

# Leadership Perspectives on the Transition from Industry 4.0 to Industry 5.0: A Broad Systematic Literature Review

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## ABSTRACT

The objective of this article is to present a systematic review of the literature on leadership in the transition from Industry 4.0 to Industry 5.0 and to highlight potential for future research. A bibliometric and content analysis of a wide range of scientific production was carried out in order to present the main trends and critical points of this subject. Through the evaluation of a sample group of two hundred and forty-one articles, it was possible to trace paths and understand approaches, identifying features, highlights and challenges of the Industry 5.0 leader. The literature analyzed shows that this leadership is mainly based on the knowledge, skills and attitudes necessary for performance and overcoming difficulties inherent to the demands of the industrial segment, which involve technological transformation, sustainability, resilience and human factors. This study fills a gap in the Industry 5.0 leadership literature by systematically exploring human-machine collaboration and sustainability-oriented leadership traits. Additionally, in addition to discussing how to address the demands inherent to Industry 5.0, this paper highlights that the consolidation of the transition from I4.0 to I5.0 is indeed in progress. In this scenario, this paper provides reflections for organizations that are experiencing this transition process.

**Keywords:** Industry 5.0, Industry 4.0, Leadership, VOSviewer.

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## INTRODUCTION

Humanity has gone through several industrial revolutions at a rapid pace. The industrial sector has been undergoing continuous transformations on a global scale and is currently immersed in the transition from the fourth industrial revolution (Industry 4.0, I4.0) to the fifth industrial revolution (Industry 5.0, I5.0). Companies around the world are still adapting to the practices and advances of I4.0.<sup>[1]</sup> While I4.0 is centered on technological and digital advancement, which in turn triggered the optimization of industrial processes and procedures, replacing human activities with automated systems, I5.0 stands out for its emphasis on symbiotic collaboration between humans and machines.<sup>[2,3]</sup> This evolution is based on premises of sustainability, resilience, and human-centeredness.<sup>[4-6]</sup>

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the transition from the fourth industrial revolution (Industry 4.0, I4.0) to the fifth industrial revolution (Industry 5.0, I5.0). Companies around the world are still adapting to the practices and advances of I4.0<sup>[1]</sup> through technological and digital innovation, optimization of industrial processes, automation and replacement of human activities by intelligent systems. In this continuous transformation, Industry 5.0 emerges as a complementary evolution of Industry 4.0, encouraging the insertion of new premises, by incorporating elements of human centrality, resilience and sustainability for processes in the industrial sector (Kans and Campos 2024). Thus, I5.0 focuses on the consequences of the separation between technological evolution and humanized practices and presents the need for synergy between humans and machines,<sup>[2,3]</sup> aiming at the balance in the interactions between technology and society.<sup>[4-6]</sup>

I5.0 expands on the ideas of I4.0, following the premises of growth and consolidation of digital technology as a way to optimize processes and production. However, beyond this perspective, the fifth industrial revolution proposes a greater balance in the organizational environment through the formation of awareness in relation to the essentiality of the human factor, combining technological advancement and construction of a sustainable, healthy and resilient environment with respect for human



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rights and the environment.<sup>[3]</sup> It is, therefore, necessary for the industry to combine increased production with technological evolution, minimizing environmental and social impacts. The industry needs to be well equipped to overcome contemporary challenges.<sup>[7]</sup>

Leadership is essentially exercised by those who lead, stimulate, guide and accompany employees in the process of evolution.<sup>[8,3]</sup> Leaders need contemporary knowledge and specific features to respond assertively to changes. An employee, in the context of the transformations arising from I5.0, is transferred from the company's cost base to become an investment in this new gear.<sup>[9,10]</sup> Transformational leaders can have a direct impact in a transition scenario.<sup>[11,3]</sup> Being visionary, innovative and committed to professional development, they inspire, stimulate and engage their subordinates.<sup>[12,3]</sup> In line with I5.0, distributive leadership develops its leadership in a network, emphasizing the importance of decentralized structures, reciprocal influence and complementary leadership behaviors of formal and informal plural leaders, with shared responsibilities.<sup>[13,14]</sup> Therefore, the complexity of this challenge requires expanding the analysis to a perspective capable of identifying the conditions that make leadership truly effective.<sup>[15]</sup>

This study presents an analysis of the current leadership landscape in the transition from I4.0 to I5.0, identifying challenges and future trends. The scientific production analyzed covers a period of five years and a comparative approach allowed highlighting new discussions through the dynamics of evolution in the context of the transition between the industries 4.0 and 5.0. This article presents the results of a systematic review based on the combination of bibliometric and content analysis techniques.

The motivation for this work is directly associated with the contemporaneity of the subject analyzed. The systematic review allows mapping the studies carried out, identifying gaps in literature and proposing new directions for research. In addition, the connection between keywords which reflect consolidated concepts and theories allows the confirmation of the transition hypothesis from I4.0 to I5.0. Understanding the scenario of this transition is necessary since it explores the typology of leadership at the current time, in addition to identifying the challenges and perspectives, aiming to equip leaders through the acquisition of new skills for the consolidation of I5.0. A changing environment requires new knowledge and new skills from leaders since this process involves the need to overcome challenges such as insecurity and job retention, resistance to change and the development of digital skills.<sup>[16-19]</sup>

This article is organized into four sections. Section 2 presents the methodology, section 3 presents the results obtained and the content analysis. Section 4 highlights the most important conclusions and contributions to the subject analyzed.

## METHODOLOGY

The SCOPUS database was used for the systematic review, considering its comprehensiveness and quality of bibliometric data.<sup>[20,21]</sup> In addition, the SCOPUS database has tools which enable the tracking, analysis and visualization of works, providing a broad view of the world's scientific production as it covers more than 20,000 journals from 5,000 international publishers.<sup>[22]</sup>

The VOSviewer software (version 1.6.20) was used to identify and analyze the papers. This platform allows the creation, visualization and exploration of maps based on bibliometric network data (extracted from the Scopus database),<sup>[23,24]</sup> the generation of maps that show co-authorship, citation and co-citation networks, as well as keyword maps.<sup>[23,24]</sup> Within the scope of the analyzed topic (I4.0 to I5.0 transition), VOSviewer enabled the recognition of a humanistic, resilient and sustainable approach through the use of appropriate keywords ("sustainability", "human resource management" and "human"), suggesting that the balance between technology and humanization is in progress. VOSviewer contributed to identifying the advancement of I5.0 goals, connecting concepts, technological elements and human factors.<sup>[25]</sup>

This work adopts a joint approach of bibliometric and content analysis aimed at understanding the constructs (theoretical model that aims to explain phenomena that are not yet fully understood) inherent to the subject analyzed.<sup>[26]</sup>

Bibliometric network analysis is a long-established method in academia for quantifying academic literature networks.<sup>[27]</sup> Furthermore, this approach reflects the relevance attributed by peers to the new knowledge generated, identifies the main keywords, authors, most productive countries and most prominent themes, as well as enabling the perception of the chronological evolution of the theme studied.

This paper aims to answer the following question: How the leadership landscape is being presented in the transition from I4.0 to I5.0? The leadership scenario involves an analysis of multiple factors that affect the leader's performance, including technological advances, climate and health issues, geopolitical dynamics, and socio-environmental pressures of contemporary society. Understanding this context allows for a more in-depth investigation, enabling the identification of challenges, desires, potentialities, and opportunities faced by both leaders and other employees. These variables shape the demand for innovative solutions and strategies that can contribute to the consolidation of I5.0, in which technology, productivity, well-being, and quality of life must be addressed synergistically.<sup>[2,28,29]</sup> What are the trends, features and perspectives related to leadership performance in this transition scenario? What are the new attributes that should be incorporated into leaders in the face of new technologies and aspects related to human factors aiming at the promotion and

integration of values such as sustainability and resilience.<sup>[3]</sup> The steps of this work are presented in Figure 1.

### Data collection, screening and delimitation

Searches were performed in the SCOPUS database considering the period from 2018 to 2024. The search considered references of paper titles, abstracts and topic selection. The integrated criteria presented in Table 1 were applied.

After defining the keywords, 241 articles were identified. After a content analysis to identify the existence of a direct relationship with the topic of interest, a total of 80 papers were selected.

## RESULTS AND DISCUSSION

After including the keywords and selecting the sample, the evaluation and correlation between the articles was carried out with the aim of recognizing patterns. In this exploratory process, similarities in the types of relationships and categories were identified. Then, bibliographic, bibliometric and content analyses were performed.

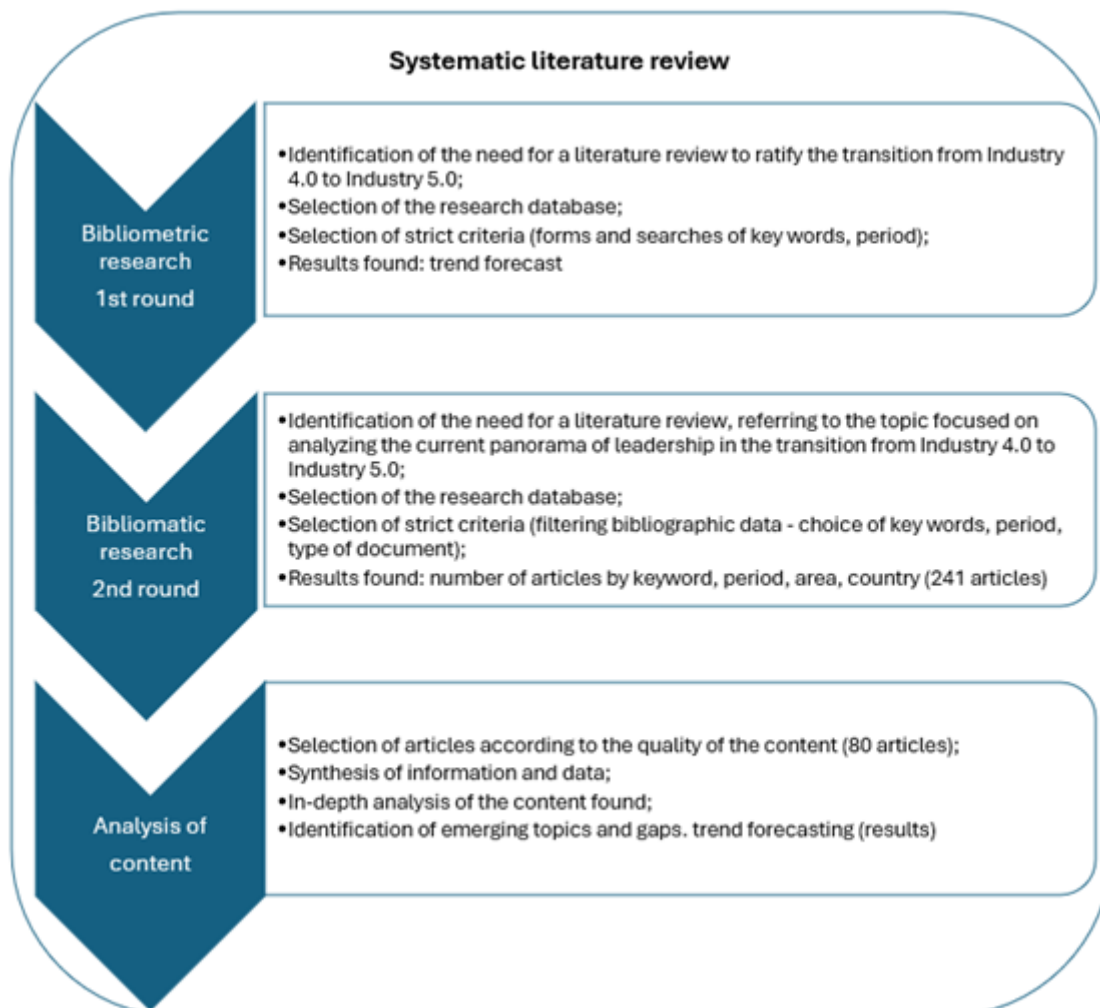
### Bibliometric and content analysis

The configuration of scientific periodical production is characterized in three aspects: annual evolution of the number of published papers, authors and keywords.

In order to preliminarily analyze the direct relationship between I4.0 and I5.0 and aiming to confirm the hypothesis that the new industrial scenario is really a transition scenario, words present in the title, abstract or keywords in publications from 2011 (birth of industry 4.0) to 2024 were tested. Words related to the basic premises of Industry 5.0 were chosen, together with the keyword “Industry 4.0” (Table 2).

Regarding the perspectives of approach within the scope of the I4.0- I5.0 transition, the works were grouped according to the topics: Sustainability, resilience and people-centeredness (Figure 2).

Figure 2 shows the evolution of publications referring to each of the topics related to Industry 5.0 (sustainability, resilience and human-centeredness), together with the word “Industry 4.0”, suggesting the gradual introduction of the ideas and bases of the



**Figure 1:** Systematic literature review.

fifth revolution which confirms the transition and consolidation of work within the scope of Industry 5.0.

The frequency variation of the 3 keywords ('sustainability', 'resilience', 'human-centered') over the period 2015-2023 also showed increasing dominant behavior. The frequency of 'sustainability' has increased from 17 (2015-2016) to 60 (2021-2022) (253%), the frequency of 'resilience' has increased from 4 (2015-2016) to 63 (2021-2022) (148%) and the frequency of "human-centered" has increased from 4 (2015-2016) to 29 (2022-2023) (63%) ('human-centered'), which clearly reveals a concentration of research related to these topics and the consolidation of the emergence of the theme of industry 5.0 as a new step in the technological level. Although the frequency of publications related to the 3 keywords showed monotonic behavior, the derivative of its increase showed a decrease mainly in the 2020-2022 triennium, which can be attributed to the reduction in the intensity of research activities worldwide caused by the pandemic. Figure 2 shows an increasing occurrence of 'sustainability', 'resilience' and 'human-centered leadership' mainly in publications from 2018 to 2024, indicating a growing academic interest in the principles of Industry 5.0. The increasing emphasis on 'human-centered leadership' suggests that researchers are recognizing the need for leadership frameworks that integrate human-machine collaboration.

Another aspect refers to the diversity of papers that address one of the three topics/ pillars (sustainability, resilience and human-centeredness) without an integrated analysis, suggesting that the transition is in its initial phase. Therefore, it is possible to

note the absence of studies that consolidate the theme of Industry 5.0 with an integrative approach of its pillars, especially with regard to the topic "leadership in Industry 5.0".

New keywords were included in a second stage in order to identify references related to the current leadership scenario, in the context of environmental awareness, rational use of resources, adaptability to changes and human factors (Table 3).

As a result of the new filters (Table 3), a total of 241 references were obtained, the evolution of which in the period 2018-2023 shows a significant growth in the number of papers published on leadership in the transition from I4.0-I5.0 (Figure 3).

Figure 3 shows a significant increase in publications between 2021 and 2023, which corresponds to the expansion of political

**Table 1: Delimitation of keywords and applied filters.**

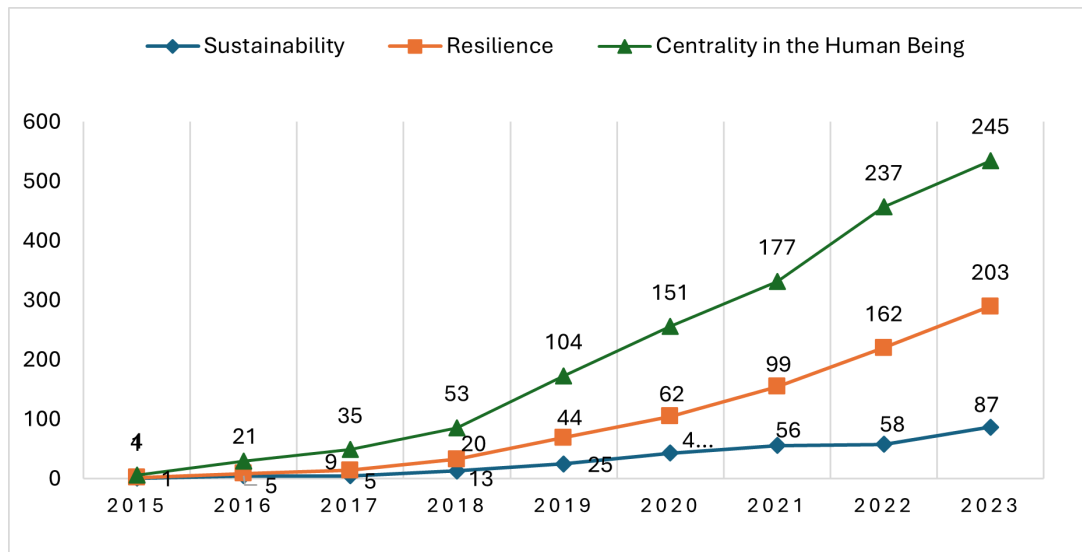
Scopus	Keywords	"industry 5.0 AND leadership"
		OR
		"industry 4.0 AND leadership"
		OR
		"Industry 4.0 AND directors, AND supervisors, AND superintendents"
	FILTER 1	Article title, Abstract, Keywords
	FILTER 2	Articles
	FILTER 3	Period (2018-2024)

**Table 2: Delimitation of keywords and applied filters.**

	Keywords found in industry 4.0 articles		Results
Industry 5.0 assumptions	Resilience	- industry 4.0 AND AND resilience OR - industry 4.0 AND resilient	701
	Sustainability	- industry 4.0 AND AND sustainable OR - industry 4.0 AND sustainability OR industry 4.0 AND sustainable AND growth	328
	Centrality of the Human Being	- industry 4.0 AND human AND factor OR - industry 4.0 AND man AND machine AND symbiosis OR - industry 4.0 AND people AND centralization OR - industry 4.0 AND human-centeredness OR - Industry 4.0 AND human-centered	1122
		Total Articles	2151

Note: Publications until May 2024.





**Figure 2:** Evolution of publications - Industry 5.0 Premises.

discussions on Industry 5.0 in the European Union and on business models focused on sustainability.<sup>[4,30]</sup> According to the publications, European leaders have expressed concerns about the current capitalist model, recognizing the urgency of structural reforms that enable better alignment between economic development and social well-being.<sup>[4,31,32]</sup>

The increase in the number of publications related to the topic of leadership over the period 2018-2024 was statistically confirmed through a regression test.<sup>[33]</sup> The regression test provided a  $p$ -value equal to 0.0002 (less than 0.05 considering a significance level of 95%), which implies rejection of the null hypothesis (there is no significant increase over time, angular coefficient close to zero) and confirms the alternative hypothesis (there is a statistically significant increase in the number of publications, Figure 3).

Figure 4 presents the authors who have published the most papers on the topic of leadership. Three groups of authors stand out: i) Jiju Antony (Khalifa University); ii) Michael Sony (Oxford Brookes Business School); iii) Olivia McDermott (University of Galway). Their respective works address the challenges of I4.0 and point out the importance of leadership in overcoming adversity.

Only three authors have six publications each related to the same specific theme on leadership. The other authors have few publications addressing the theme of leadership in the transition from I4.0 to I5.0.

Figure 5 shows the distribution of publications by area of knowledge and it can be seen that the theme of leadership is a transversal theme, discussed in works related to the development of products, processes and the provision of services, on a global scale.

Figure 6 shows the keywords contained in the title or keywords or in the abstract of the 241 papers. The most prominent keyword was “industry 4.0”, followed by “leadership” (both chosen as a

parameter for the research). The most prominent words appear with words that characterize the technological context of I4.0, which is verified through words such as “digital transformation”, “digitalization”, “innovation”, “artificial intelligence” and “internet of things”.

The keywords are grouped into five clusters (Table 4). Table 4 highlights that 66% of the occurrences are related to the technology sector, in accordance with the potential of I4.0. On the other hand, it is noteworthy that the technological characteristic has continuity in the context of I5.0, which aims to associate this aspect with the balance between man and machine.

In addition to the technological perspective, a more humanistic, resilient and sustainable approach is also evident, with keywords that reflect this focus (sustainability, sustainable development, human resource management, human, COVID 19). Among the 153 occurrences directly related to the theme Leadership in Industry 5.0, 34% are focused on exclusive aspects of Industry 5.0, which suggests progress in the I4.0-I5.0 transition.

In this scenario of technological consolidation, the skills and capabilities of individuals and organizations are transformed to meet a high-tech scenario,<sup>[34]</sup> and leadership emerges as a dominant influence in this digital transformation of organizations.<sup>[35]</sup> In this process of constant change, leaders act as facilitators so that workers can expand their production capacity, become versatile and creative to meet the possible challenges of a technological and behavioral transition.<sup>[34]</sup>

## Content Analysis

Eighty papers associated with the theme of leadership in the I4.0-I5.0 transition were considered with their respective authors<sup>1</sup>. The deductive approach and content analysis were applied, organized into three categories: (1) Importance, (2) Features and (3) Challenges of leadership in the industrial transition.

## The importance of leadership

Leadership is one of the main factors determining the success of any organization.<sup>[15]</sup> Effective leadership facilitates and inspires the development and training of employees.<sup>[35-37]</sup> Leadership studies not only focus on the leader but also on followers, contexts, and cultures.<sup>[38]</sup> In the era of digital transformation, leaders need to act from a human-centered perspective, recognizing how organizational changes affect the inclusion of employees in an interdisciplinary approach, with a holistic understanding, aiming for a sustainable and resilient environment.<sup>[39]</sup>

The leader must play a mediating and facilitating role in organizational learning processes, which include: strategic alignment, competence in information technology, institutional trust and willingness to make organizational changes.<sup>[40,41]</sup> What features do leaders need to have to meet the transformations that emerge from the I4.0-I5.0 transition process?

## Leadership features

Leadership style is the way in which people are directed and motivated by a leader to achieve organizational goals.<sup>[15]</sup> There are different styles that have gained prominence in recent years, namely, transformational, transactional, autocratic, charismatic, bureaucratic and democratic. The literature highlights that some of these styles are more effective in the I4.0-I5.0 transition scenario, such as transformational leadership which encourages changes in employees, shares the organization's vision and objectives, presents the necessary resources and promotes intellectual stimulation.<sup>[42,43]</sup> According to,<sup>[38,3]</sup> transformational leadership tends to positively inspire processes and results, and facilitates an environment of support and interaction with followers through continuous training and personal and professional development, encouraging employees to act collectively, beyond their own interests.

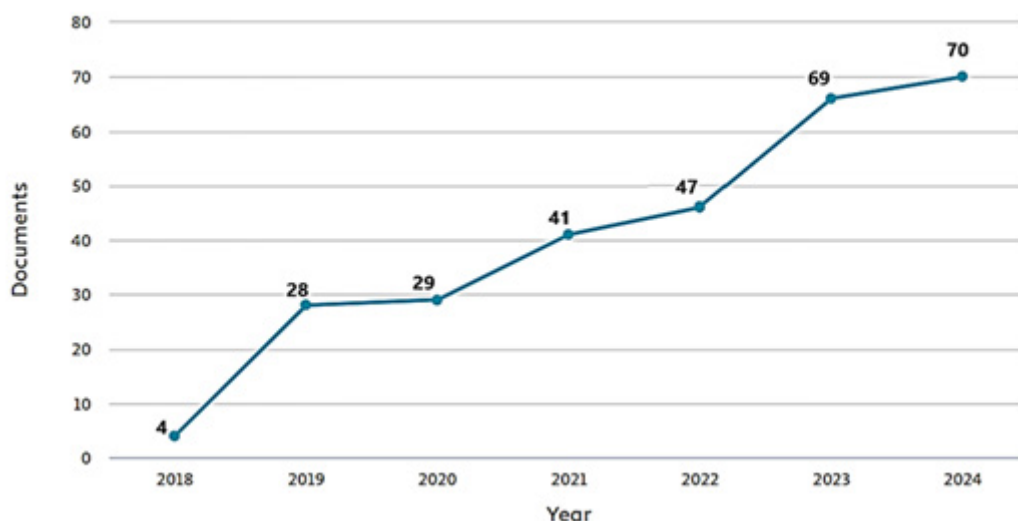
The current scenario requires leadership that achieves the implementation of well-defined strategies, effective change

**Table 3: New keywords - second stage.**

Scopus	Keywords	"industry 5.0 AND leadership"	<b>RESULTS:</b> 241 articles found
		OR	
		"industry 4.0 AND leadership"	
		OR	
		"Industry 4.0 AND directors, AND supervisors, AND superintendents"	
	FILTER 1	Article title, Abstract, Keywords	
	FILTER 2	Articles	
	FILTER 3	Period (2011-2024)	

Note: Publications until May 2024.

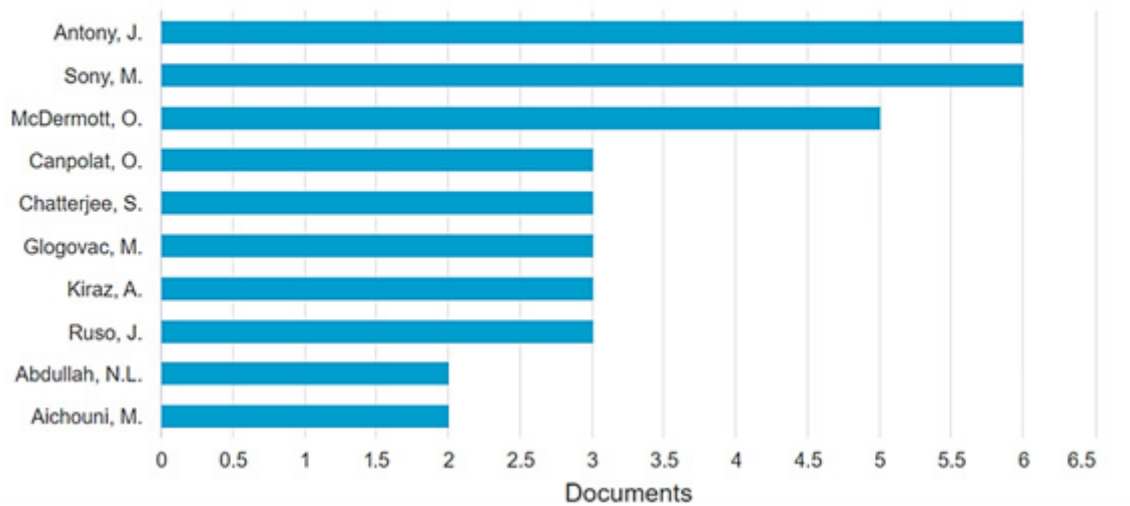
**Documents by year**



**Figure 3:** Number of publications (vertical column) over five years (row) of research related to leadership in the transition period between I4.0 and I5.0. Note: Publications until Dec 2024.

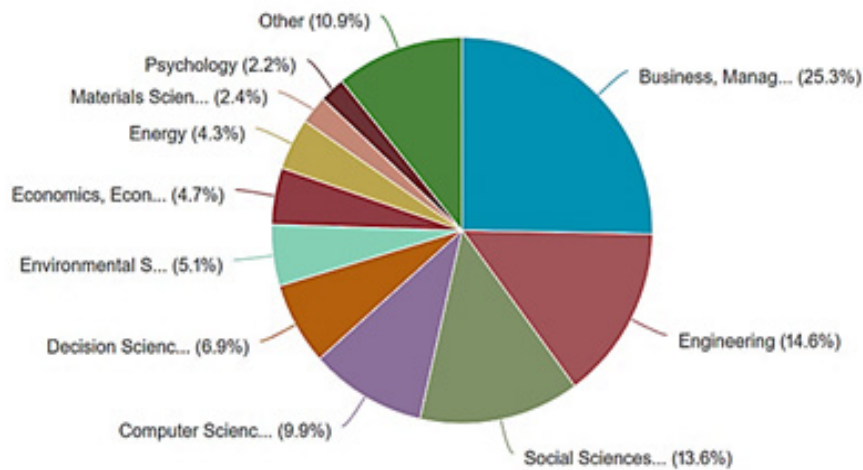
## Documents by author

Compare the document counts for up to 15 authors.



**Figure 4:** Authors and number of articles published (column) (I4.0 - I5.0 transition).

## Documents by subject area



**Figure 5:** Approach to the topic of leadership by area of knowledge in the transition period I4.0-I5.0.

management, and a collaborative culture that considers the benefits and effectiveness of knowledge management, sustainability, employee support, and the use of advanced technologies.<sup>[35,44]</sup> To this end, the leadership style must involve individual, technical, personal, methodological, and social skills that inspire the development and training of employees in new challenges.<sup>[44,45]</sup> Researchers recommend that companies aim for leadership styles capable of improving team skills and abilities.<sup>[46,35,47-79,16,80,17,81-87,10,88-102,34,103-114,31,115-118,32,19,119]</sup>

The most important skills for leadership are effective communication, innovation, cooperation, creativity, problem

solving, lifelong learning, knowledge of Information and Communication Technologies (ICT) and motivation.<sup>[90,19]</sup> These skills stimulate decision-making, emotional intelligence, cognitive flexibility, service orientation, coordination/management skills, critical thinking and creativity, technological skills and complex problem-solving.

According to,<sup>[3]</sup> leaders of the fifth industrial revolution must have features based on knowledge of enabling technologies, team management, data-driven decision-making and an attitude capable of bringing revolutionary concepts about this new scenario into work practice.





reality, through welcoming, identifying learning gaps and managing training.<sup>[41,16,17]</sup>

It is important that leaders are aware of their role, the organizational context, and are well equipped with skills and knowledge about their organization and their subordinates.<sup>[36]</sup> On the other hand, humanity is experiencing pressure for more sustainable solutions, with adaptability to abrupt social and environmental changes.<sup>[77,120]</sup> According to,<sup>[121]</sup> the COVID-19 pandemic has unbalanced organizations, bringing unforeseen, adverse situations and highlighted the need for organizational leaders to develop resilience, recovery, agility and reaction capabilities.

Understanding the role of the leader, as well as their demands and adaptation priorities, is essential for the transition from an exclusively technological focus to a more balanced approach which meets the technological needs of the industrial environment but, at the same time, promotes the well-being of the people involved. This process involves the incorporation of principles related

to sustainability, human-centered and resilient approach, as advocated by Industry 5.0.<sup>[122,123]</sup> A leader aligned with the three fundamental premises of Industry 5.0 contributes significantly to the transformation of the various industrial sectors, promoting innovations that balance productive efficiency and organizational well-being, in addition to fostering a more adaptable environment capable of responding to global changes. Multinational automakers have management that is more committed to human relations and sustainability.<sup>[124]</sup> Programs or practices focused on ESG (Environmental, Social and Corporate Governance) provide the automotive sector with technological resources to achieve productive efficiency and product innovation.<sup>[125,126]</sup> In the context of abnormal situations, such as the COVID-19 pandemic, it is important that organizational leaders develop resilience, adaptation, agility and recovery capabilities.<sup>[121]</sup>

## CONCLUSION

Observing the last few years of research, there is a trend towards consolidation of the transition from I4.0-I5.0, with the gradual increase in ideas and premises of the fifth industrial revolution (sustainability, resilience and human-centricity) in works related to I4.0.

Leadership in the context of I5.0 faces the challenge of mapping features that promote the acquisition of skills appropriate to the context of constant change. These changes impose, among other things, the need for a different perspective on human factors which, unlike technological challenges, remain little explored.

Contemporary leadership requires attributes that go beyond the position held and is anchored in knowledge, technical and behavioral skills that add value and facilitate the facing of emerging challenges. These skills allow the leader to play a mediating role, which is essential in the context of technological and humanistic transitions.

Bibliometric research contributes to the recognition of the transitional context in which leadership and industry are inserted. The trends and competencies identified suggest reflections and alternatives focused on achieving a sustainable, resilient and human approach in the technology industry. To this end, industry needs to equip itself. The results suggest future research that details the skills needed by leaders so that the industry can promote appropriate training through continuous learning plans, in addition to providing the sectors with tools to attract new leadership positions.

There is a noticeable gap in the literature regarding the analysis of leadership competencies in the transition process from Industry 4.0 to 5.0, considering the innovative nature of this topic. Future studies can expand this literature review and conduct field research, involving both industrial and academic experts, in order to generate more robust data on the skills required of leaders in this new scenario.

**Table 4: Description of keywords extracted from the VOSviewer tool.**

Keyword	Occurrences
Industry 4.0	126
Leadership	49
Innovation	20
Digital transformation	20
Sustainability	18
Industrial Revolutions	15
Digitization	13
Quality 4.0	12
Fourth Industrial Revolution	12
Human Resources G are	11
Manufacturing	11
Article	10
Decision Making	10
Artificial intelligence	10
Industrial research	9
Project management	9
Supply chain management	9
Sustainable development	8
Human	8
Supply chain	8
Information management	7
Internet of Things	7
Digitization	7
COVID-19	7
Quality Management	7
Technology	7

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## CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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