)	Extraction of the searches found	The searches were extracted from the databases in the format ". ris ", treated using the JabRef program.
v)	Duplication elimination	The elimination of duplicate articles was done by the JabRef tool.
vi)	Definition and exclusion criteria for articles	After treating the results found for the removal of duplicates, the articles went through the refinement phase using the inclusion and exclusion criteria.
vii)	Search for number of citations and impact factor	For the execution of Methodi Ordinatio, the number of citations of the articles and the impact factor of the journal in which the article was published are required.

Source: The authors (2020).

To ensure that all articles could be consistently accessed with fewer subjective opinions, the fundamental review principles for inclusion and exclusion criteria in step vi were defined in Table 2:

Table 2: Inclusion and exclusion criteria and their descriptions.

Inclusion / Exclusion	Criteria	Description
Exclusion	Unavailable Articles (UA) Non-related (NR)	UA: Articles that could not be read. NR-1: An article that does not address any of the topics of anxiety, depression, quality of life or industry 4.0.
Inclusion	Parcially related (PR)	PR-1: An article about anxiety, but unrelated to industry 4.0 PR-2: An article on depression, but unrelated to industry 4.0 PR-3: An article on quality of life, but unrelated to industry 4.0 PR-4: An article on industry 4.0, but unrelated to anxiety, depression or quality of life PR-5: An article on industry 4.0 in relation to quality of life PR-6: An article on industry 4.0 related to anxiety PR-7: An article on industry 4.0 in connection with depression PR-8: An article on anxiety and depression, and / or quality of life, but unrelated to

		industry 4.0.
	Closely related (CR)	FR-1: An article that is specifically dedicated to anxiety, depression, quality of life and industry 4.0.

Source: The authors (2020).

3.2 Systematic literature review method

In this study, the combination of the terms proposed in step ii generated the results in each selected database. 372 results were found using the combination and search criteria in the database Scopus, Web of Science, PubMed and MedLine, which are presented in Table 3 according to the keyword in the title, abstract and keywords, selecting only articles for filtering.

Table 3: Exploratory search results.

	Scopus	Web of Science	PubMed	MedLine
"Industry 4.0" AND "quality of life" AND "anxiety" AND "depression"	0	0	1	22
"industry 4.0" AND "quality of life" AND "anxiety" OR "depression"	0	1	3	53
"Industry 4.0" AND "quality of life" AND "HADS"	0	0	0	0
"industry 4.0" AND "WHOQOL" AND "anxiety" AND "depression"	0	0	0	0
"industry 4.0" AND "WHOQOL" AND "HADS"	0	0	0	1
"industry 4.0" AND "quality of life"	12	11	49	0
"industry 4.0" AND "quality of life" OR "depression"	13	12	57	0
"industry 4.0" AND "WHOQOL"	0	0	0	8
"industry 4.0" AND "HADS"	63	0	0	5
"industry 4.0" AND ("anxiety" OR "depression" AND "quality of life")	0	5	3	53

Source: The authors (2020).

After collecting the articles from the databases in the .ris format, the articles were treated using the Mendley® software to identify and remove duplicate articles, and by the JabRef® software to result in an electronic spreadsheet containing the following data: author, title, year of publication, journal, type of document and DOI / URL.

An illustrative scheme of the execution of step vi is shown in Figure 2. Through this step, the number of articles found was filtered according to the inclusion and exclusion criteria previously defined, resulting in 102 articles for analysis at the end.
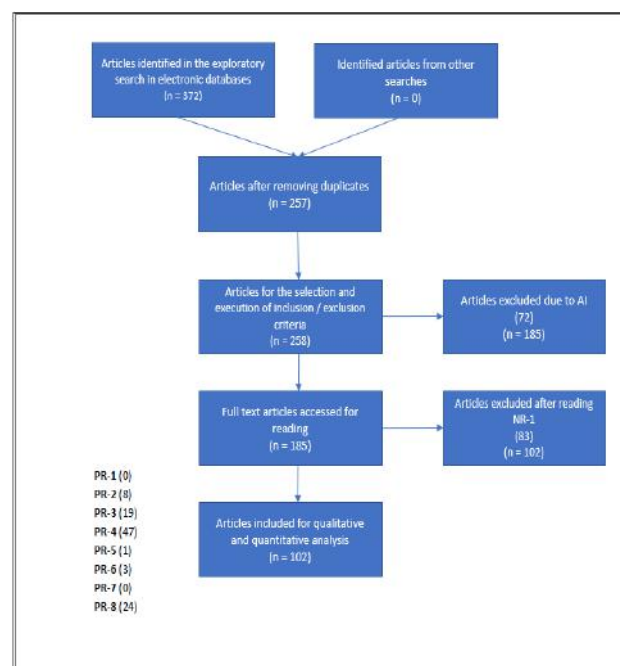

Fig 2: Flowchart of the different stages of the systematic review

Source: The authors (2020).

For the application of the Methodi Ordinatio proposed by Pagani et al. (2015), it was necessary to add the number of citations for each article and the impact factor of the journal in which it was published. The number of citations was obtained by searching Google Scholar and the impact factor of the journal was identified by means of JCR 2020 (base year 2019), made available by Clarivate Analytics (2020).

3.2.1 Data analysis

The data of the articles were analyzed quantitatively, through the frequency of publications in countries, the number of citations per article, the authors with the highest number of publications and the number of articles published per year. The qualitative analysis took place by forming clusters, in which the related articles were grouped and the content was analyzed, such as keywords, methodology and results.

IV.   RESULTS AND DISCUSSION

Figure 3 shows the graphs used for the quantitative analysis of the articles found, such as graph A representing the number of articles per year, graph B with the number of citations per article, and graph C illustrating the number of articles by country.
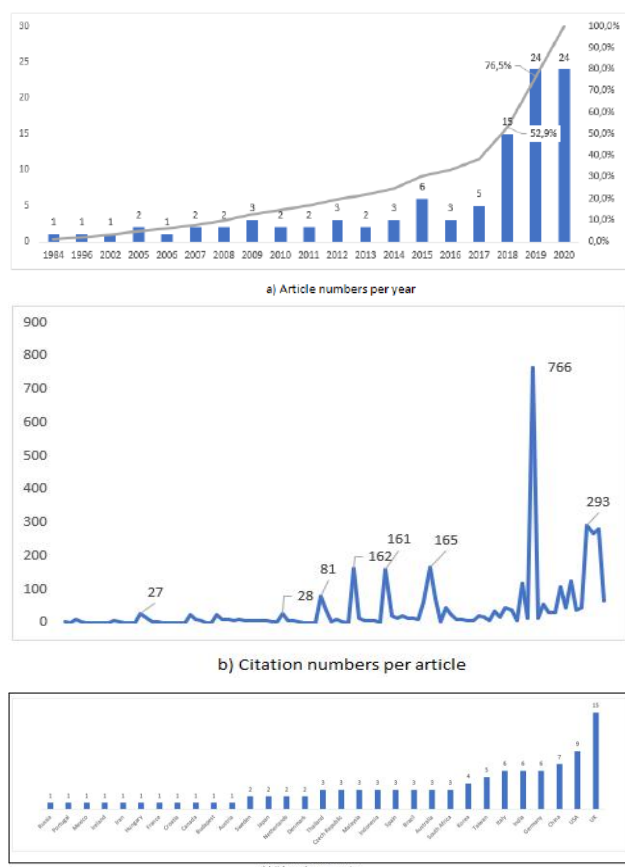
Fig 3: Quantitative Analysis Charts Group

Source: The authors (2020).

Graph A showed that 52.9% of the articles published and present in the databases were published between 2018 and 2019, reinforcing the current status of industry 4.0, anxiety, depression and quality of life. Two works stood out for preceding the 21st century: Hallstrom (1984), which discusses depression in women in Sweden; and Lindgren (1996), which also addresses the depressive disorder, however it is a neuropsychological test for treatment, therefore, dealing with an article more focused on medicine.

In graph B, which shows the number of citations per article, it is possible to analyze that in the first years the number of articles provided a low number of citations, and over time, the number of citations increased. In 2010, the article by Dyrbye et al. (2010) presented the highest number of citations (766), which addressed the depression and quality of life of medical students in the United States.

The analysis of the number of articles by country, shows the countries of origin of the first authors of the articles collected. The United Kingdom, which stands out with 15 publications on the topics, is recognized for research in mental health and for being one of the major

industrial hubs since the beginning of industrialization. the second country with the largest number of publications on the subject was the United States of America (USA) with 9 articles, and like the United Kingdom, the country presents a high technological technological advance, therefore, these two countries were expected among the first of publication number.

The top ten authors with the highest InOrdinatio publications are represented in Table 4. Through this table it is possible to identify that 70% of the articles with the highest InOrdinatio indexes were published in 2020 and 30% correspond to the 2018 publications.

Table 4: Main authors and their InOrdinatio index

| Author	Title	Year	Journal/Proceedings	InOrdinatio
Beier, G., Ullrich, A., Niehoff, S., Reißig, M. and Habich, M.	Procurement 4.0: factors influencing the digitisation of procurement and supply chains	2018	Business Process Management Journal	38390,081
Bienhaus, F. and Haddud, A.	Investigation of T4 and T6 heat treatment influences on relative density and porosity of AlSi10Mg alloy components manufactured by SLM	2020	Computers and Industrial Engineering	37330,005
Bodiako, A.V.	Commercial ICT smart solutions for the elderly: State of the art and future challenges in the smart furniture sector	2020	Electronics (Switzerland)	34400,003
Gingerich, K., Ding, I.-J., Lin, S.-K., Grenčiková, A.,	Critical success factors for integrating artificial intelligence and robotics	2020	Digital Policy, Regulation and Governance	34400
Bravi, L., Murmura, F. and Santos, G.	Converting maintenance actions into standard symbols for Augmented Reality applications in Industry 4.0	2018	Computers in Industry	34380,037
Chen, H.-L. and Chen, Y.-J.	Open innovation session as a tool supporting innovativeness in strategies for high-tech companies in the Czech Republic	2018	Economies	34380,003
Chiarini, A.	Scopus scientific mapping production in industry 4.0 (2011–2018): a bibliometric analysis	2020	International Journal of Production Research	33120,011
Dewi, R.S., Alhabsji, T., Arifin, Z. and Abdillah, Y.	The Ability of Project Managers to Implement Industry 4.0-Related Projects	2020	IEEE Access	33120,002
Dewi, D.P., Soekopitojo, S., Larasati, A., Kurniawan, M.F. and Hartanti, E.R.S.	The promotion of technology acceptance and work engagement in industry 4.0: From personal resources to information and training	2020	International Journal of Environmental Research and Public Health	33120,001
Dhanabalan, T. and Sathish, A.	Made in China 2025 and manufacturing strategy decisions with reverse QFD	2020	International Journal of Production Economics	33120,001

Source: The authors (2020).

The article by Beier et al. (2018) present 81 citations and is the article with the highest InOrdinatio index (38,390,081). This work relates industry 4.0 with factors that influence the digitalization of commerce, with daily support and administrative tasks, in addition to supporting the decision-making process.

Among the ten articles with the highest InOrdinatio index, none were related to anxiety, depression or quality of life, but all are related to industry 4.0 and therefore published in journals with a high impact factor and a high

number of citations. In addition, there was no author who published more than one article on the topic among the data collected in this period.

Through graphics D and E, shown in Figure 4, it is possible to analyze the impact factor of journals in relation to the average citations of the collected articles, and the articles that presented the InOrdinatio above the index average (7,320).
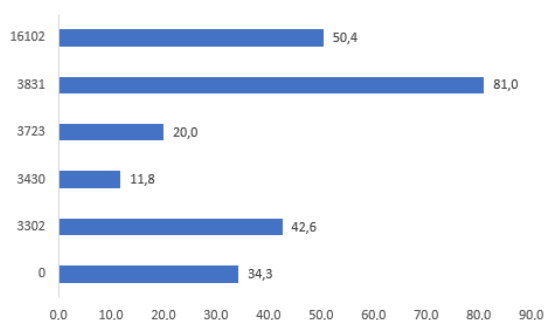
d) Graph of impact factor x average of citations
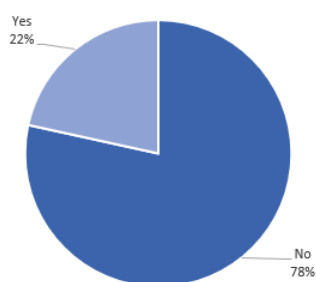
e) Graph of articles above the average of InOrdinatio

*Fig 4: Set of graphics referring to InOrdinatio*

Source: The authors (2020).

When analyzing graph D, it was found that journals with an impact factor between 3302 and 3831 have higher average citations, than journals with a very high impact factor, or with zero impact factor.

The InOrdinatio index was used to prioritize the reading of articles with higher index values, as they have greater impact and relevance. From this, analyzing Graph E, the articles can be divided into above average of the InOrdinatio value and below the average value of the index. After analysis, it was identified that most articles are below the average value, therefore, a minority represent a higher value of citations and publications in journals with a high impact factor.

Figure 5 groups the graph F that represents the clusters of the consolidated groups and the graphs G, H and I

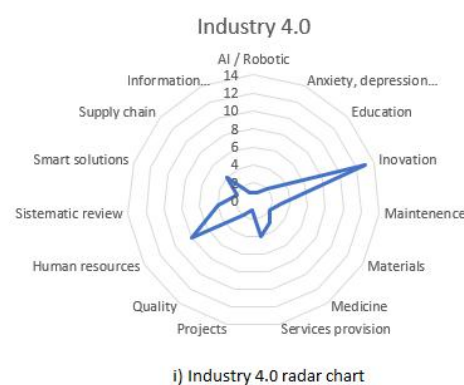referring to the subcategory formed when analyzing the clusters.
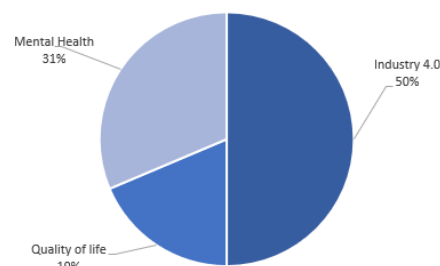
f) Clusters of consolidated articles
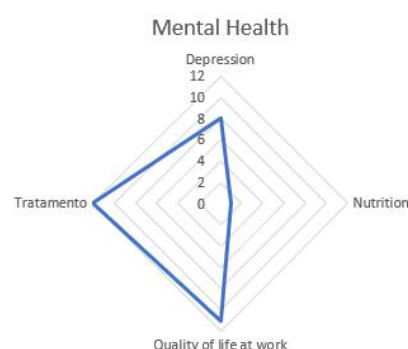
g) Mental health radar chart

h) Quality of life radar chart

i) Industry 4.0 radar chart

Fig 5: Set of graphs for qualitative analysis

Source: The authors (2020).

4.1 Analysis of industry 4.0 cluster

When analyzing the graph F it is possible to identify that most of the works found are related to industry 4.0. Of these works, 25% belong to the Innovation subcategory. Rady et al. (2019) worked with infrastructure and technological development in the food industry, in addition, Rady et al. (2019), Perisa (2019) and Chiang (2019) studied the use of sensors in the industry.

In the maintenance subcategory, Garcia et al. (2019), Scurati et al. (2018), Attanasio et al. (2017) worked with maintenance processes for manufacturing. Scurati used augmented reality to standardize symbols and convert maintenance actions.

Regarding the materials subcategory, Majeed (2019) worked with iron alloys and the best manufacturing techniques, studying the parameters and conditions of heat treatment for the density and prosodity of the alloy, and Suárez-Macías (2020) worked with polymers of polycarbonate produced by a 3D printer.

In the medicine subcategory, Loppolo et al. (2020) for studying medicine 4.0 and its new health technologies for the use of innovation in preventive health, and Reinhardt et al. (2020) who studied the development of industry 4.0 in the pharmaceutical sector, conducted a survey of the sector in Ireland and found that 42% of respondents knew about industry 4.0, and concluded that the implementation of industry 4.0 is growing significantly in the pharmaceutical industries.

Wang et al. (2019) and Chiarini (2020) comprised the subcategory quality because they studied quality management in industry 4.0, Chiarini conducted a literature review with 75 articles, being one of the first articles of literature review on the theme of Quality 4.0, while Wang worked with China 2025, which is the industrial revolution within China, using the QFD tool and manufacturing decision strategy.

Human Resources make up one of the formed subcategories, it consists of articles that promoted leadership training, such as Dewi et al. (2020), who developed an instrument to measure the student's ability to work in a cooking program, to identify the soft skills and competencies that affect future work in industry 4.0. Brahma et al. (2020) researched a program for work executives, designed for the development of the digital work environment of industry 4.0, and the results presented challenges such as the fragmentation of work, which is due to the lack of connection between members of the same team.

4.2 Analysis of mental health cluster

In the mental health cluster, a subcategory stood out, many of the articles found were about treatments, among which we identified treatments for adults such as Castells et al. (2018), and for children, studied by Rochat et al. (2019). Within this subcategory, the study by Mohammadi et al. (2015), who studied the effect of probiotics on the mental health of a group of workers in a petrochemical sector, and their study resulted in a positive applicability of the drug in the population of workers in the industry.

There was a high incidence of articles involving treatments for depression, related to school age, such as the article by Root et al. (2019) that analyzes depression among other mental disorders in children. The articles that stood out were by Horton et al. (2011) and Kawada et al. (2010) who studied depressive symptoms and the relationship between depression and workload.

The SMT subcategory, which refers to mental health at work, highlighted the work of Rudolphi et al. (2020) and Edimansyah et al. (2008), in which they studied depression, anxiety and stress among farmers, and in the automotive industry, respectively. Padma et al. (2015) studied the health problems faced by workers in an information technology company, and Cohidon et al. (2008), studied the mental health of Toulese workers in France after the explosion at the industrial plant and affected three thousand people.

4.3 Analysis of quality of life cluster

Within the quality of life cluster, the subcategory with the largest number of studies was in the area of medicine, among them, van Dijk (2014) and Hesapçioglu et al. (2014) studied the quality of life and self-esteem of children. There have been studies on the quality of life of breast cancer survivors such as those by Kim et al. (2020), and disorders at the time of women's menopause as studied by Blume-Peytavi (2012).

The second subcategory created for the quality of life cluster was nutrition, a portion of articles presented studies on diet and food supplementation to improve quality of life, as in the study by Witte et al. (2005), Arjuna et al. (2018) and Inoue et al. (2018).

Finally, the third subcategory of this cluster is quality of life at work (QWL), within which the work of Chattopadhyay et al. (2014), Choi et al. (2012) and Andersen et al. (2002), who worked on the quality of life of workers at an iron sponge plant, engineers, and health problems resulting from repetitive work, respectively.

V. CONCLUSION

Depressive and anxious disorders have been under discussion for decades, and remain a topic of debate in several areas, as well as industry. The human presence within the industry is facing an adaptation in the midst of automation, the collaborators who go through this transition, will need to be trained more and more to the new technologies, and will be subject to go through stressful factors, which can trigger anxiety disorders and depressive.

This article sought to work on the axes of industry 4.0, anxiety and depression, and quality of life, to analyze whether there is any connection between them in the literature, the new industrial revolution is in evidence in the academic area, and mental health has become a concern during the 21st century, in this way, the impact that industry 4.0 has on the mental health of its collaborators was not documented in scientific articles searched by the databases that compose this research, presenting a gap for future works.

In this literature review work, the researched databases, which still have a high academic value and reliability, do not include all the research that could address the themes. In addition to the databases, the restrictions and criteria defined may be a limitation, since all files that are not scientific articles have been removed.

ACKNOWLEDGEMENTS

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