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A Six-Decade Bibliometric Analysis of Market Orientation in the Steel Industry

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Abstract

This article provides a detailed investigation and assessment of publication trends, authors productivity, citation impact, keyword frequencies, and co-citation networks in studies related to market orientation in the iron and steel industry from 1964 to 2024. The analysis was conducted using Biblioshiny and Nvivo, based on 19 documents sourced from the Scopus database. Additionally, the study examines common buzzwords beyond marketing and economic aspects, with a particular focus on the iron and steel industry. Co-citation networks are analyzed to understand the connections between researchers and their contributions. The results highlight the interconnectedness of various research areas and the significance of specific topics in shaping academic discourse and influence within the industry. This study provides insights into the research dynamics and intellectual landscape of the field, emphasizing key processes, market strategies, environmental, and economic elements. It offers valuable information for academics, policymakers, and industry participants seeking to understand the development and impact of research in this area.

Introduction

The global steel market significantly impacts economies and the environment worldwide. The demand for steel caused by urbanization affects prices, the construction, automotive and manufacturing sectors. Technological advances have improved the quality of steel, resulting in greater efficiency and sustainability. In addition, trade policy and international relations determine the dynamics of the steel market, with protectionist measures and tariffs affecting the availability of steel (Benguria & Saffie, 2024). González and Kamiński (2011, pp.7) stated that the steelmaking process has four phases: raw material mining and preparation, iron production, steel production, and the final phases of casting, rolling, and finishing. Examination of steel markets shows a relationship between steel demand and per capita GDP that follows an inverted U-shaped curve (Yang et al., 2024), highlighting the essential role of steel in various sectors where there are no viable substitutes.

Market orientation (MO) is an organizational culture that fosters behavior more effectively and efficiently to increase customer value, which suggests a better result for the business, according to Narver and Slater (1990, pp.20). Further, they stated that market orientation presents an outward-looking viewpoint in which an organization's genuine significance is found in the value it provides to its clients. As Kohli and Jaworski (1990, pp.4) state, an organization's capacity to provide data on the requirements of its present and potential customers matters. MO has been growing slowly but gradually, making its way into organizations' strategies. When reducing the emphasis on organizational procedures and making marketing a department, this trend is evident that marketing will become more integrated into the organization towards placing greater significance on customers and

competitors (Martey et al., 2017). One of the few studies to date that promises a link between MO and firm performance, addressing some of the most enduring strategic challenges facing organizations, is by (Valenzuela et al., 2016).

The steel industry's ability to be successful now and in the future is heavily market driven. This industry has recently faced numerous opportunities amidst ongoing challenges resulting from recent market dynamics and technical innovations (Schulz et al., 2024). Consumer tastes, driven by the advancements of technology in a digital age and automation, along with pressures on environmental sustainability, have moved on. However, how they affect manufacturing might suggest that traditional marketing methods are quietly retiring. As such, the iron and steel industry's marketing strategy are one that companies need to understand to survive in the changing ecosystem. A customer-centric mindset in line with the market's needs could lead businesses to sow seeds of improved customer delight, brand loyalty, and sustainable growth (Basu et al., 2024). Companies can adapt and take advantage of MO, provided they know new trends in the business, the regulatory framework in which they are embedded or play and their competitor strategies (Merigo' et al. 2017).

Bibliometric analysis involves the systematic analysis, counting, reporting, and assessment of the creation and dissemination of scientific knowledge (Sreenivasan & Suresh, 2023). It can also evaluate the performance and impact of scientific research articles by analyzing statistical indicators (Valenzuela-Fernández et al., 2018; Toigo, 2017). The global advancements in the scientific growth of this discipline have aligned with the development of market orientation theory (Merigo et al., 2014). Marketing-oriented scientific publications have consistently supported this growth; however, expansion in the field has been limited due to the lack of a centralized research-sharing platform at the global level (Leonidou et al., 2010).

This article is based on a bibliometric study, an exhaustive quantitative analysis of scientific production that offers visibility to the trend of MO in the iron and steel industry. The purpose of this study is knowledge mapping - combining diverse publications that evaluate the industry's responsiveness to market dynamics and identifying major research issues and trends. With an extensive examination of bibliographic data on publication frequency, citation patterns, and subject clusters, the authors intend to make notable contributions concerning the marketing orientation of the steel industry. Beyond this, the findings also offer prescriptive insights for industry practitioners, politicians and scholars seeking to navigate an increasingly critical economic terrain, shedding additional light on prevailing research paradigms. The research utilizes Bibiloshiny and Nvivo to explore the growth of publications, specifically in MO and steel, between 1964 and 2024, tracking trends as well as the extent of author productivity. In addition, the influence of highly cited papers is assessed, the frequency of keywords is examined, and co-citation networks are examined. It provides a comprehensive analysis of the field's scientific influence and the dynamics of its research (Trotta et al., 2024).

Evolution of the Steel Industry Insights Studies and Research

Maghreb Steel, a study of crisis management by (Allioui et al., 2024). Maghreb Steel was a well-established, family-owned business founded by the Sekkat family in 1975. It was the sole manufacturer of flat steel in Morocco, making its larger industrial footprint within local steelmaking. The company faced many problems during the crisis. The case study performs a detailed financial and strategic analysis of the company's condition and progression to develop a workable recovery strategy for Maghreb Steel. Analyzing innovation activities in Czech metallurgical companies, Peterková, Krbová et al. (2019) examine the innovation behavior of Czech metallurgical companies. One case study focuses on the innovation dynamics within this sector, pinpointing factors, strategies, and practices that foster or hamper innovation in Czech conditions.

Kumar and Shetty's (2018) research explore the motivations of Indian enterprises to participate in voluntary environmental programs (VEPs). This study uses a unique cement, power, and steel industry dataset to explore how legislative, societal, economic, and internal contexts influence self-regulated environmental behavior. However, the overall market remains volatile and unpredictable, with demand slightly up in some specific areas but down for most other types of steel (Dahmen 2014). Tomar (2011) studies the pay and benefits, including variable pay, at a leading Indian steel maker, showing an increase in dependent and performance-linked incentives. Pichurin (2011) highlights a long-term challenge: the export orientation of Ural metallurgy, which was an eternal glory under socialism but now represents one risk in the region's economic security. Fortescue (2009) reviews the key features that help in the steel's success industry and export orientation, investment in modern processes, and rigid control exerted through new private ownership. This study gave some learning points about the impact of the global financial crisis during 2008-2009, with a notable fall in world steel prices, credit tightening, debt servicing problems, and government assistance programs.

Kerkhoff (2007) stresses benchmarking with competitive consulting and opinion-formative companies. Also noted is this paper's author's previous work (Chmelik, 2007) on carbon implications in the Czech Republic because of the relatively poor quality of coal used for energy production and, as a result, a high per capita or GDP unit of carbon intensity. Kraft and Reichardt (2005) describe the plant layout and design features of Master Production Schedule in coal mills dedicated to cement plants, power plants, and steel plants. According to Schliephake (2005), the leading position of Georgsmarienhütte GmbH in the selected segments of the German steel industry provides market position, procurement strategy, innovation and customer focus. Holzhinrich-Scherler and Krischer (2001) report on stabilizing the Russian economy following the 1998 financial collapse. In the steel sector in Western Europe, export-oriented Russian steel makers and their exchange rate form a different but critical part of the competitive landscape. In the Dynamics of Mexico's Transition and Steel Sector, Wichert (1999) documents Mexico's aggressive use of developmental potential after joining the North American Free Trade Agreement (NAFTA). The increase in import volumes and the decline in steel prices sharply pushed up the market supply while domestic production remained stable.

Feng (1994), with reference to the Chinese steel sector, notes a change in industrialized countries, particularly China. High demand from China, the world's largest consumer and producer of steel, and the country's considerable comparative economic advantage have also led to rapid expansion in this sector. The scientific research of Svistunov (1991) has examined factors such as product competitiveness, product production organization influencing ferrous metallurgy investment policy, market strategy, and training staff personnel under market conditions. Ravenhill and Matthews (1991) find that Australia's trade orientation turned from Western Europe to Northeast Asia, especially Japan, which replaced the EC as Australia's leading trading partner by a wide margin in the 1970s. Japan's decline in heavy industry reduced Australia's reliance on Japanese steel and iron ore exports. Bridging the competitive gap, Darnall (1985) identifies a competitive gap beyond steel to other core sectors.

Environmental Impacts and Sustainability Efforts in the Steel Industry

The steel industry is at the heart of a global infrastructure and is vital to economic development. At present, high carbon emissions, high energy consumption, water usage and pollution, and waste generation are some of the environmental impacts of the steel industry. s the significant issues present significant problems. The following details investigate these impacts and explore emerging sustainability initiatives to help mitigate them, such as carbon capture, recycling, and climate-friendly hydrogen adoption.

- **Carbon Emissions:** Steel production contributes 7-9% of global CO_2 emissions, primarily due to polluting blast furnaces dependent on coal (International Energy Agency, 2020). Traditional processes like BF-BOF emit around 1.85 t CO_2/t steel (World Steel Association, 2021), and De-carbonization is essential for meeting the reduction of global warming by the 1.5°C target of the Paris Agreement -2016. Carbon Capture and Storage (CCS) technologies, for example, technologies piloted within the Ultra-Low CO_2 Steelmaking (ULCOS) project target the capture of 50–80% of emissions generated from Blast furnaces (Fischedick et al., 2014). CCS initiatives like the efforts of ArcelorMittal in Belgium represent just a few of the industry's investments in integrating the technology. However, high costs remain a barrier to widespread adoption.
- **Energy Consumption:** Steel manufacturing is an energy-intensive process that uses 20-25 GJ per ton of steel, mainly from fossil energy sources (International Energy Agency, 2020). Dependency on Fossil fuels aggravates greenhouse gas emissions and energy security issues, emphasizing the significance of enhancing efficiencies and deploying renewable resources. Electric arc furnaces (EAFs), which rely on electricity to melt scrap steel instead of coal, consume 60% less energy and produce 70% lower emissions than the Blast Furnace-Basic Oxygen Furnace route(World Steel Association, 2021). In 2024, EAFs accounted for 49% of global steel, with some regions, such as the U.S., achieving 70% scrap usage, underscoring the feasibility of circular economies. Waste heat recovery systems and AI-enabled process optimization have improved energy efficiency. For example, Tata Steel's use of heat recovery in the Netherlands has lowered energy consumption (15%), demonstrating the potential for innovative manufacturing technologies (International Energy Agency, 2020).
- **Water Usage and Pollution:** Steel plants use 10–15 cubic meters of water per ton of steel, which results in pollution and contamination (European Commission, 2020). For example, improperly treated discharge from steel plants can harm aquatic ecosystems, requiring new water treatment technologies. Zero water discharge systems and recycling water are some methods used to reduce water usage and pollution.
- **Waste Generation:** According to World Steel Association report 2024, the global crude steel generation is over 1800 million tons annually. Approximately 400 kg of waste per ton of steel is being generated during the steel making process. Although some waste is being recycled in the form of construction material, road laying etc., standardized waste management protocols are needed for sustainability.
- **Green Hydrogen:** As per Hydrogen Breakthrough Iron making Technology (HYBRIT, 2021) project implemented by SSAB, LKAB, and Vattenfall steel plants in Sweden, where cooking coal is substituted with hydrogen generated in renewable energy processes to achieve carbon-neutral steel. It could lower Sweden's CO_2 emissions by 10% and serve as a model for the world.
- **Carbon-Neutral Production Initiatives:** Swedish H2 Green Steel aims to build a fully publicly renewable powered plant using green hydrogen and scrap (European Commission, 2020). Likewise, Thyssenkrupp's tkH2 Steel project in Germany aims to reduce over 3 million tons of CO_2 annually by 2030 using hydrogen-based direct reduction.

While the environmental effects of the steel industry can be considerable, innovative solutions such as Carbon Capture and Storage (CCS), Electric Arc Furnaces (EAFs), and green hydrogen can provide routes to environmental sustainability. Although technological and economic challenges remain, collaboration among governments, industry, and research is essential now more than ever.

Research Gap

The prolonged duration of the study, marked by inconsistent growth rates and dormant phases, shows potential deficiencies in the continuity of research efforts. The absence of international co-authorships and the prevalence of single-author papers suggest a shortfall in collaborative endeavours and a diversity of viewpoints. The lack of international co-authorship underscores the imperative for more integrated global research collaborations. The resurgence of publications in 2024 shows a renewed interest in recent advancements that may have been overlooked. The study's emphasis on the iron and steel industry, explicitly referring to "marketing" and "steel production," highlights a void in interdisciplinary research that merges technical, economic, and societal aspects. The co-citation networks reveal a concentrated interest in the iron and steel sector. However, they also underscore the necessity for an additional inquiry into associated areas, such as productivity and international commerce. These identified lacunae offer avenues for future investigations to augment the current knowledge within the domain.

Objectives of the Study

The study aims to analyze the growth and development of publications within a specific field. The analysis includes a growth rate analysis to determine the annual growth rate of publications from 1964 to 2024 and identify emerging trends. Author productivity is assessed by publication frequency, total, and annual citations. Citation Impact evaluates the most cited articles based on total citations, average annual citations, and normalized citation scores. Keyword frequency analysis examines the most common keywords and highlights the industry's focus areas. Finally, co-citation networks are examined to reveal the interconnectedness of research topics and the influence of central topics. Together, these comprehensively analyze the field's scholarly impact and research dynamics.

Research Methodology

The research provides a comprehensive literature analysis, as shown in Table 1, for a specific area from 1964 to 2024 which includes 15 sources, journals, books, and 19 documents. The annual growth rate of publications is nominal, with documents averaging 20.3 years old and receiving an average of 2.947 citations each. The field experienced a revival in 2005 with the publication of three significant articles. However, the publication rate has stabilized and shows neither a significant increase nor a decrease. This research uses Bibiloshiny and Nvivo to examine the expansion of publications in a specific area from 1964 to 2024, identifying trends and measuring author productivity. In addition, the influence of highly cited papers is assessed, and the frequency of keywords and co-citation networks are examined. It provides a comprehensive analysis of the field's scientific influence and the dynamics of its research (Trotta et al., 2024).

Research Questions, Analysis and Results

RQ 1: What is the growth rate of publications in a specific field over time?
The growth rate of publications in the area: Figure 1 monitors the number of articles published each year, identifies any trends or patterns and suggests that the field got off to a slow start, with only one article in 1964, further no publication until 1985. A slight increase occurred in 1991, with two articles observed and sporadic individual publications over the following years. Notably, a peak was reached in 2005 when three articles were published. However, after 2005, the publication rate stagnated, with mostly one article per year and no publication in the last three years (2021–2023). It also shows a resurgence in 2024 with a release. Overall, the growth rate of publications in this area has been uneven, with periods of inactivity alternating with years of minimal to moderate publication activity. Figure 1 shows

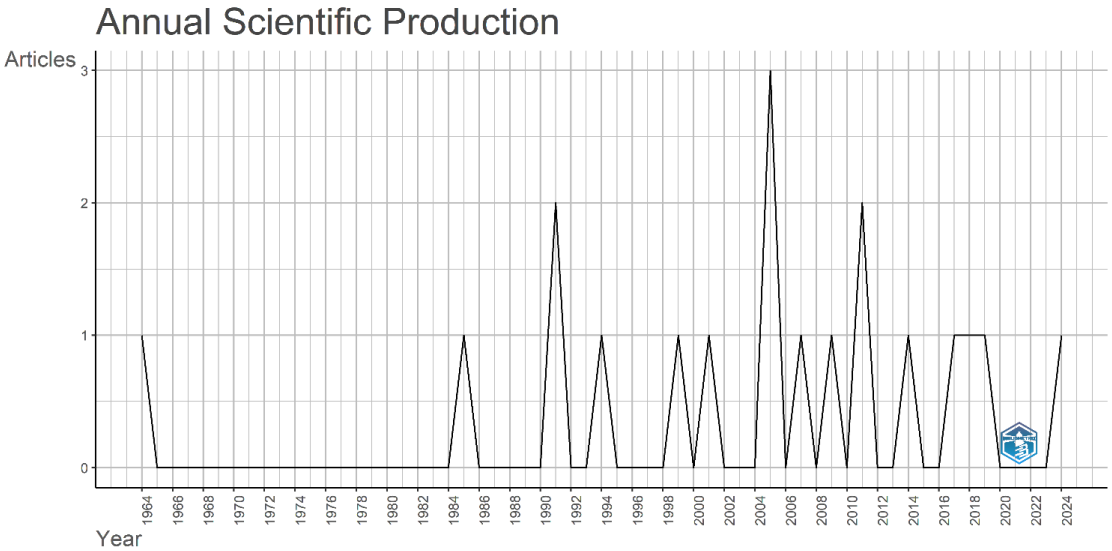
no clear upward or downward trend, suggesting that the field may be niche or highly specialized, with research outcomes depending on specific developments or interests within the field.

Table 1
Research Approach

Description	Results
Timespan	1964:2024
Sources (Journals, Books, etc)	15
Documents	19
Document Average Age	20.3
Average citations per doc	2.947
References	219
Keywords Plus (ID)	98
Author's Keywords (DE)	44
Authors	3
Co-Authors per Doc	3
article	12
book chapter	1
conference paper	3
review	3

Source: Author Compilation from the Scopus database with Bibilioshiny

Figure 1
Annual Scientific Production

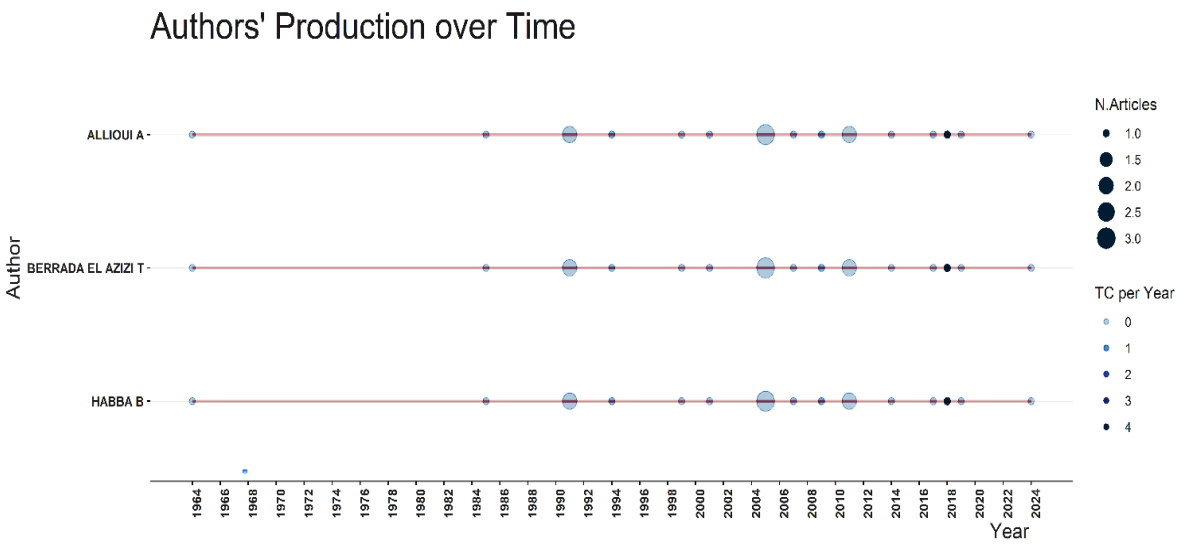


Source: Author Compilation from the Scopus database with Bibilioshiny

RQ 2: Who are the most productive authors in a specific field?
As the most prolific author in the field, (see Figure 2) emphasized publication frequency, total citations (TC), and citations per year (TCpY). Publication Frequency: All authors have published multiple publications over different years, showing consistent research activity. Top Citations: In 2018, all three authors reached their peak of 30 TC for a single publication, showing a significant contribution or influence that year. Citations per year: The TCpY also peaked in 2018 at 4.286, showing the high relevance of his work during this period. Overall productivity: While TC and TCpY are essential indicators, productivity also depends on the

field's context and the research quality, and their research influences their subsequent work. The authors have shown remarkable productivity, especially in 2018.

Figure 2
Author's Production Over Time



Source: Author Compilation from the Scopus database with Bibiloshiny

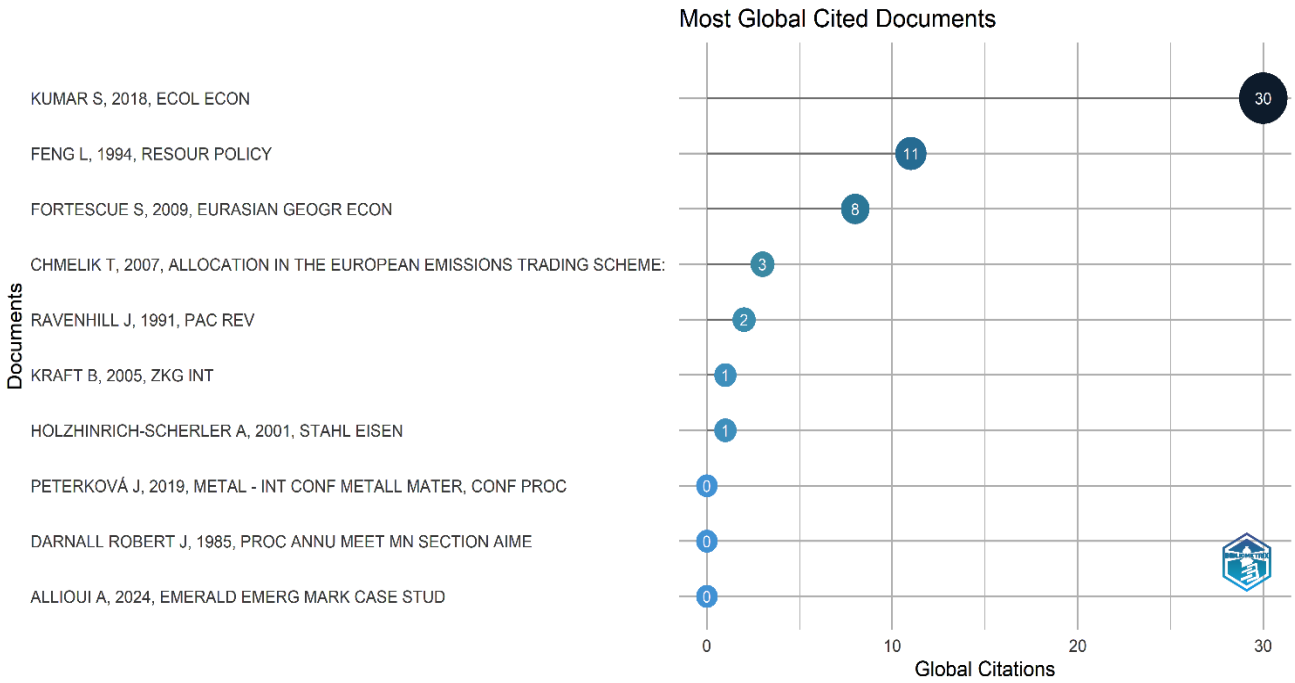
RQ 3: What are the most highly cited articles in a specific field?
The most cited articles in this area based on Figure 3 shows Kumar (2018), Ecological Economics: This article has the highest total number of citations at 30, with an average of 4.29 citations per year and a normalized citation score of 1.00, which shows a significant impact on the field. Feng (1994), Resource Policy: With 11 citations and a normalized citation score of 1.00, this article has a notable effect, although its annual citation rate is lower at 0.35. Fortescue (2009), Eurasian Geography and Economics: With eight citations and a normalized citation value of 1.00, this work has a constant citation rate of 0.50 per year. Chmelik (2007), Allocation in the European Emissions Trading Scheme: Although he only has three citations, his normalized citation score 1.00 reflects his relevance in the field. These articles stand out in their respective fields and show the importance and recognition they have received from the academic community. Citation metrics provide a quantitative measure of their scholarly impact.

RQ 4: What are the most frequently used keywords in a specific field?
The most used keywords in a sector, shown in Figure 4, are the iron and steel industry. This term appears the most, with eight mentions, showing a strong focus on this sector. Marketing: Appears four times, showing its importance in the industry context. Steel manufacturing: With three occurrences, it highlights the core process within the iron and steel industry. Customer orientation and industrial economics: Both terms are mentioned twice, reflecting their relevance to the industry's economic aspects and customer-oriented strategies. The rest of the keywords show diverse topics related to the iron and steel industry, including environmental concerns, international trade and modernization. This diversity suggests a multifaceted approach to the sector, encompassing technical, economic, and social dimensions. This insight into industry priorities and areas of interest focuses on critical processes, market strategies and financial considerations.

RQ 5: What are the co-citation networks of scholars in a specific field?
Co-citation networks represent the relationships between scholars or work within a field based on how frequently they are cited in the literature. Within the scope of Figure 5, the

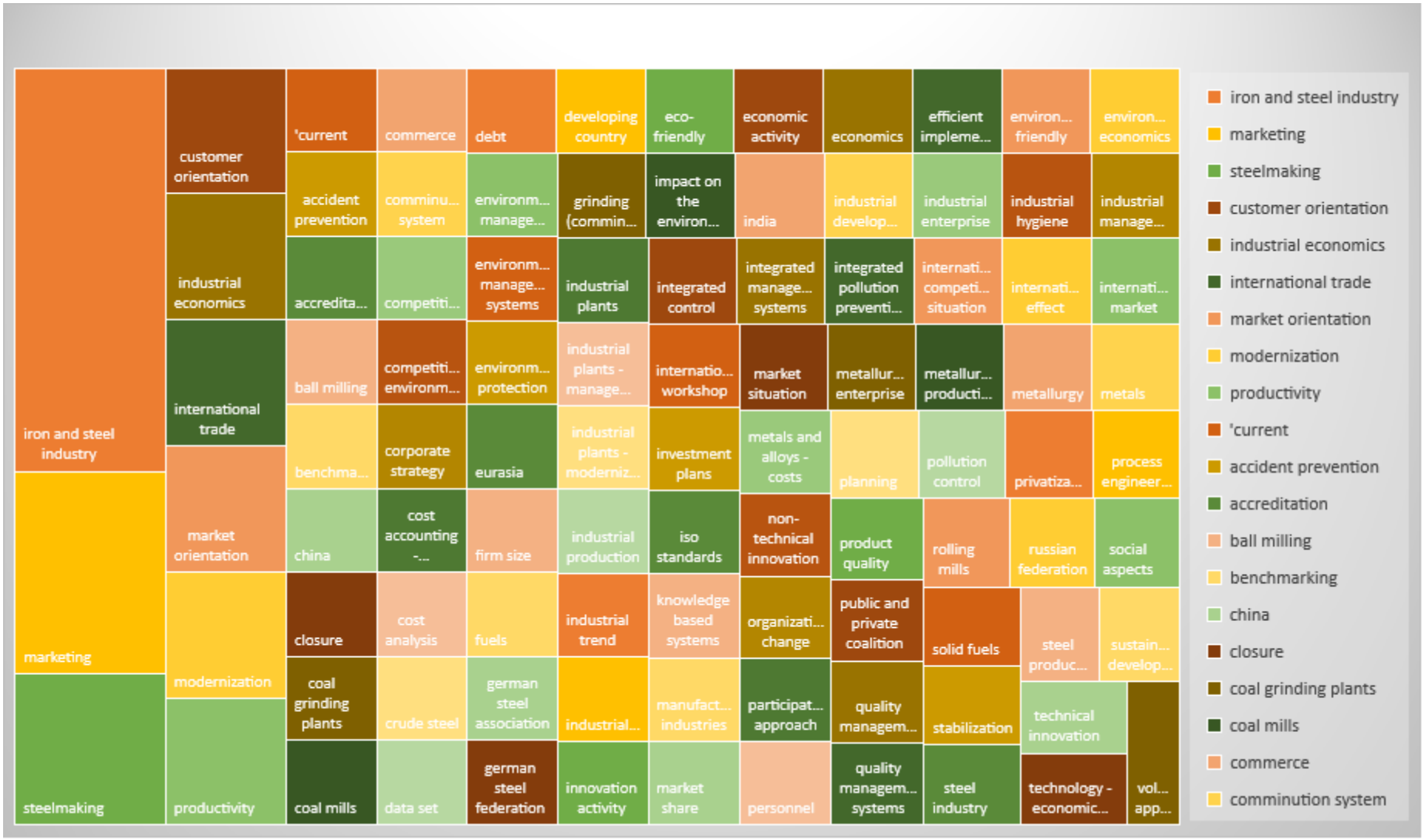
network focuses on the iron and steel industry and related topics, such as marketing, customer orientation, modernization, productivity, industrial economics and international trade. The "Iron and Steel Industry" node appears to be a central node within Cluster 1, with the highest betweenness centrality of 14, showing its significant role as a connector between different nodes in the network. It also has the highest PageRank of 0.414, showing that it is highly cited and influential within the network. The other nodes in Cluster 1, including Marketing, Customer Orientation, Modernization, and Productivity, have lower centrality measures, meaning they are less central but still connected to the core theme. Cluster 2 includes industrial economics and international trade, which have slightly higher proximity centrality than the non-core topics in Cluster 1, suggesting that they are closer to other nodes in the network. Finally, the co-citation network (see Figure 6) underlines the interconnectedness of various research topics in the broader iron and steel industry, with specific topics serving as linchpins of scientific communication and influence. The bold text highlights vital metrics and themes in Figure 7 within the network.

Figure 3
Most Global Cited Documents



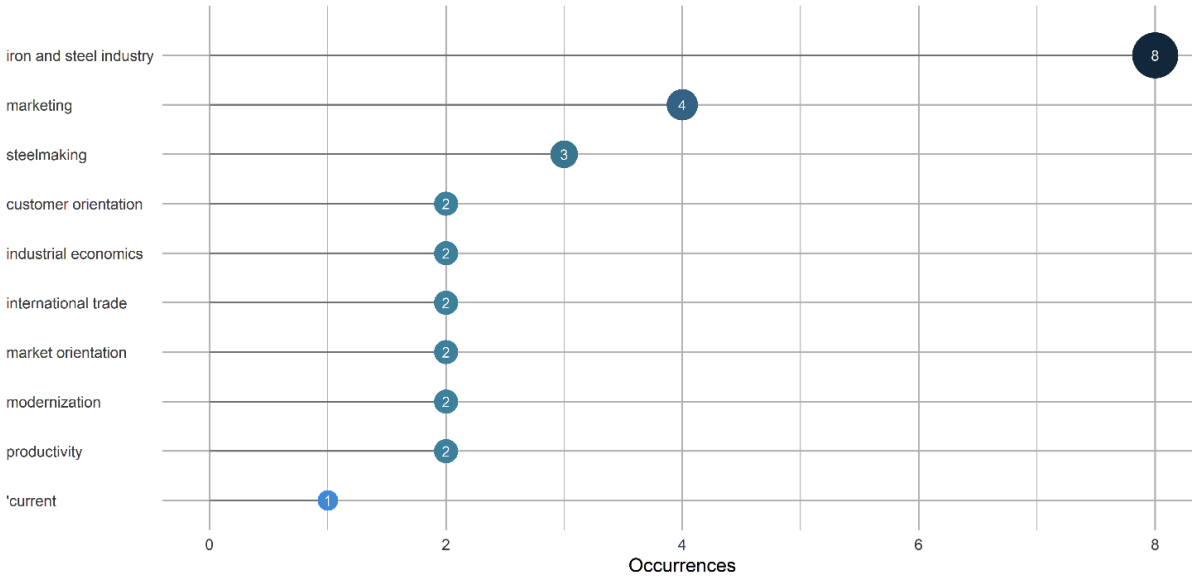
Source: Author compilation from the Scopus database

Figure 4
Most Relevant Words



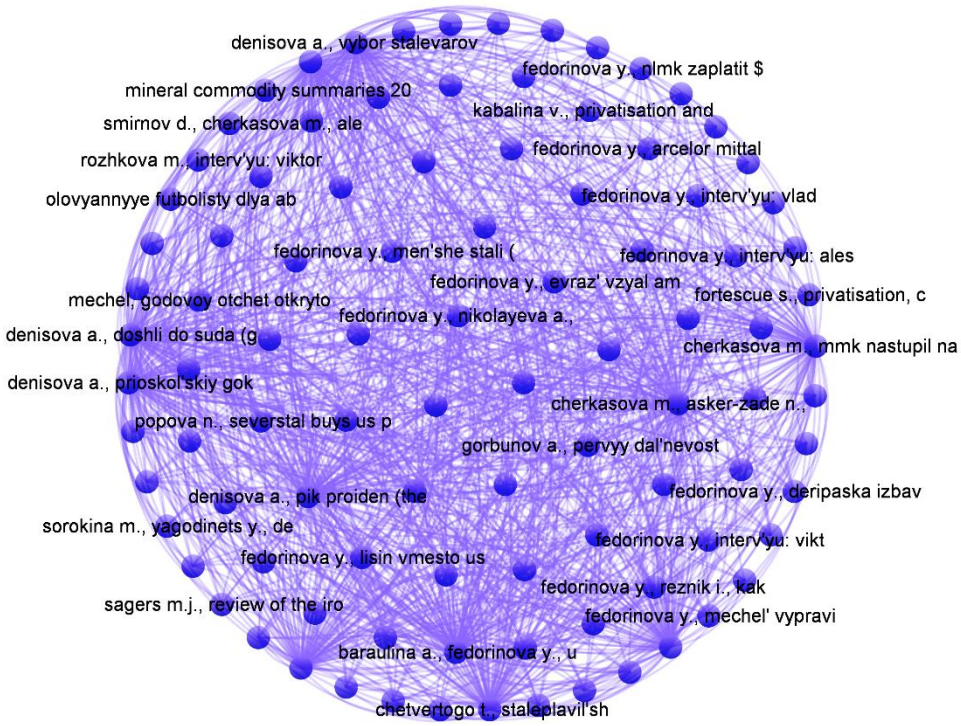
Source: Author compilation from the Scopus database

Figure 5
Most Occurrences Keywords



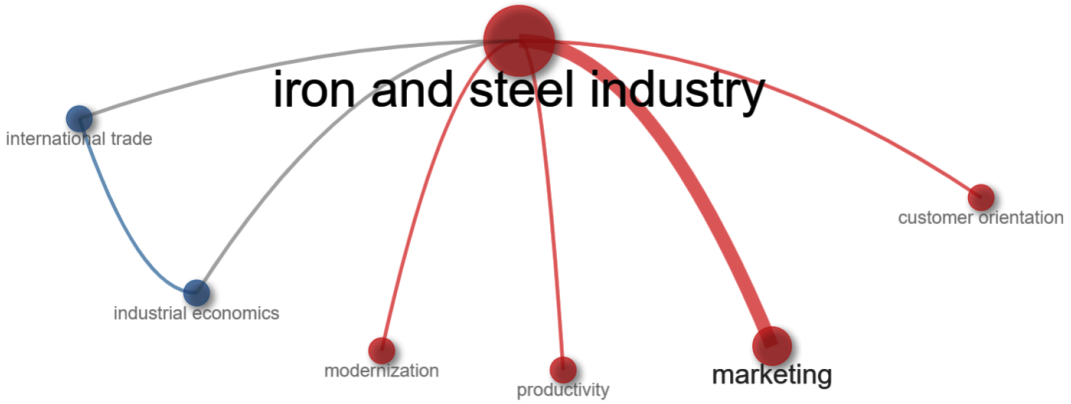
Source: Author compilation from the Scopus database with Biblioshiny

Figure: 6
Publication Patterns Analysis



Source: Author Compilation from the Scopus database with Nvivo

Figure 7
Research Dynamics Visualization



Source: Author Compilation from the Scopus database with Bibilioshiny

Findings and Discussion

The study results provide insights into publication trends, author productivity, citation impact and keyword usage in the analyzed area. Analysis of the spread trend shows that the growth rate varies depending on the period of inactivity and that the field has a unique nail or character. The study identifies 2018 as a critical year for the author's description and significance and highlights significant contributions to the course. The work of Kumar and his colleagues is characterized by many references that show their considerable influence in this field. Keyword analysis often refers to "iron and steel" and "marketing programs" as areas of focus in the industry. The study examines detailed publication models, author productions, descriptive influences, keyword prevalence and associated descriptive networks related to the iron and steel industry from 1964 to 2024.
The study uses a variety of sources, including journals and books, as well as data collected in 19 documents, which show the annual growth rate of publications and their average age. The results show that the growth rate varies depending on dormancy and low-release activity, which is evidence of expertise in this field. This study examines most articles and emphasizes their scientific importance and recognition. It is generalized to keywords, paying particular attention to the marketing and economic size of the iron and steel industry. The study also examines communication networks to identify connections between researchers and their engagement in the field. It describes it as the central hub of the "iron and steel industry" and emphasizes its central role in the network. The results show that different research topics are interconnected and how important specific topics are in promoting scientific debate and impact in the iron and steel sector.

Limitations and Future Research

The limitations of the study are essential in interpreting its results. The research spans 60 years, from 1964 to 2024, and may suffer from fluctuations in methodology and the relevance of the sources and documents reviewed. The small corpus of 19 papers and an annual growth rate of 0% suggests stagnation in the field's development. An average document age of 20.3 years implies a possible exclusion of more recent studies, missing recent advances. The average of 2.947 citations per document from 219 references shows moderate scholarly interest. The lack of documents from individual authors and international collaborations shows that there is only a limited range of research partnerships. The focused

keywords may only partially reflect the progress of the field. These elements highlight the need for a broader and more current study to grasp the direction and influence of the field entirely. Future research in the iron and steel industry should fill the gaps in publication activity, address environmental and sustainability topics that have occasionally attracted attention, and expand the contributions of critical authors. It is recommended to prioritize highly cited articles as a basis for new research while using common keywords to ensure continued relevance. Expanding co-citation networks through international partnerships could improve the scope of research and introduce new perspectives and groundbreaking methodologies.

Conclusion

Study from 1964 to 2024 shows a fluctuating growth rate in the publication of documents related to this topic, with a notable peak in 2005, followed by a resurgence in 2024. The most prolific authors have shown a steady flow of research activity. 2018 was characterized by significant scientific contributions, as evidenced by the total number of citations and the annual citation rate. The most cited articles highlight the scientific importance of the research conducted in this area, with Kumar S.'s (2018) article in Ecological Economics emerging as the most influential. The most common phrases, on the other hand, are related to the iron and steel industry and marketing and economic dimensions. This further demonstrates the plurality in the field. The co-citation networks illustrate the research from 1964 to 2024, depicting a history of publication growth rate in related documents followed by relative stagnation and a brief peak in 2005 but with a return to prominence in 2024. The most prolific authors have demonstrated a consistent message of research output. Most notably, given the total citations and the annual citation rate, 2018 was a year of exceptionally high scientific productivity. Most cited articles. The most cited articles reflect the scientific significance of the research conducted in this area; one example is Kumar's (2018) paper on ecology.

Economics may be the biggest one so far. The most prevalent keywords are related to the iron and steel industry, as well as marketing and economic aspects, reflecting the diversity in this sector. The co-citation networks display, on the other hand, research topics surrounding and reinforce the central role of the iron and steel industry in scientific debates. Finally, this study provides a detailed overview of the publication patterns and authors' influence on seminal works which reflect both the peculiar or specialized approach of this sub-field. In conclusion, this study comprehensively analyses the publication patterns, authors' influence, and seminal works in the field, reflecting its unique or specialized nature and dynamic interest in research over the decades.

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