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INDUSTRY 4.0 AND THE SMALL BUSINESS SOMETHING BEHIND THE TECHNOLOGY – A LITERATURE REVIEW

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Abstract

Small and medium-sized enterprises (SMEs) are especially vulnerable to technology issues, often because they lack the financial resources or the skills to properly exploit new technologies.This paper presents the results of a study that explores the link between Industry 4.0 and SMEs through a systematic literature review. The results show that this link is dominated by themes that can be grouped into the following categories: "Industrial revolutions", "Technology", "Management", "Operations Management/ Industrial Engineering", "Social issues/ Sustainability", and "Methodology". The study shows the relevance of the topics Management, Social Issues, and Sustainability, which is not then reflected in publications of articles on Industry 4.0 in journals in these areas. Eventually, the establishment of partnerships between research teams in these areas of knowledge and the teams studying Industry 4.0 could mitigate this insufficiency. The themes Social Issues and Sustainability are underrepresented and therefore an effort is needed to develop research on the impacts of these themes on Industry 4.0 and vice versa.

Keywords: Industry 4.0, SMEs, industrial revolutions, management, social issues, sustainability

1. INTRODUCTION

The concept of SME is established in the European Union in 1996 when the European Commission published a recommendation (CR, 1996) that sought to harmonize the different definitions that existed in the various countries. Later, in 2003, a new formulation was adopted that remains in use until today: an SME is a company that has fewer than 250 people employed, has an annual turnover of up to 50 million euros, or a balance sheet total not exceeding 43 million euros (CR, 2003).

Other countries (e.g. Australia, United Kingdom) have definitions of SMEs

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equivalent to those of the European Union, adjusted to their reality. Also, the USA has a definition of SME, however, in this country, this definition is not so explicit, and varies from activity sector to activity sector (see SBA (2009)). One of the reasons for such a varying definition is technological change. The Small Business Administration (Office for small business of the US government) considers that technological change affects the production process of the industry, e.g. automation may lead to fewer employees being needed to produce the same product. This phenomenon can affect sectors differently, so it is the very definition of an SME that varies from sector to sector.

SMEs are the driving force behind economies, both in Europe and around the world. They drive job creation and economic growth and ensure social stability. In 2013, more than 21 million SMEs provided 88.8 million jobs across the EU. Nine out of ten companies are SMEs and SMEs provide two out of three jobs (European Commission, 2020).

The access of SMEs to technological developments is not easy, not only due to the scarcity of resources but also due to the difficulty in accessing the centers of development of these more advanced technologies (European Commission, 2021). At a time when we are witnessing a transformative process based on Industry 4.0 technologies, this can be a great challenge for SMEs insofar as they have a limited budget of resources and limited IT knowledge (Chavez et al., 2022).

Given the importance that these companies have for the economy and society, if the aforementioned technological change creates difficulties for SMEs, it could put them at risk, which would possibly have serious consequences on the two aforementioned dimensions.

Aiming to better characterize the relevant factors of the introduction of new technologies associated with Industry 4.0 in SMEs, this article performs a systematic review of the most relevant literature published on the topic.

2. LITERATURE REVIEW

SMEs are a very heterogeneous reality (Mangematin et al., 2003; Karoui et al., 2017; Aronica et al., 2021), varying in multiple aspects, including access to technology and other resources necessary for their operation (Aronica et al., 2021).

This heterogeneity of SMEs can be seen especially in the issue of technology. Often the introduction of new technologies and the processes of technology-based innovation are done by high-tech SMEs (Wonglimpiyarat, 2015), which have specific problems such as their dynamics in internationalization processes (Sedoglavich, 2012) or scalability issues (Bouzakis, 2021).

At the other extreme, we find low-tech SMEs, also with their dynamics in the adoption of new technologies and the innovation process (Cuerva et al., 2014; Oduro, 2019).

When the situation is relatively stable from a technological point of view, SMEs adjust to their business environment (as long as they can manage specific problems, such as scalability). The situation becomes more complicated if there are major changes from a technological point of view. If technologies allow the development of an entire sector, it is the (technology-based) SMEs themselves that are at the center of this development, as has happened in the last thirty years with the internet (Google,

Facebook, Amazon, etc.) and currently with biotechnology companies.

More difficult are the impacts of these new technologies on SMEs in sectors that are only users of these new technologies (for example, the impact of online commerce on small local stores). In these circumstances, the adoption of new technologies by SMEs can be very challenging. This is the case with Industry 4.0 (Vrchota & Řehoř, 2021).

The revolution associated with the technologies that make up the concept of Industry 4.0 (Cyber-Physical Systems, Internet of Things, Simulation and Modeling, Big Data Analytics, Augmented Reality, Additive Manufacturing, Robotics, Cloud Computing, Blockchain, etc. (Martins et al., 2020; Selicati & Cardinale, 2021) has the potential to extend to all types of companies, across all industries. There will be combs that mastering these technologies will be at the center of this revolution, but there will be many others, that being only users of these technologies, for whom Industry 4.0 represents a huge challenge.

This challenge is all the more significant as the 4.0 concept leaves the traditional domain of technologies (industry/manufacturing) and extends to other areas: Government (Valle-Cruz & Sandoval-Almazán, 2014; Trček, 2022), Services (Paschou et al., 2018; Sader et al., 2021) or Agriculture (Rose & Chilvers, 2018; Klerkx et al., 2019).

It is in this context that this research proposes to study the most relevant literature published on Industry 4.0 and SMEs, using a sample of articles taken from the Web of Science. It will be sought, through content analysis, to determine the most relevant topics of the literature under study.

Six systematic reviews are frequently mentioned in the literature focusing on different aspects of Industry 4.0: supply chains (Dallasega et al., 2018); sustainability (Kamble et al., 2018); technologies (Klingenberg et al., 2019); the concept itself (Liao et al., 2017); presence in management studies (Piccarozzi et al., 2018), and relationships with the circular economy (Rosa et al., 2020).

The Table 1 summarizes the main topics identified and the method used in these systematic literature reviews.

As can be seen, there is a predominance of issues of a technological nature and linked to the Operations Management/Industrial Engineering aggregate. However, the table over-summarizes these works, and some nuances should be highlighted. Liao et al. (2017) support a significant part of their study on the Kagermann et al. (2013) report, which considers that Industry 4.0 features the following eight key areas:

Table 1. Synthesis of the systematic literature reviews

Paper	Main focus / Topics	Method
Dallasega et al. (2018)	Technologies.	Classification of topics by authors.
Kamble et al. (2018)	Technologies e and Operations Management/ Industrial Engineering (smart manufacturing).	Keywords statistics, research categories, general content analysis.
Klingenberg et al. (2019)	Technologies and Operations Management/ Industrial Engineering.	Content analysis after full reading.
Liao et al. (2017)	Technologies and Operations Management/ Industrial Engineering.	Keywords, analysis of references.
Piccarozzi, et al. (2018)	Production Method, Business Model, Strategy, Impacts, and consequences of Industry 4.0.	Content analysis after full reading.
Rosa et al. (2020)	Technology.	Content analysis.

Source: Author

1. Standardization and reference architecture
2. Managing complex systems
3. Comprehensive broadband infrastructure for industry
4. Safety and security
5. Work organization and design
6. Training and continuing professional development
7. Regulatory framework
8. Resource efficiency

The results presented by Liao et al. (2017), and their focus on Technologies and on Operations Management/ Industrial Engineering, should be interpreted in light of this more general framework. Also Kamble et al. (2018), for publishing a paper on sustainability, present a rich and more complex picture than the one summarized. The authors consider that Industry 4.0 must respond to a sustainability imperative, arguing that issues such as this: environmental protection, automation and process safety, economic sustainability must be taken into account. The authors argue for a Sustainable Industry 4.0, and consider that this issue has been put aside within the work on Industry 4.0.

Thus, we will study the literature that addresses the topic of Industry 4.0 and SMEs, expecting to find a strong presence of issues related to Technologies and Operations Management/Industrial Engineering but admitting that other issues may also be present.

3. EXPERIMENTAL (RESEARCH)

The publication of academic papers is a phenomenon with a very significant regular and continuous growth for several decades (Larsen & von Ins, 2010; Bornmann, 2021). This phenomenon is not characteristic of specific areas of knowledge or particular article repositories. Bornmann et al. (2021) show that growth occurs in several knowledge areas, that output doubles at a frequency of fewer than 20 years and that it shows convergence regardless of the repository considered.

This situation has led to the popularization of studies of analysis and synthesis of published academic works. It is in this way that Bibliometrics, Scientometrics, and Informetrics have developed in the last decades, seeking to organize and structure this growing volume of information, evaluating this growth, the structure, the interrelationships, and the productivity of different scientific fields (Hood & Wilson, 2001).

All three approaches to the question of science metrics and their outputs make significant use of mathematics for the characterization of scientific production (Hood & Wilson, 2001; Mejia et al., 2021), producing, as a rule, studies of a quantitative nature. Very aggregated approaches, as is the case of bibliometric studies, are less likely to describe the contents and characterize the contents of a given academic area, especially if this area is very recent and still has a relatively small volume of publications, as is the case of Industry 4.0. For these situations, a good alternative is Systematic Literature Reviews (SLR), which are, usually, more interpretative (qualitative) studies.

Lightfoot et al. (2013), Thomé et al. (2016), Zhou et al. (2021), and Nguyen et al. (2022) are examples of SLR, within the scope of operations management/production management and industrial engineering (OM/PM & IE).

At the end of the 20th century, we began

to witness the standardization of protocols for SLR performance, first the QUOROM protocol, published in 1999, and then, in 2009, the first version of the PRISMA protocol (see the description of the process in Moher et al. (2009) or Liberati et al. (2009).

The PRISMA protocol is based on a checklist and flow chart (available at: http://www.prisma-statement.org/PRISMAStatement/PRISMAStatement) that allows replication and updating of the study (Page et al., 2021). The Figure 1 shows the sequence of steps characteristic of a systematic literature review.

Although originating from the health area, the PRISMA protocol has been increasingly used in other areas of knowledge, namely in the context of OM/PM & IE (Agostino et al., 2020; Battesini, et al., 2021).

The PRISMA protocol was revised in 2020 and the update is available in Page et al. (2021). This article defines an SLR as "A review that uses explicit, systematic methods to collate and synthesise findings of studies that address a clearly formulated question".

Systematic reviews vary greatly in how information is analyzed and systematized, and then in how it is presented. In this study, we opted for an exhaustive analysis of the words used, individually or forming expressions, in the most cited articles.

This is a study by counting the frequency of words or expressions, similar to the keyword studies mentioned earlier, but in this case, the entire text of the articles will be used to study and count the words.

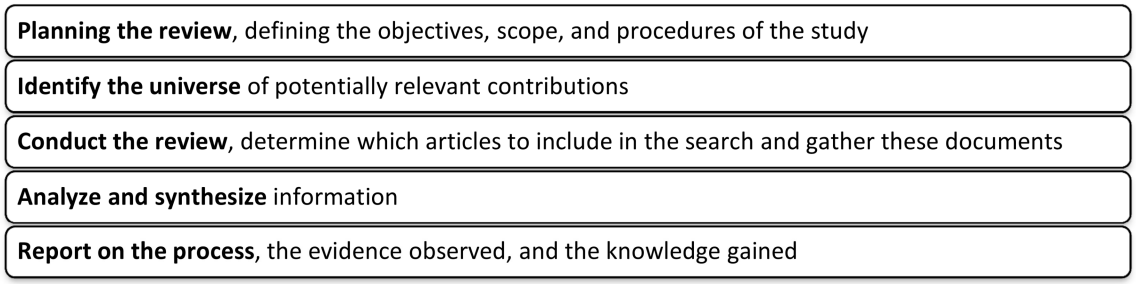
Thus, the guidelines of the Prisma protocol will be followed for the constitution of the work sample. As a work sample, we will use a selection of articles collected from the Web of Knowledge/ Web of Science. The subsequent analysis will focus on the content of the articles being analyzed, exploring the issues addressed and, thus, the structure of existing knowledge about the topic Industry 4.0 and SMEs.

4. RESULTS

The research was conducted in February 2022 and the following Query Key was used:

- Content: ("industry 4.0" {All Fields}) and ("small business" OR "small and medium enterprises" OR "small and medium-sized enterprises" OR SMES {All Fields}); AND
- Document Types: Articles or Early Access or Review Articles or Editorial Materials or News Items.

The search resulted in a list of 284 documents with the following characterization.



Source: Based on Williams Jr et al. (2020) and Dias Lopes and Losada (2022)

Figure 1. PRISMA Protocol

4.1. Research Areas

The Table 2 shows the 10 most frequent disciplinary areas. The technological areas are predominant (Engineering, Science Technology Other Topics, Computer Science, Operations Research Management Science, Materials Science, Chemistry, Physics) but there is also a strong presence of areas with a more social dimension (Business Economics, Environmental Sciences Ecology, Public Administration).

4.2. Countries/Regions

The Table 3 shows the ten countries with the most publications (the same document can be classified in more than one country because of international partnerships).

As can be seen, works from European countries predominate in this list, as in Piccarozzi et al. (2018) but in a different way to Kamble et al. (2018). India and Malaysia, from Asia, and the USA from the American continent are the exceptions. In a broader list that includes the twenty-five countries with the most publications, the European predominance continues, Peoples Republic of China (13 documents), France (12 documents), Thailand (11 documents), Pakistan and Portugal (9 documents), Canada, Denmark, Lithuania, Serbia and

Table 2 - Research areas distribution

Research Areas	Record Count (*)	% of 244 (**)
Engineering	114	40.141%
Business Economics	94	33.099%
Science Technology Other Topics	53	18.662%
Environmental Sciences Ecology	48	16.901%
Computer Science	36	12.676%
Operations Research Management Science	27	9.507%
Materials Science	16	5.634%
Chemistry	14	4.930%
Physics	12	4.225%
Public Administration	12	4.225%

Source: Author
(*) It totals more than 282 because the same document can be classified in more than one area.
(**) It totals more than 100% because the same document can be classified in more than one area.

Table 3. Countries and Regions

Countries/Regions	Record Count (*)	% of 284 (**)
Italy	38	13.380
India	24	8.451
Germany	19	6.690
Poland	19	6.690
England	18	6.338
Malaysia	18	6.338
Czech Republic	16	5.634
Spain	16	5.634
Austria	15	5.282
Slovakia	14	4.930
USA	14	4.930

Source: Author

Turkey (8 documents), Australia and Taiwan (7 documents), Slovenia and South Korea (6 documents).

4.3. Publication Titles

Concerning the titles in which the articles were published, Sustainability stands out. According to the publisher "Sustainability is an international, interdisciplinary, academic, peer-reviewed, open-access journal on the environmental, cultural, economic and social sustainability of human beings" (https://www.mdpi.com/journal/sustainability). In a second group, we find a set of journals related to technology and processes (Journal of Manufacturing Technology Management, Applied Sciences Basel, Technological Forecasting and Social Change, and Processes).

In a third tier, we found four journals related to operations or technology (Annals of Operations Research, Computers in Industry, Computers Industrial Engineering, and Journal of Cleaner Production). We also found in this layer a publication on entrepreneurship (Entrepreneurship and Sustainability Issues), which accepts papers that "present outcomes of initiatives and findings across all fields of science and technology, especially social sciences and humanities [with a multi/interdisciplinary approach]" (http://jssidoi.org/jesi/aims-and-scope-of-research).

At the next levels, we find the journals that published four or three articles (International Journal of Advanced Manufacturing Technology; International Journal of Production Economics; Journal of Manufacturing Systems, with 4 articles and Annual Reviews in Control; International Journal of Computer Integrated Manufacturing; International Journal of Production Research; Journal of Competitiveness; Management Decision; Social Sciences Basel, with three articles). The scenario is similar to that seen previously - a strong predominance of journals on technology or production processes, while there continue to be journals with slightly different focuses (Production Economics, Competitiveness, Social Sciences).

Finally, one last remark about editors. As

Table 4. Sources

Journal	# of articles	% of 284	Publisher
Sustainability	36	12.676%	MDPI, Switzerland
Journal of Manufacturing Technology Management	13	4.577%	Emerald Publishing Limited, UK
Applied Sciences Basel	12	4.225%	MDPI, Switzerland
Technological Forecasting and Social Change	10	3.521%	Elsevier B.V., Netherlands
Processes	8	2.817%	MDPI, Switzerland
Annals of Operations Research	5	1.761%	Springer Nature, Germany
Computers in Industry	5	1.761%	Elsevier B.V., Netherlands
Computers Industrial Engineering	5	1.761%	Elsevier B.V., Netherlands
Entrepreneurship and Sustainability Issues	5	1.761%	Entrepreneurship and Sustainability Center, Lithuania
Journal of Cleaner Production	5	1.761%	Elsevier B.V., Netherlands

Source: Author

you can see, the journals are all edited by major global publishers (although all located in Europe) except for Entrepreneurship and Sustainability Issues which is published by a local Lithuanian publisher.

4.4. Analysis of the results

This data allows us to better understand the dynamics of the publication of articles about Industry 4.0 and SME, and from there to draw two relevant conclusions. The first one is that although the articles are mainly classified in technological areas, there are other relevant areas for the discussion of the topic (Business Economics, Environmental Sciences Ecology, Public Administration). However, when looking at the publications where the articles were published they are almost exclusively in technology and process management journals. Although the topic has interest outside the technology and process area, it is almost only published in journals from this area.

A second important finding has to do with the countries from which the articles originate. As can be seen, the center of research and publication on the subject is in Europe.

4.5. Content analysis

A content analysis was performed evaluating the repetition of word combinations - repetition of the same three-word sequence. The MAXQDA software (version PRO 2020) was used for this purpose.

All articles were manually coded, and only the text part of the article itself, and the respective appendixes, was selected from each one. Titles, author identification, keywords and abstracts, foot/end notes, references, and other complementary information of the same nature were not highlighted for analysis.

The search for expressions was carried out without lemmatization and resulted in 1412 expressions with interest. This is a very varied set of expressions, many of them only appearing in a single article (1067 expressions).

Thus, two additional criteria were established for the selection of the expressions to be analyzed, namely

-The expression should appear in two or more articles and at least four times in total (if it only appeared in two or three articles, in one of them the expression would have to appear repeated); or

- The expression should appear in three or more articles and at least three times in total.

Other criterion tests were done, and this one proved to be the most effective. The application of the criterion resulted in 107 different expressions. Each of these expressions was analyzed for its explanatory character, and it was concluded that 21 of them did not have that character and were, therefore, eliminated. The list of expressions to be studied was thus reduced to 86 expressions.

These expressions were evaluated taking into account two criteria: the frequency (the number of times) with which they appear in the sample of articles and the comprehensiveness (the number of articles where they appear).

The expression "fourth industrial revolution" is the one that appears most often (28) and also the one that appears in most articles (18). The expression "new business models" appears 25 times (one of the second most frequent) and is also one of the second in the number of articles (12). After these first two, it becomes difficult to establish a

ranking, for example, the expression "industrial value creation" appears 25 times but only in 6 articles, while the expression "big data analysis" appears in 12 articles (more, therefore) but appears less frequently (only 19).

Thus, the next step of the analysis through grouping the 86 sentences into a four-quadrant matrix taking into account frequency and coverage (Figure 2, in Appendix I). The modes for one of the features (the number of appearances and the number of articles) were determined and these values functioned as thresholds separating the most frequent expressions (appearances above the mode) from the less frequent expressions (in the mode or below the mode) and the expressions present in more articles (above the mode) from the less comprehensive expressions (in the mode or below the mode).

This organization of expressions resulted in the matrix shown in Figure 2 and the summary shown in the Table 6.

An interpretative analysis of the results was carried out and it was concluded that it would be possible to classify most expressions into six categories: Industrial revolutions; Technology; Management; Social issues/ Sustainability; Operations Management/ Industrial Engineering; SME; and Methodology. Only five expressions were not classified in one of these six categories. This classification proposal accommodates 81 of the 86 (91%) most significant expressions found in the sample of articles. The five other phrases were classified in the "Others" class. The organization of the expressions is as follows:

- **Industrial revolutions** (Fourth industrial revolution, First industrial revolution, Three industrial revolutions, Third industrial revolution);
- **Technology** (Advanced manufacturing technologies, Big data analytics, Big data internet, Big data IOT, Cloud computing internet, Cloud computing platform, Computing big data, Cyber physical system, Cyber physical systems, Cyber-physical systems cps, Data analytics data, Industrial internet consortium, IOT cloud computing, Key enabling technologies, Physical systems cps);
- **Management** (Annual balance sheet,

Table 5. The most frequent expressions

	Articles	Number of appearances
fourth industrial revolution	18	28
industrial value creation	6	25
new business models	12	25
big data analytics	12	19

Source: Author

Table 6. Quadrant Summaries

Quadrant	# of expressions
1st (appear many times in many articles)	22
2nd (appear many times but in few articles)	18
3rd (appear a few times and in a few articles)	42
4th (appear a few times in many articles)	4

Source: Author

Balance sheet total, Business model changes, Business model elements, Business model innovation, Business model innovations, Business model research, Business models new, Business models through, Creation value offer, Critical success factors, Current business models, Digital business development, Entire business model, Entire value chain, Existing business models, Gross value added, Horizontal vertical system, Knowledge about industry, Life cycle management, New business models, New business opportunities, New customer groups, New product development, New products services, New value offers, New value propositions, Novel business models, Product life cycle, Required financial resources, Top management support, Value creation value, Vertical system integration);

- **Social issues/ Sustainability** (Corporate social responsibility, Few human resources, Negative attitude towards, Requires continued education, Too few human, Triple bottom line);
- **Operations Management/ Industrial Engineering** (Autonomous production systems, Deliveries unnecessary waiting, Enterprise resource planning, Entire supply chain, Industrial value chains, Industrial value creation, Manufacturing execution system, Models through industry, Overall equipment effectiveness, Readiness assessment tool, Role toward industry, Smart manufacturing readiness, Supply chain management, Supply chain partners, Unnecessary material flows, When implementing industry);
- **SME** (Medium-sized enterprises SMEs, Sized enterprises SMEs);
- **Methodology** (Case study approach, Multiple case studies, Case study design, Case study research, Multiple case study);
- **Others** (without classification) Company database Bisnode, Data transparency throughout, Decision support tools, Developing countries like, Very high impact).

If this model is proven, it seems clear that the debate on Industry 4.0 / SMEs cannot be limited to a discussion about advanced technologies and their impact on production systems and the ability of SMEs to access these technologies.

To evaluate this situation, we analyzed the words used in the text of the articles, but considered individually, and not in expressions. The table below, and the word cloud in the following figure, show the 50 most frequent words. The MAXQDA software was used to create this list of words, and a stoplist was used to eliminate adverbs, conjunctions, and other sets of characters ("words") not relevant to the analysis.

In the Table 7, and in the Figure 3 (word cloud), the words most related to the classes Management and Social issues / Sustainability are marked. Eleven words are marked, which can be understood as a strong presence of these themes.

5. DISCUSSION

As shown in the previous section, the literature on the subject of SMEs and Industry 4.0 is far from focusing only on its technological dimension or on the dimension related to industrial management. Along with the three most expected themes - Industrial revolutions, Technology, Operations Management/ Industrial Engineering - the study also reveals the relevance of Management and Social issues/ Sustainability issues, which previous studies have already indicated (Liao et al., 2017; Kamble et al., 2018).

Given the results obtained, one last test was carried out by performing a set of searches in Scopus (the indexing database was changed to reduce possible contagion effects between the initial searches and those now performed, and the survey focused on just five categories: "Industrial revolutions", "Technology", "Management", "Operations Management/Industrial Engineering", and "Social Issues/Sustainability").

The search keys were ("industry 4.0") and the conjunction of the previously identified expressions in each of the identified thematic classes. In addition, for each of the classes a

Table 7. The most frequent words

Word	#	Word	#	Word	#
industry	2581	industrial	467	development	325
smes	1570	implementation	437	sustainability	321
data	1125	systems	414	knowledge	311
technologies	1002	smart	391	products	309
manufacturing	875	company	387	management	303
business	868	models	377	system	288
research	755	innovation	374	challenges	287
new	753	employees	373	product	276
production	657	level	370	enterprise	254
value	608	process	359	performance	253
companies	578	results	356	strategy	253
study	568	design	354	there	250
model	563	different	350	case	247
enterprises	525	sme	348	sustainable	247
digital	517	information	339	adoption	245
technology	501	analysis	335	well	239
more	499	processes	327		

Source: Author

Source: Author

Figure 3. Word Cloud (the most frequent words)

second search was conducted, this time with the additional condition of also including the word SME in the filter. The filters were applied to the "Title", the "Abstract" and the "Keywords". Only documents published in Journals (articles, reviews, editorials, etc.) were considered. The results are presented in the Table 8.

Without the SMEs filter, we observe a predominance of articles resulting from the selection with words from the classes "Industrial revolutions" and "Technology". At a second level, we find the articles selected with words from the classes "Management" and "Operations Management/ Industrial Engineering". If we only consider the articles that address the topic of SMEs (numbers in the second line and parentheses) these four classes are relatively closer. In both cases, the papers resulting from the selection based on words from the "Social issues/Sustainability" class appear much lower, presenting inferior values than the other classes, it is possible, however, that this results from lower adequacy of the selection criteria for this particular class.

In the more general literature, the first two

Table 8. Results of Scopus searching

Classes	Results (#)*
Industrial revolutions ("industry 4.0") AND ("Fourth industrial revolution" OR "First industrial revolution" OR "Three industrial Revolutions" OR "Third industrial revolution")	815 (26)
Technology ("industry 4.0") AND ("Advanced manufacturing technologies" OR "Big data analytics" OR "Big data internet" OR "Big data IOT" OR "Cloud computing internet" OR "Cloud computing platform" OR "Computing big data" OR "Cyber physical system" OR "Cyber physical systems" OR "Cyber-physical systems cps" OR "Data analytics data" OR "Industrial internet consortium" OR "IOT cloud computing" OR "Key enabling technologies" OR "Physical systems cps")	1125 (31)
Management ("industry 4.0") AND ("Annual balance sheet" OR "Balance sheet total" OR "Business model changes" OR "Business model elements" OR "Business model innovation" OR "Business model innovations" OR "Business model research" OR "Business models new" OR "Business models through" OR "Creation value offer" OR "Critical success factors" OR "Current business models" OR "Digital business development" OR "Entire business model" OR "Entire value chain" OR "Existing business models" OR "Gross value added" OR "Horizontal vertical system" OR "Knowledge about industry" OR "Life cycle management" OR "New business models" OR "New business opportunities" OR "New customer groups" OR "New product development" OR "New products services" OR "New value offers" OR "New value propositions" OR "Novel business models" OR "Product life cycle" OR "Required financial resources" OR "Top management support" OR "Value creation value" OR "Vertical system integration")	306 (17)
Social issues/ Sustainability ("industry 4.0") AND ("Corporate social responsibility" OR "Few human resources" OR "Negative attitude towards" OR "Requires continued education" OR "Too few human" OR "Triple bottom line")	48 (3)
Operations Management/ Industrial Engineering ("industry 4.0") AND ("Autonomous production systems" OR "Deliveries unnecessary waiting" OR "Enterprise resource planning" OR "Entire supply chain" OR "Industrial value chains" OR "Industrial value creation" OR "Manufacturing execution system" OR "Models through industry" OR "Overall equipment effectiveness" OR "Readiness assessment tool" OR "Role toward industry" OR "Smart manufacturing readiness" OR "Supply chain management" OR "Supply chain partners" OR "Unnecessary material flows" OR "When implementing industry")	400 (24)

(*) Documents in journals, the first number outside the parenthesis.
Inside the parentheses documents that additionally fulfill the condition (TITLE-ABS-KEY(SME)).

categories stand out for their preponderance, being this preponderance less evident in the specific literature on Industry 4.0 and SMEs. In both cases, the Social issues/ Sustainability category is always much less relevant.

The study thus seems to indicate that the transition to Industry 4.0 poses to the SMEs challenges of the same nature as those faced by companies in general, namely the big ones.

The central issue will thus not be the nature of the challenges, but rather the ability of SMEs to deal with these challenges. The question that needs to be urgently assessed is whether or not the problems that are often associated with SMEs (low capitalization problems, difficult access to finance, lack of awareness of the benefits of [technological] solutions, low technical competence outside of the core business, and low capability for long-term investment (Grau, Indri, Lo Bello, & Sauter, 2021)) makes it easier, or not, for the SMEs to deal with the challenges of Industry 4.0.

Policy-makers, entrepreneurs, and academia should make efforts to assess whether constraints, specific to SMEs, create greater than usual difficulties for them in accessing and using the technologies associated with Industry 4.0. If these difficulties are greater, redoubled efforts should be made to minimize them. What the study shows is that these efforts cannot be limited to technical issues or access to technology. Other issues such as management capacity, operations management, and sustainability must also be considered.

6. CONCLUSIONS

The study characterizes the publications on the topic of Industry 4.0 and SMEs. The results show that this literature is dominated by themes that can be grouped into the following categories: "Industrial revolutions", "Technology", "Management", "Operations Management/Industrial Engineering", "Social Issues/Sustainability" and Methodology.

The importance for Industry 4.0 of technology and issues related to the management of production processes (lato senso) had already been identified in previous studies (Liao et al., 2017; Dallasega et al., 2018; Kamble et al., 2018; Piccarozzi et al., 2018; Klingenberg et al., 2019; Rosa et al., 2020). Some of these studies also indicated the importance of themes from the realm of management and Social Issues and Sustainability, without, however, presenting evidence about this issue. This study brings such evidence, thus constituting an evolution concerning to the existing evidence-based knowledge about the theme.

The literature tells us that SMEs have difficulty in accessing technology, in many cases due to difficulty in obtaining financing or in accessing resources with the skills to properly use these technologies, so it is natural that the Management and Social Issues dimensions, linked to human resources, affect this segment of companies. This study shows that discussing the subject of Industry 4.0 in SMEs requires, in many cases, addressing management or human resources issues, and it is this requirement that this study makes clear.

The study also shows that the sources where the studied articles were published are almost exclusively journals about technology and process management. It is important that

the discussion of these themes also have its space in publications from other fields of knowledge, namely management.

The work is limited by methodological choices, namely the way the sample was constructed and the way content analysis was carried out. Other methodologies may be applied, in complementary studies, to confirm the results now obtained.

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ИНДУСТРИЈА 4.0 И МАЛИ БИЗНИС НЕШТО ИЗВАН ТЕХНОЛОГИЈЕ – ПРЕГЛЕД ЛИТЕРАТУРЕ

José Dias Lopes

Извод

Мала и средња предузећа (МСП) су посебно осетљива на питања технологије, често зато што им недостају финансијска средства или вештине да правилно искористе нове технологије. Овај рад представља резултате студије која истражује везу између Индустрије 4.0 и МСП кроз систематски преглед литературе. Резултати показују да овом везом доминирају теме које се могу груписати у следеће категорије: „Индустријске револуције“, „Технологија“, „Менаџмент“, „Управљање операцијама/Индустријски инжењеринг“, „Друштвена питања/ Одрживост“ и „Методологија ”. Студија показује релевантност тема менаџмента, друштвених питања и одрживости, што се онда не огледа у објављивању чланака о индустрији 4.0 у часописима из ових области. На крају, успостављање партнерства између истраживачких тимова у овим истраживачким областима и тимова који проучавају индустрију 4.0 могло би ублажити овај недостатак. Теме друштвена питања и одрживости су недовољно заступљене и стога је потребан напор да се развију истраживања о утицају ових тема на индустрију 4.0 и обрнуто.

Кључне речи: Индустрија 4.0, МСП, индустријске револуције, менаџмент, социјална питања, одрживост

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APPENDIX

	Few articles		Many articles
Many times	Advanced manufacturing technologies Big data internet Big data IOT Business model changes Business model elements Business model innovations Creation value offer Critical success factors Digital business development Few human resources Key enabling technologies Multiple case studies Novel business models Requires continued education Too few human Triple bottom line Value creation value When implementing industry		Big data analytics Business model innovation Case study approach Case study research Corporate social responsibility Cyber physical systems Cyber-physical systems cps Enterprise resource planning Entire supply chain Entire value chain Fourth industrial revolution Industrial value creation Knowledge about industry Manufacturing execution system Medium-sized enterprises SMES Multiple case study New business models Physical systems cps Product life cycle Supply chain management Third industrial revolution Vertical system integration
Few times	Annual balance sheet Autonomous production systems Business model research Business models new Business models through Case study design Cloud computing internet Cloud computing platform Company database Bisnode Computing big data Current business models Cyber physical system Data analytics data Data transparency throughout Decision support tools Deliveries unnecessary waiting Developing countries like Entire business model First industrial revolution Gross value added	Horizontal vertical system Industrial internet consortium Industrial value chains IOT cloud computing Life cycle management Models through industry Negative attitude towards New business opportunities New customer groups New products services New value offers New value propositions Overall equipment effectiveness Readiness assessment tool Required financial resources Role toward industry Sized enterprises SMES Smart manufacturing readiness Supply chain partners Top management support Unnecessary material flows Very high impact	Balance sheet total Existing business models New product development Three industrial revolutions

Figure 2. Matrix of expressions