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TOWARDS THE CONVERGENCE OF TWO SCIENTIFIC RESEARCH AGENDAS: SUSTAINABLE DEVELOPMENT AND VALUE CHAINS

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ABSTRACT

Sustainable development has become a prominent concept in the global political, economic, social and scientific agendas, due to the urgent need for transformation of social and economic systems to satisfy the present needs, without compromising future resources. These changes impact different socioeconomic aspects, especially the organization of production through value chains. This article focuses on the convergence between research agendas about sustainable development and value chains, inquiring into the central question: What type of thematic convergence is observed between these agendas? To address the objective, a bibliometric methodology is used, highlighting the analysis of word networks, co-occurrence networks, and conceptual structure of scientific publications. The results reveal annual growth of 45% in the number of scientific publications during the period examined, which tripled in the most recent period (2015 to 2021). In the network analysis, 20 thematic clusters were identified resulting from the convergence, with three highly interconnected central nodes standing out: Global Value Chains, governance, and sustainability management. In the Sustainable Development Objectives, other themes stand out, such as corporate participation, impact of emerging technologies in commercial strategies, Industry 4.0, and circular economy. The convergence of research agendas reflects the investigative evolution on global preoccupations and the need for integrated approaches. In addition, it represents an inter-, multi- and trans-disciplinary process that facilitates the generation of new knowledge to approach complex contemporary challenges.

Keywords: bibliometric analysis; circular economy; governance; industry 4.0.

INTRODUCTION

The concept of sustainable development (SD) has gained presence in the public discussion and has been consolidated in political, economic and social agendas globally. Various actors have expressed their worry over the productive models dominated by the exploitation and intensive use of fossil resources, which have demonstrated to have severe negative effects on the environment. This situation risks the balance in ecosystems, and, therefore, vital support systems of the planet (Steffen *et al*., 2015).

The current patterns of economic development are unsustainable. Diverse predictions warn that if emerging economies continue on the same path as consolidated industrialized economies, an unprecedented increase in the anthropogenic use of resources in the world could take place. This projection, together with other evidences, supports the idea that there is a limit to growth (Rockström *et al.*, 2009), which implies the urgent need to reconsider present productive patterns. In this context, a change in paradigm is required, especially in developed countries, towards a more balanced economic model that allows living equitably within the load capacity of the planet (Ghisellini *et al.*, 2016).

Given that the analysis of the set of variables mentioned before exceeds the limits of this article, the approach of this study is centered specifically on one of them: productive patterns. This analysis is conducted through the predominant form of organization: value chains (VCs).

Therefore, it is crucial to identify and analyze the nature of the interaction between the agendas of scientific research on SD and VCs. This would allow defining the type of convergence between these agendas and determining if, at a scientific level, a dominion is being configured on both themes. The research question set out for this study is: What type of thematic convergence is observed in the research agendas on SD and VCs? The hypothesis suggests that the thematic convergence between SD and VCs implies a change in scientific practice, which is manifested through new methodologies, interdisciplinary approaches, and integral analytical frameworks, and situates the interest for sustainability as a central axis that begins to be dominant in the priorities and approaches of the research agendas on VCs.

According to Bunge (2000), the study is described as a process directed at recognizing, suggesting and approaching problems. A problem is defined as any difficulty that cannot be overcome through experience or common knowledge, which requires the implementation of specific activities for its resolution. A scientific research agenda implies the identification of relevant or new debates and problems which have still not been resolved, within the scientific paradigm, and which require the collaboration of diverse disciplines to propose solutions, whether in terms of basic or applied knowledge, rules, norms, public policies or guidelines, among others.

A research agenda establishes lines or themes of interest that emerge from the relationship between the scientific community and society, and it requires open collaboration with various non-academic sectors (Gras *et al.*, 2023). It seeks to answer questions that have still not been resolved or which do not have a satisfactory solution, at the same time that it generates new questions that contribute to the creation of socially valuable knowledge that is also relevant and applicable in practice (Alonso and Napoli, 2021).

The configuration of a research agenda depends on various factors and levels of interest. The relevance of a theme can be derived from national or supranational public policies, which tend to have an influence on the allocation of financing, both public and private (Naidorf and Alonso, 2018). Although the definition of research agendas is not limited to this aspect, this factor tends to be defining, since by directing resources towards themes considered "strategic, priority or of interest", research leaders, groups and students tend to adapt their lines and approaches to gain access to programs or projects with financial backing.
The formation of a research agenda sometimes emerges from the intersection of two different research agendas that converge in common themes due to unresolved questions and new directions of study. For this reason, this study argues that the concept of convergence is useful to understand the dynamics of the research agenda that has emerged between SD and VCs.
In this article, the notion that convergence implies a cumulative and transforming interaction is highlighted, as well as a cognitive integration between diverse scientific disciplines, technological advances, and the communities that produce them with the objective of achieving greater integration, sharing objectives and promoting a more effective synergy in their application and implementation (Stezano *et al.*, 2017; Reyes *et al.*, 2017). The scientific convergence addressed here refers to the process that involves the confluence and interaction of various disciplines with the aim of generating knowledge to solve problems. In the context of scientific research agendas, convergence is presented as the intersection between two defined themes, which, in a directed or random way, establish meeting points and, with time, generate a dominion with new thematic lines or axes as an emergent phenomenon.
To reach the objective established and to answer the research question, this article uses a methodological approach based on bibliometry, which allows it to perform an analysis of word networks, applied to the titles and keywords of scientific publications. Through this method, the structures of the most relevant keywords are compared, as well as their co-occurrence in the documents, with the aim of identifying and analyzing the existing relationships, thematic evolution, and convergence between both research agendas.

THEORETICAL FRAMEWORK

Research Agendas: Sustainable Development and Value Chains

Sustainable Development

The concept of SD, proposed in the Brundtland Report by the World Commission on Environment and Development (1987), marked a transcendental milestone in the definition of research agendas. One of the most relevant

emerging themes is the relationship between the dimensions of sustainability (environmental, economic and social) and the predominant organizational model of current productive systems, the VCs. It is important to mention that there is an open debate about the use of the terms "sustainable development" and "sustainability". Although this discussion is important, this study opts for using the term "sustainable development" as starting point, following the criterion established by the Brundtland Report (ONU, 1987).

After the Second World War, a developmentalist economic model emerged, which prioritized accelerated economic growth. However, at the end of the 1960s, a critical situation emerged which revealed the ecological limitations of this paradigm, especially its inattention towards the sustainable use of natural resources. In response to this crisis, governments and international organizations have directed their attention towards the need to adopt new productive paradigms. An emblematic example of these efforts is the Agenda 2030 for Sustainable Development, published by the United Nations (UN), which establishes 17 Sustainable Development Goals (SDGs) and 169 associated goals, designed to address these global challenges integrally.

Although the origins of the concept of SD are not entirely clear, the most recognized definition is the one presented by the Brundtland Commission in the report Our Common Future (1987), where SD is described as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (Brundtland, 1987).

In recent decades, SD has been consolidated as an effective strategy to communicate, sensitize and materialize the concept of sustainability. The relevance of this approach lies in its capacity to provide society with tools that promote its continuity and the population's welfare. In addition, SD establishes directives to approach complex challenges, from the local scope to the global scale, becoming a key element for the advancement of humanity. The integral and intergenerational perspective conceives SD as the simultaneous search for economic prosperity, environmental quality, and social equity, considering the long-term effects of present decisions. In the field of scientific research, Seuring *et al.* (2008) highlight three large dimensions of interest: environmental, economic and social.

SD is conceived as a progressive transformation process, which fosters a greater environmental consciousness, and recognizes that entrepreneurial sustainability integrates both economic profitability and social welfare. This perspective, in addition to underscoring the importance of entrepreneurial profitability, also highlights the need to protect people and the planet. Therefore, businesses and other productive organizations that aspire to having sustainable trajectories must balance the functionality of ecosystems,

the reduction of vulnerability of communities, economic growth, and question the conventional models of development (Sultan, 2013; Ruggerio, 2021).

The agenda on SD is fundamental to establish a shared vision of the principles of sustainability, particularly in the transition process where stakeholders and their activities attempt to reach different objectives in balance with the environmental, economic and social dimensions. However, complex socioenvironmental interactions have generated increasingly more evident consequences, such as climate change, loss of biodiversity, water stress, as well as increase in poverty, job insecurity, and economic inequality (Rockström *et al.*, 2009). These phenomena threaten both the preservation of systems for vital support of the planet, and the satisfaction of fundamental human needs. As consequence, concern for the implications of the production of goods and services has intensified, exerting greater pressure on productive entities, to minimize their negative externalities (Govindan, 2018).

Addressing these challenges requires a transformation in the models of production and consumption, favoring the management of environmental impacts, social inclusion and economic equity, with the objective of moving towards more sustainable developmental trajectories, and it suggests the need for productive organizations to integrate elements of sustainability in all their operations (Ahi and Searcy, 2013; Khan *et al.*, 2021).

Value Chains

A VC includes all the necessary activities to take a product or service from its origin, through the production stages, to its consumption. The metaphor of "chain" emphasizes the interconnections and interdependence between stakeholders, activities and underlying dynamics for the production of goods and services. Although initially it was centered on the company as unit of analysis, this framework transcends its analysis of creation of competitive advantages, through the understanding of the chain's environment, organization and structure in its totality (Porter, 1996).

The study of VCs has given rise to specific thematic lines, such as Global Value Chains (GVCs). The GVCs are characterized by the formation of inter-organizational networks with contextual specificity, social development and local integration (Dussel Peters, 2018). The evolution of VCs signals macro, integral and complex conceptual frameworks, which consider multiple levels of aggregation, centered on industrial or sectorial aspects. For example, studies about VCs in the automotive, agroindustrial or health industries (Sturgeon *et al.*, 2008; Henson and Humphrey, 2010; Seabrooke and Wigan, 2022).

The growing importance of the geographic distribution of productive activities has driven the development of concepts such as Local Value Chains

and Regional Value Chains (Humphrey and Schmitz, 2002; Govindan, *et al.*, 2013). These perspectives, which integrate the spatial scale (Kaplinsky, 2013), complement the analysis of Global Value Chains (GVCs), the most influential thematic line in this field. GVCs analyze the dislocalization of production and emphasize governance through the evaluation of power relationships between the stakeholders involved. This approach is centered on the role of global producers and buyers, the promotion of learning and innovation activities, highlighting the concept of scaling (Gereffi and Luo, 2015; Fernández-Stark and Gereffi, 2019).

To understand the growth trajectories, especially in companies, industries and developing countries, approaches have been developed which integrate theoretical and methodological perspectives such as the convergence between National Innovation Systems and VCs (Jurowetzki *et al.*, 2018). These frameworks examine the growth trajectories, emphasizing the importance of the institutional dimension, particularly for companies, industries and developing countries, focusing on research, development and innovation processes in various economic and social phenomena.

In conclusion, the contemporary perspectives of the scientific agenda of VCs allows understanding the entrepreneurial interactions within complex socioeconomic systems. These interactions involve commercial transactions, information exchange, and cooperation to reach common goals (Bair, 2008; Springer-Heinze 2019). The evolution of these approaches has broadened their reach, from the analysis of individual businesses, to the consideration of specific goods, particular sectors, and the geographic distribution of productive activities. This broader and contextualized vision recognizes the need to address the challenges of contemporary trade, which demonstrates the cumulative, dynamic and adaptable character of the research agenda in this field.

Towards the convergence of research agendas

Academic literature offers diverse perspectives on the interrelationship between SD and VCs. Both concepts have experienced a significant evolution, as explained previously, and the interaction between both concepts has become important at different levels, particularly in their impact on scientific research agendas. Nosratabadi *et al*. (2019) indicate that the incorporation of the vision of SD in the productive scope allows progress in economic activities, in balance with the dimensions of sustainability, without diminishing the competitive advantages and the creation of value. Ahi and Searcy (2013) point out that this paradigm implies the capacity of organizations to maintain their resilience, establishing healthy connections with environmental, economic and social systems.

Rodríguez and Avilés (2017) emphasize that it is about the recognition of a multidimensional phenomenon, centered on maintaining economic results, generating knowledge, and developing capabilities by producing goods and services considering elements and practices directed at sustainability.

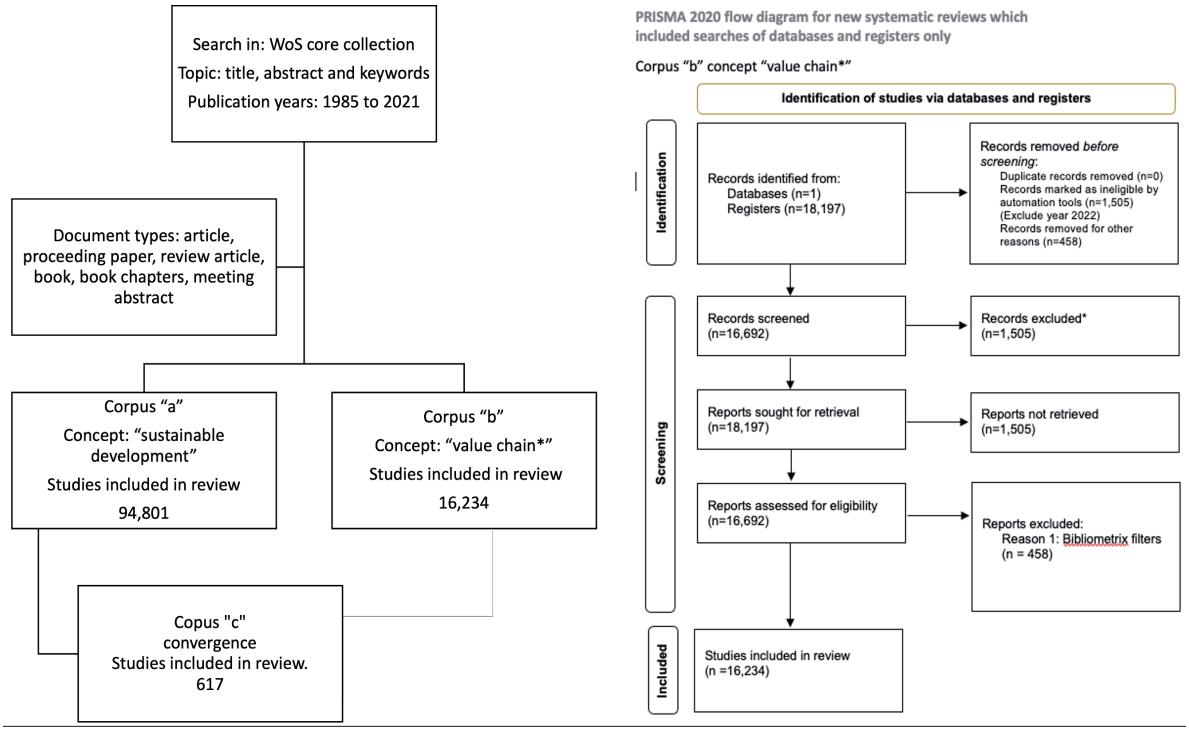
The convergence between the agendas of SD and VCs has gained attention in academic research. Although both concepts have been object of numerous independent debates in the last decade, there is a growing body of research that explores their interaction, mainly from a conceptual perspective. This has resulted in thematic lines that address this integration, where the following stand out: Sustainable Value Chains (Anthony, 2019; Fearne *et al.*, 2012), Adoption of Sustainable Value Chains (Huybrechts *et al.*, 2018), Management of the Green Supply Chain, Sustainable Management of the Supply Chain, and the Development of Green or Ecological Value Chains (Ashby *et al.*, 2012; Hasan *et al.*, 2019). The emergence of these integral frameworks suggests a convergence between both agendas, potentially generating a new dominion of research.

In this context, a network analysis of co-occurrence of keywords and their temporal evolution is carried out in the present study, which allows to characterize the main research areas and emerging trends in this field. When different subperiods are examined, changes in the most relevant themes and the appearance of new key concepts are identified. This exploration provides a general view of the evolution of these fields of study and identifies areas of intersection between them. It is expected that the results from this study will guide future research towards new lines of study, on the convergence of SD and VCs, thus contributing to the development of more sustainable production models and the innovation in the management of both concepts.

METHODOLOGY

A systematic bibliometric review of the concepts of SD and VCs is presented, using academic documents published on the Web of Science (WoS) database. This source is recognized for the quality of the scientific journals that it hosts, as well as for its indexing structure, characteristics that guarantee obtaining reliable and representative findings.

The review was carried out following the PRISMA protocol (Page *et al.*, 2021), which ensures transparency and the adequate record of the process. The search for literature was conducted using the words “sustainable development” and “value chain” combined with the operator “AND”. Academic publications in English registered between 1985 and 2021 were included. The studies selected were downloaded in flat text format with the option of complete record. The strategy for search, selection and eligibility of the studies is detailed in the PRISMA flow diagram for the corpus “value chain” (Figure 1).



Source: prepared by the authors.
Figure 1. Example of PRISMA for the "Value Chain" concept and strategy for search, selection and downloading of scientific publications related with "Value Chain", "Sustainable Development", and their "Convergence".

The analysis of the resulting literature corpus used various bibliometric techniques, including the descriptive analysis of keyword frequencies and publication trends, the analysis of co-occurrence networks, and the evaluation of the conceptual structure through cluster analysis (Aria *et al*., 2020). Initially, a co-occurrence analysis of keywords was carried out to identify the emerging themes, based on the keywords of authors. This method allows visualizing the relationships between the most frequent and relevant terms in the field of study. For a more detailed comprehension of the semantic relationships between concepts, the initial analysis was complemented with a co-occurrence network study of diverse elements of the documents (titles, abstracts and keywords). For this analysis, the MapEquation tool was used, designed specifically to reveal the structure of communities in large and complex networks. MapEquation uses a net clustering algorithm to identify hierarchical communities in complex networks, which allows visualizing the conceptual structure of the study field, in a clearer and more detailed way (Rosvall and Bergstrom, 2010).

Later, the conceptual structure of the publications was evaluated through Bibliometrix (Aria and Cuccurullo, 2017), a tool based on R, which allows the

creation of thematic maps and the analysis of thematic evolution throughout time (Aria *et al.*, 2020). The resulting thematic maps showed the structural and cognitive patterns of the dominion, grouping the themes into clusters based on the values of centrality and density (Callon *et al.*, 1991). These maps are divided into four quadrants that represent the different types of themes: motor, fundamental, emerging and specialized. For the construction of these maps, the field "keywords plus" was used, since, according to Olawumi and Chan (2018), this field helps to identify concepts and key contents of scientific documents, in addition to showing the development of the dominion throughout time.

The temporal evolution of the themes was examined using a modified version of the inclusion index (Rip and Courtial, 1984), considering the co-occurrences of each word in defined periods: 1999-2015, 2016-2018, 2019-2020 and 2021. This analysis allowed identifying how the themes are connected and develop through different subperiods.

This integral set of techniques provides a detailed view of the evolution and convergence of the SD and VC concepts in scientific literature. The approach allows a deep understanding of the emerging trends and patterns in this field of research, combining quantitative and qualitative analyses to offer a complete perspective of the interrelationship between these concepts in academic and scientific production.

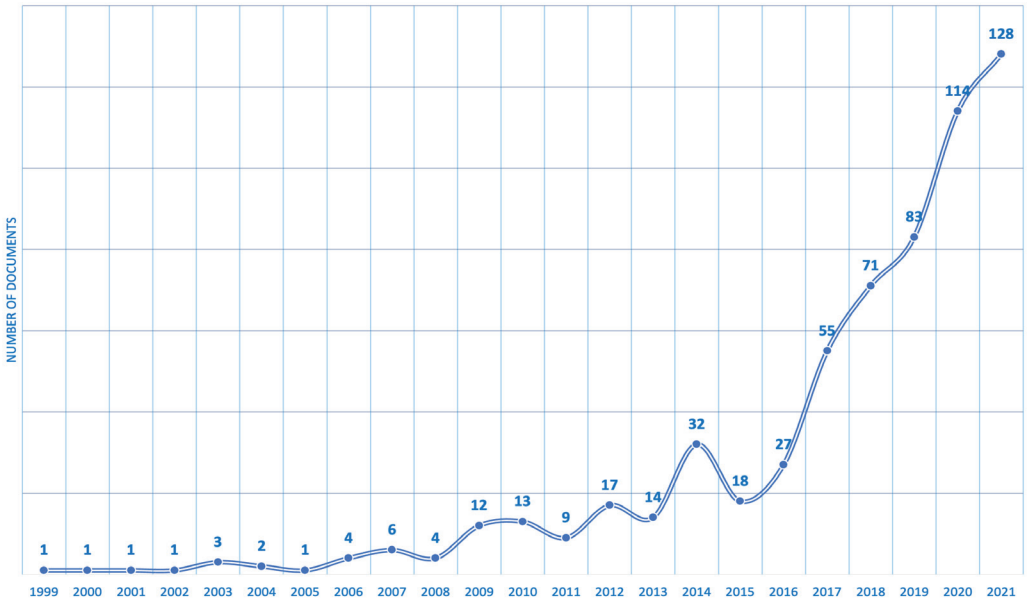
RESULTS

Data Science (1987-2021)

The study analyzed three sets of scientific publications from the WoS database: SD, VCs and "Convergence". The SD corpus, the most extensive, included 94,801 publications from 1987 to 2021, distributed into 63.7% scientific articles, 26.6% congress proceedings, and 5.6% review articles. For their part, the VC corpus included 16,234 publications in the same period, with a similar distribution: 65.8% scientific articles, 26.6% congress proceedings, 5.7% books, and 1.85% other categories.

The third corpus, called "Convergence", explored the interaction between SD and VCs. This set included 617 documents published between 1999 and 2021, made up by 63.5% scientific articles, 18.6% congress proceedings, 10.7% review articles, and 4.2% book chapters. In this set of documents, it was observed that the first related studies appeared 12 years after the beginning of individual studies in these fields, which indicates a previous period of consolidation, before researchers explored the interconnections between both concepts.

The numerical variation of the publications from the "Convergence" corpus showed an exponential growth in the period analyzed (Figure 2). Between



Source: prepared by authors.
Figure 2. Annual development of the number of publications from the "Convergence" corpus.

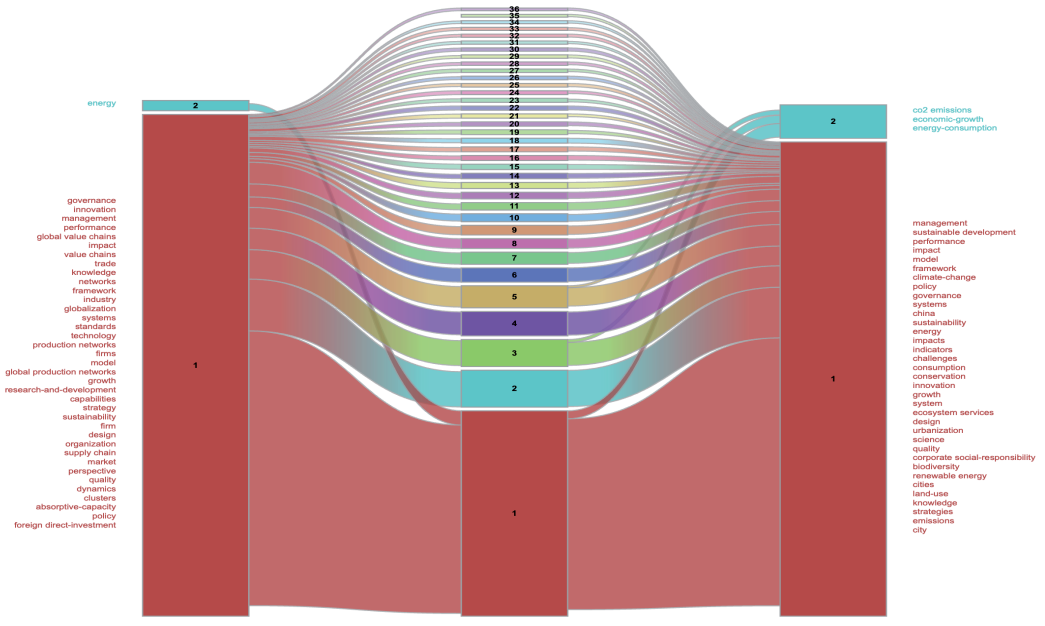
1999 and 2021, an average annual growth rate of 45% was observed in the number of publications, which evidences the growing interest in this field of study and places it as one of the fastest growing in scientific research. This growth acquired a remarkable momentum in the most recent period. In the last seven years (2015-2021), on average 10 more articles were published per year (average of 70.8 articles per year) than in the previous period (1999-2014) (average of 7.5 articles per year), revealing an emerging field in continuous expansion and development.

The increase in volume of publications also manifested in the diversity of journals and research areas that address this theme. Among the most important scientific journals in the "Convergence" corpus, according to the number of publications, Sustainability led the list with 66 documents published, followed by Journal of Cleaner Production with 28, and Sustainable Development with 8. When it comes to the research areas with greatest representation, measured by the number of publications, Environmental Sciences and Ecology stood out with 240 documents, followed by Technological Sciences with 175, and Economy together with Business, which reached 157 documents. This distribution of publications, through various disciplines, revealed the interdisciplinary nature of the field, evidenced in the combination of theoretical approaches and methodologies from different areas, and the development of inter-, multi- and trans- disciplinary approaches in this field of study.

Conceptual analysis of the "Convergence" corpus

After the descriptive review of the publications, a co-occurrence network analysis of keywords was conducted, with the aim of identifying emerging themes in the "Convergence" corpus. The results are visualized through an alluvial diagram (Figure 3). This type of diagram was selected for its ability to effectively represent the transformations in the organizational structure of scientific agendas throughout time. In the diagram, the clusters of keywords that are formed indicate specific themes within the study field, as well as innovative connections that point to the emergence of new disciplines or the fusion of existing fields.

Through an algorithm of community detection, 36 thematic blocks were identified for the "Convergence" corpus. The blocks in each column of the alluvial diagram represent thematic clusters, and the height of the block indicates the volume or size of the field of study. Block 1, which stood out as one of the most relevant, presented publications about various interrelated themes: sustainable management in food systems, corporate participation in Sustainable Development Goals (SDGs), impact of emerging technologies in commercial strategies, Industry 4.0, circular economy, and management of social problems in productive chains (Goyal *et al.*, 2018; Nagy *et al.*, 2018; Van



Source: prepared by the authors with Mapequation.

Figure 3. Alluvial diagram of the themes in corpus: a) SD; b) VCs; and c) "Convergence" until the year 2021.

Zanten and Van Tulder, 2018; Yawar and Seuring, 2017). The rest of the blocks represent the diversity of emerging themes, reflecting the multidisciplinary and complex nature of the "Convergence" dominion. These blocks show how various aspects of technology, society, economy and the environment are interconnected in contemporary scientific research.

The co-occurrence analysis through MapEquation (Figure 4) provided an additional perspective on the conceptual interrelationships, thus complementing the previous co-occurrence analysis of keywords. The analysis identified 20 principal nodes, where the largest represent more important elements in the network structure. Three central nodes were identified as highly interconnected in the information flow: "yield", "management" and "governance". In the second level of connection, concepts were observed that are closely related with the value chains, such as consumption and production of goods and services, greenhouse gas emissions, waste management, and energy consumption. In addition, a medium-high interconnection was identified between the central nodes and the themes related with sustainable development, including food security, food systems, ecosystem services, and sustainability criteria and indicators.

The intensity of these interconnections was determined through the quantitative analysis of the frequency and strength of the co-occurrences

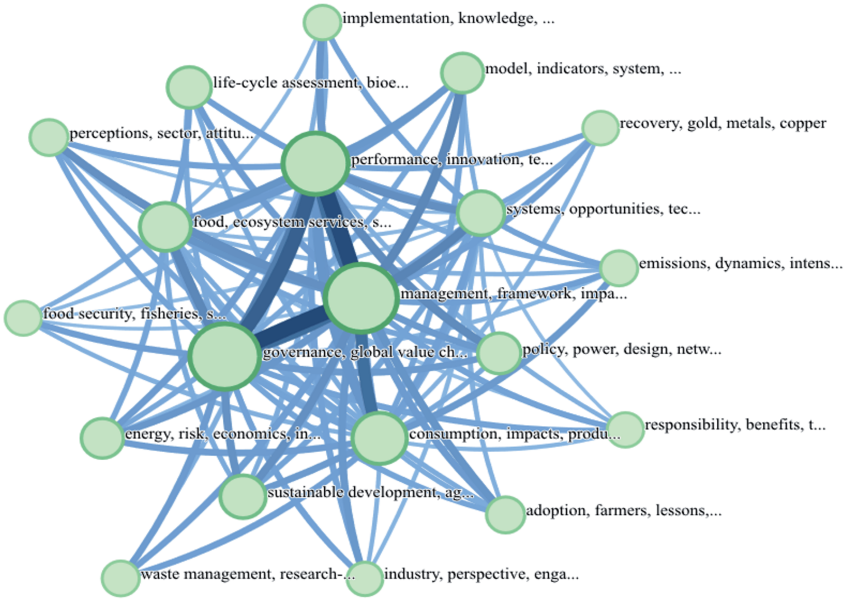


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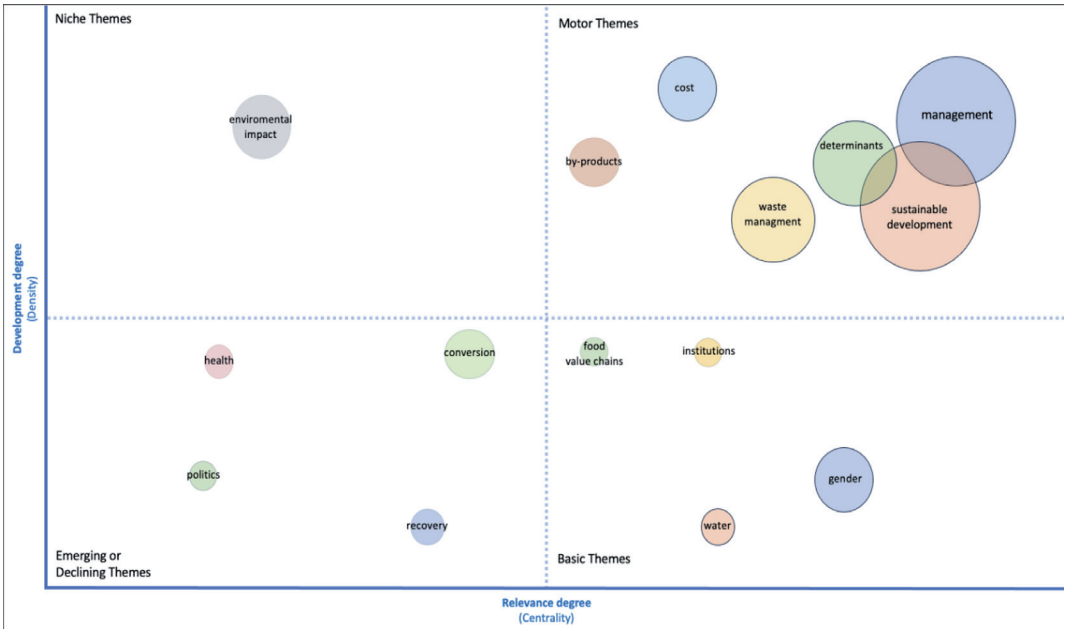
Figure 4. Co-occurrence network (first 1,000 most frequent words) in the "Convergence" corpus, visualized with MapEquation.

between these concepts in the corpus studied. This network allowed modelling the information flow, identifying hierarchical structures and relationships at different scales, visualizing the relative importance of each concept and their interrelation in the context of "Convergence" of the research agendas.

Thematic analysis and evolution

In this section, the conceptual structure of the documents selected is evaluated. The thematic map (Figure 5), based on values of centrality and density, revealed the formation of 15 clusters, which represent subgroups of terms that are strongly linked, each cluster representing a specific research theme. In the upper right quadrant, "motor themes", six main clusters were identified. The most consolidated cluster was focused on economic analyses and on internal management of the businesses. The second cluster, "sustainable development", emphasized the analysis of the production systems and agricultural consumption, within the framework of sustainability. The third cluster, "determinants", referred to the literature that analyzes the public policies that influence the GVCs.

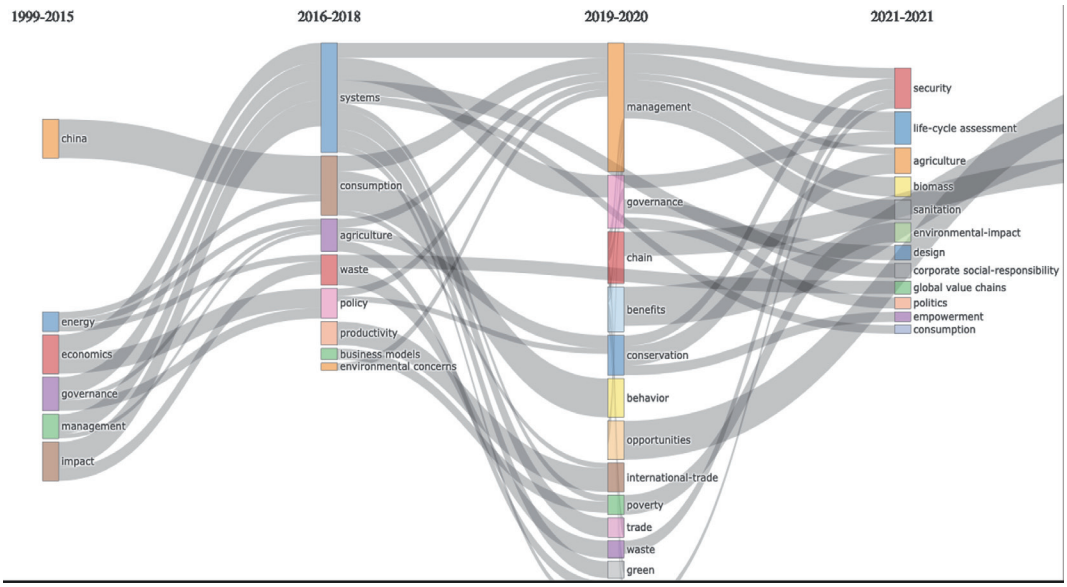
This cluster analysis and the thematic map provide an overview of the conceptual structure of the field of study, allowing the identification of dominant, emerging themes and their interrelations, which laid the foundations for a deeper analysis of the evolution and trends in research in this area.



Source: prepared by the authors with Bibliometrix.
Figure 5. Thematic map of the "Convergence" corpus in the period 1999-2021.

To examine the temporal evolution and to understand the primary research currents, the interval of time studied, from 1987 to 2021, was analyzed in four phases: 1999-2015, 2016-2018, 2019-2020 and 2021. This has allowed identifying how different themes behave throughout different subperiods, revealing a transformation in the research agendas, characterized by an expansion and diversification of the topics of study.

Figure 6 illustrates the temporal evolution through a Sankey diagram. In initial stages (1999-2015), the research centered on broad terms such as China, energy and economy. In a particular analysis, the concept of "management" in this period was focused on publications about innovation and productive activities in sectors such as agriculture and livestock production (Bhaskaran *et al.*, 2006; Soosay *et al.*, 2012; Tarawali *et al.* 2011). Later, an evolution was observed in themes related to sustainability, environmental and social aspects. In the period 2016-2018, "management" was associated with new terms like "framework" and "governance", focused on social problems, environmental and social performance, and innovation in supply chains (Arnold 2017; Jelsma *et al.* 2017; Yawar and Seuring 2017). In 2021, the themes had an emphasis on topics like corporate social responsibility and environmental impact. The particular monitoring of the concept of "management" was related with barriers and drivers for SD, the relationship of different activities with the SDGs, and technological diversification (Baffoe *et al.* 2021; Cheng *et al.*, 2021; Sidibé *et al.* 2021).



Source: prepared by the authors with Bibliometrix.
Figure 6. Diagram of the thematic evolution in different time subperiods for the "Convergence" corpus.

DISCUSSION

The formulation of research agendas emerges from a multifactorial interaction that encompasses needs for development, problems and opportunities at different scales. This process transcends the exclusive identification of areas and gaps in knowledge, involving the allocation of financial resources by various entities, as can be seen in data from the EU, where 47.7% of the R+D+i budget is destined to entrepreneurial investment, 23.1% to public R+D, and 17.7% to outreach programs (Veugelers, 2016). Financing comes primarily from national budgets, complemented by structural European funds. These elements, together with public policies and individual interests of researchers, contribute collectively to the diversification and expansion of the study fields.

In recent years, the interaction between the concepts of SD and VCs has experienced a substantial evolution, reflecting a fundamental change in the conceptualization of productive systems. This progression has led to the creation of an integral approach that values the balance between welfare of the stakeholders in the VC, social prosperity, and health of ecosystems. In this context, the commitment of companies with the SDGs has shown a gradual increase. Van der Waal and Thijssens (2020) reported that, in 2017, only 23% of the largest 2,000 companies in the world mentioned the SDGs in their sustainability reports. On the other hand, Galeazzo *et al.* (2024) mention that the most frequently addressed SDGs are SDG 8 (Decent Work and Economic Growth), SDG 13 (Climate Action), and SDG 12 (Responsible Consumption and Production), which suggests a selective and limited approach by the companies. Although these figures have increased with time, the general commitment continues to be restricted.

The concepts of SD and VC have converged to address contemporary global preoccupations, especially in the production and distribution of goods and services. Diverse authors agree in the urgency of transforming the productive patterns to generate "shared value", understood as the creation of benefits both for the VC and for society in general. This approach marks a change in paradigm, moving away from an exclusively economic vision towards a more integral and sustainable model (Anthony, 2019; Fearne *et al.*, 2012).

Our bibliometric analysis confirms this evolution, evidencing a shift in the research agenda: from an initial approach centered on the economic performance of VCs, towards integral analytical frameworks. In particular, governance and environmental management of productive systems have emerged as central axes in the intersection of both agendas. In parallel, the thematic evolution has expanded the reach of the study, incorporating dimensions such as gender equality, labor regulations, and the transition towards sustainable VCs.

In this sense, Jacob *et al.* (2023) point out that this transformation reflects a deeper understanding of the complexity and interconnections within the VCs, underlying the interdependence between economic, social and environmental factors.

The implementation of these integral approaches suggests both challenges and opportunities. On the one hand, it demands a reconfiguration in entrepreneurial management, with the adoption of new sustainability metrics and the possible need for initial investments in infrastructure and training. On the other hand, it opens new pathways for innovation in products, processes and business models, which not only strengthen competitiveness, but also allow approaching social and environmental challenges in a more effective way.

The technological revolution associated with Industry 4.0 performs a key role in this transformation, redefining the structure and operation of the VCs and accelerating the alignment with SDGs. The network analysis of co-words evidences a growing interrelationship between advanced technologies, SDGs and circular economy. This synergy is also observed by Bag *et al.* (2021), who suggest that the adoption of technologies characteristic of Industry 4.0 is reconfiguring the VCs in a dual manner; on the one hand, it drives entrepreneurial competitiveness through the optimization of processes, and on the other, it facilitates the integration of principles of sustainability in the production and distribution of goods and services.

Our findings, in agreement with the conceptualization of circular economy by Geissdoerfer *et al.* (2017), show how these technological innovations strengthen the principles of regeneration and minimization of residues throughout the whole VC. It should be mentioned that the impact of this technological-sustainable relationship transcends the optimization of productive processes, generating a reduction in costs and, consequently, an increase in profitability.

The emerging themes that result from our analysis agree with the observations by Telukdarie *et al.* (2018), about how emerging digital abilities are revolutionizing the management of sustainability indicators in the VCs. The implementation of technologies such as blockchain, for example, significantly improves the traceability and transparency of operations.

Results from this study, from a theoretical perspective, reaffirm that the conceptual convergence extends to contemporary concepts such as circular economy, sustainability, and digital transformation in the VCs, which reflects the need to continue developing integral methodological frameworks that incorporate these dimensions adequately for different productive activities, as has been proposed in previous studies (Geissdoerfer *et al*., 2017; Nosratabadi *et al*., 2019). In addition, an evolution is observed in the framework for VCs, transcending conventional approaches that are exclusively based on economic

efficiency, to adopt perspectives with a multidimensional impact on social and environmental wellbeing, in line with the growing preoccupation of SD (Fearne *et al*., 2012). In this sense, the hypothesis suggested is verified, since a change in scientific practice is identified, which positions interest over sustainability as an axis that tends to be dominant in research agendas.

In the applied sphere, the findings suggest that the adoption of emerging technologies, such as Industry 4.0 and blockchain, represent an important opportunity to improve the competitiveness of companies, essential to accelerate the transition towards sustainable production models, as recent studies show (Bag *et al*., 2021). The effective implementation of these innovations requires, nonetheless, a strategic combination of investment, strengthening capacities, and definition of public policies that encourage their generalized adoption, thus avoiding the generation of technological gaps that limit their impact on less benefited sectors, as has been evidenced in other contexts (Van Zanten and Van Tulder, 2018).

CONCLUSIONS

The convergence of research agendas on SD and VCs reflects the evolution of global preoccupations and the need for integral approaches to address contemporary challenges. Our bibliometric analysis reveals exponential growth in scientific publications, with an average annual growth rate of 45% between 1999 and 2021. This progression shows a transition from purely economic approaches towards analytical frameworks that incorporate environmental and social dimensions. The most consolidated themes include global value chains, governance and sustainability management, while the emerging themes, such as sustainable agriculture production and responsible consumption patterns, reflect alignment with the SDGs.

The convergence observed is the result of an interdisciplinary and transdisciplinary process that facilitates the generation of new knowledge to address complex problems. The growing relevance of technologies associated with Industry 4.0 is redefining VCs, simultaneously driving entrepreneurial competitiveness and sustainability. Beyond convergence, what could be observed is the emergence of a research agenda, which at the same time determines a shift in scientific interests that identify that there are theoretically, scientifically and socially relevant themes around SD, or those which have yet not been addressed. This dominion can be determined by financing mechanisms or international agencies, although this is a line of research that stems from the results obtained.

It is important to recognize the limitations of this study, primarily related to the bibliometric approach used. Future studies could benefit from a more

detailed analysis of the impact of global policies and case studies on the practical implementation of these concepts.

The dynamism of this emerging field emphasizes the importance of maintaining fluid communication channels between academy, industry and those responsible for public policies. Only through this continuous exchange can there be guarantees that the conceptual advances will materialize in concrete and positive transformations of the global production systems, thus contributing to a more balanced and sustainable development for society in its entirety.

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