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The Emergence Of Green Logistics For International Sustainable Development: A New Management Levers.

IAZZA Wafaa[1], ZOUINE Abdessamad[2]
[1]PHD student, National School of Commerce and Management El Jadida University – Morocco, Research and Study Laboratory in Management Economics, wafaaiazza99@gmail.com
[2]Research professor, National School of Commerce and Management El Jadida University – Morocco, Research and Study Laboratory in Management Economics, zouine.abdessamad@gmail.com

Abstract:
Logistics has become a strategic issue for all companies, regardless of the sector in which they operate. Strong competition and globalization have prompted organizations to do everything in their power to optimize their supply chain. To this end, economic, environmental and social constraints are driving companies to be constantly on the lookout for new developments, whether technological and/or organizational. Green logistics has become a crucial component of sustainability in the logistics services sector. This study looks at how international logistics service providers are integrating green logistics principles into their operations, in line with the green logistics charter. This research explores the scope and effectiveness of the commitments made by these companies. Through this exploration, we have assessed the green logistics practices adopted and their impact on development performance. The main objective of this contribution is to attempt to clarify the basic concepts of Green logistics and sustainable development.
Key-Words: *Green Logistics, Sustainable development, Economic, Companies, Environment.*

INTRODUCTION

Over the past 20 years, researchers have been increasingly interested in green supply chains due to global environmental concerns. Green supply chain management aims to reduce waste and pollution by integrating environmental thinking into the design and management of end-of-life products. Due to global environmental concerns. (Rehman, s. d.)

Economic growth increases the level of energy and material consumption, contributing to environmental problems and resource depletion. It has become increasingly important for organizations facing competition, regulation and community to balance their economic and environmental performance.

Today, most companies are starting to go green in their operations for environmental sustainability. They have realized the greater benefit of adopting green procurement technology in business, which also affects suppliers and customers.

Companies that engage in green supply chain practices benefit from reduced costs and increased profits, making these practices effective in developing sustainable competitive advantages (Walker et al., 2008). Also, Green supply chain management is attracting increasing interest from researchers and practitioners in operations and supply chain management. The growing importance of green supply chain management is mainly due to increasing environmental degradation. For example, diminishing raw material resources, waste overflows, increased energy consumption and greenhouse gas emissions. (Can One Green Deliver Another Harvard Case Study Solution & Online Case Analysis, s.)

Indeed, the logistics sector has undergone a significant evolution, gradually integrating sustainability principles. The transformation of the sector has been influenced by various factors, including government policies, economic reforms and international agreements. In the 1980s, the use of logistics to address environmental challenges and implement sustainable development principles began to gain ground worldwide (Hasanspahić et al. 2020). Integration of sustainability in logistics was a central focus, with studies highlighting the need to integrate sustainable policies and strategies into business and industrial operations to ensure environmental preservation (Baah et al., 2021). In addition, the development of sustainable distribution logistics systems has been a key objective, aiming to effectively integrate sustainability principles into distribution logistics (Drejeris and Samuolaitis, 2020). The impact of the logistics sector on the environment has been scrutinized, leading to efforts to decouple mobility from adverse effects and reduce carbon dioxide emissions (Savastano et al., 2016). In general, green logistics is any initiative for the supply and storage of goods that aims to achieve sustainable development. Its aim is to improve business processes and, above all, reduce the ecological footprint. Initiatives can vary - it all depends on the company and the industry. Companies are mainly looking to emit less carbon dioxide into the atmosphere, use fully renewable energies and invest in projects to reduce the greenhouse effect.

Our introductory exploration paves the way for a comprehensive analysis current logistics framework, juxtaposing its practices and challenges in the context of global sustainability trends and regional economic dynamics. We then proceed with a contextualization of the logistics sector. We will then explore the adoption of sustainable practices for green logistics at international level, assessing their prevalence and environmental impact, and identifying challenges to be overcome for effective implementation. Our methodological framework is based on a bibliometric analysis of activity reports, with a rigorous selection of the entities studied. Our results highlight a positive trend towards green logistics practices, with variability in integration and sustainable efficiency.

1. Concept of the Green Logistic

"Logistics is the part of supply chain management that effectively and efficiently plans, implements and controls the upstream and downstream flows of goods, services and related information between the point of origin and the point of consumption, in order to meet customer requirements (CSCMP, 2013). This definition is appropriate in an academic setting as it concerns the efficient and effective upstream and downstream realization of goods flows from source to customer. This is important in the context of environmental/green management, as it enables organizations to have the greater anthropogenic impact on the natural environment through manufacturing, transport and storage processes.

The addition of environmental concerns to logistics transforms it into logistics compatible with a green logistics (GL) (Browne and Allen, 1997). Green logistics can relate to issues such as ecological concerns, conservation, corporate social responsibility (CSR), humanitarian concerns, fair trade, clean water, animal welfare, equality and sustainability. This presents a number of challenges as the definition remains broad and complex - it can mean different things to different people (Saha and Darnton,2005). The definition and scope of green logistics in the literature is vast and complex, making it similar to the concept of logistics. Numerous acronyms have been used in the literature to describe it (Srivastava, 2007; Zhu and Sarkis, 2004; Sheu et al., 2005).

This new form of logistics can be seen as an organizational philosophy combining economic objectives, the reduction of ecological risks and impacts, and the improvement of ecological efficiency.

There are various definitions of green logistics in the literature, some of them very specific (Gilbert, 2001; Diabat and Govindan, 2011). In contrast, other authors such as (Zsidisin and Siferd, 2001; Srivastava, 2007; Sarkis et al., 2011) have taken a broader view of SCMD. We refer to Srivastava's, the most widely cited, who defines green logistics as: "the integration of the environmental dimension into the supply chain, including product design, materials sourcing and selection, manufacturing processes, final delivery of the product to the consumer, as well as the management of the environmental impact of the supply chain.

Green logistics studies ways of planning and reducing the environmental impacts of ordinary logistics (GOTO, 2012). The main objective of green logistics is to coordinate activities within a supply chain in such a way that the needs of the beneficiaries are met at the "lowest cost" to the environment. A component of this is the principle of reverse logistics. The "cost" of the past has been defined in purely monetary terms, where "cost" can now also be understood as the external costs associated with logistics: climate change, air pollution, waste disposal (including packaging waste), soil degradation, noise, vibration and accidents [...] (QUIUMENTO, 2011).

Green logistics arises as a response to the growing concern to protect the environment, and has become part of the development of each of the processes of the logistics chain. From production processes, through packaging, to distribution, there is a constant search for the development of each phase to be friendly to the ecosystem, and in this sense, consumers are increasingly concerned about the social impact of products (Rodrigue, Slack, and Comtois 2001).

2. Genesis and definitions of sustainable development

High consumption of natural resources has resulted in accelerated deforestation, declining fish stocks, loss of agricultural land, diminishing drinking water supplies, loss of habitat, animal and plant species, and so on. These losses have also been accompanied by increasing pollution and dramatic industrial accidents.

Non-governmental organizations (NGOs) for environmental protection are also on the rise. They are multiplying and forming alliances, campaigning against international financial institutions and industrialized countries to protect the environment.

This led to the emergence of the concept of sustainable development, not only as an extension of the debate on development, but also as a demand for a different kind of globalization, based on alternative social projects or development models.

Sustainable development (Dominique Wolff, 2010) is a much-discussed concept that has given rise to several meanings. Indeed, after its official appearance in the 1987 Brundtland Report, it has been the subject of a multitude of definitions. However, the best-known definition is that of the World Commission on Environment and Development (WCED), "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs". In addition to this famous quotation, the report goes on to specify that two concepts are inherent in this notion: the concept of "needs", particularly the essential needs of the most deprived, to whom the highest priority should be given, and the concept of the environment's capacity to meet present and future needs (CMED, 1989, p. 51). In addition, Sustainable development is defined as "a development that meets the needs of the present without compromising the ability of future generations to meet their own needs". Although many reports are published and several international conferences are held, the international community is struggling to put sustainable development into practice. In this sense, the main outcome of the last "Earth Summit" on the "green economy" and the "institutional framework for sustainable development", which took place in June 2012 in Rio de Janeiro, is the launch of a process leading to the establishment of sustainable development goals

Nevertheless, it is widely accepted that sustainable development encompasses three dimensions: economic, environmental and social. As indicated by Garetti and Taisch (2012), when only two dimensions are considered, the system is qualified as viable (economy + environment), equitable (economy + social) or livable (environment + social).

Figure 1: The three dimensions of sustainable development
(Garetti and Taisch, 2012)

3. ImpactSustainable development on Green Logistics and it's objectives

The impact of sustainable development on green logistics is increasingly recognized and considered by players in the logistics sphere. It concerns the changing nature of flows, the reconfiguration of supply chains, the reconfiguration of logistics spaces and new approaches to logistics organizations. These changes are due to the focus and orientation of green logistics in corporate activities, as mentioned by several authors, in the adoption of environmental, economic and social requirements in logistics procedures from supplier to customer. In order to achieve the objective of efficient and adequate consumption of natural resources, safe management of waste and residues, reduction of pollution and optimal use of transport, thus reducing the environmental impact of organizations. The objective of green logistics is to systematize all supply chain processes, with the aim of satisfying consumer needs, considering aspects such as pollution, product life cycles and climate change.

Awareness has been growing in logistics operations, as we see more pollution in the various stages of the Supply Chain, such as raw material procurement, production, distribution and consumption. For this reason, managers are recognizing the impact of their activities on the environment, the economy and society, and are trying to reduce impacts through regulatory measures such as order consolidation and the reduction of small shipments, thus reducing the use of means of transport. This has led companies to rethink the execution of their procedures, both in production and logistics, transforming their activities, for example with the appropriate use of resources, implementing corporate social responsibility and ensuring sustainable and economic development, so that the management of these aspects is considered relevant in a competitive market. To this end, we will study the three dimensions of sustainable development that impact green logistics:

3.1. Scope of the environmental component :

As Srivastava (2007) and Zhu et al. (2005) point out, there is a growing body of research in the field of MDSC. However, the approaches and angles used differ.

Srivastava's study of research carried out in the field of MDSC has led him to identify three main types of problem addressed - all linked to the environmental dimension: the importance of "green" supply chain management in the operation and performance of companies, "green" design (through the product life cycle approach) and "green" operations management (through the development of environmentally-friendly processes such as recycling or reverse logistics).

We can see that the environmental angle is the most widely adopted and analyzed in the field of supply chain management. This is due to the strong emphasis placed on environmental protection and the first concepts developed in the 80s, notably that of industrial ecology. However, some researchers are trying to adopt a more global vision, integrating the three pillars of sustainable development: economic, environmental and social.

The scarcity of raw materials, the obligation to comply with environmental regulations and the increase in ecological taxes are all factors that make green logistics an important part of today's discourse and practice. Within the scope of environmental/green logistics, three main areas can be considered:

- Green operations relating to: to waste management, with the aim of limiting the amount of ultimate waste, i.e. that which is landfilled. Examples include directives on the management of waste electrical and electronic equipment (Directive 2002/95/EC-ROHS of January 27, 2003 and Directive 2002/96/EC-DEEE of January 27, 2003), and the eco-contribution to finance the collection and recycling of furniture introduced in May 2013;

And about the return's management it unsold items, repairs, etc; And the green production and re-production, with a view to using as few materials as possible in the manufacturing process, or giving machines a second life.

- Green design, which affects both the product (through eco-design thinking right from the R&D stage) and the building (low-energy building or High Environmental Quality construction or renovation);
- Green transport seeks multimodality by using several less-polluting means of transport (sea, rail, river) or less fuel-intensive transport (LPG, hybrid, electric, biogas, new-generation engines). These choices are all the more important given the existence of ecotaxes on heavy goods vehicles or regulatory constraints (deliveries in city centers limited to certain types of vehicle, according to certain schedules, etc.).

3.2. Scope of the economic component:

Sustainable development creates both costs and revenues, so any attempt to promote economic development in a sustainable way must consider the traditional cost-benefit analysis. This involves reconciling the viability of a project or organization (economic performance) with ethical principles such as environmental protection and the preservation of social ties. According to this system, the price of goods and services must reflect the environmental and social cost of their entire life cycle, i.e. from resource extraction to recovery, considering manufacturing, distribution and use.

Logistics is implemented through green logistics, comprising five main processes identified in the literature: eco-design, eco-sourcing, eco-manufacturing, green and reverse logistics, and recycling. Green logistics is therefore an integrated solution with a positive economic impact. In economic terms, green logistics is first and foremost reflected in the product itself, since packaging is designed to respect the ecosystem right up to the end of its useful life. In this way, recyclable and reusable packaging reflects the commitment of companies to the organization of their procedures (Graça and Camarinha, 2017; Lisec et al, 2018).

To this end, it's worth mentioning that, just as green logistics supports the efficient development of the international economy, so the economy complements green logistics, as mentioned by the WTO (2011).

Green logistics also paves the way for suppliers, producers and traders of economically innovative products, making these companies more competitive and increasing their profits, as the ability to innovate on international markets promotes the specialization of green products that require sustained research and development.

That said, there are other elements to consider when it comes to economics. These include transport management, the role of logistics service providers, traceability management and, of course, all aspects of information management:

- Transport management is based on a desire to pool the players involved. The aim is to maximize the use of means of transport, both inbound and outbound, with a view to managing costs as effectively as possible;
- The functions of logistics service providers are evolving. In addition to managing transport and inventories, they can also plan transport and inventories;

- Traceability has almost become a household word. In practice, many of its components are similar to those of global logistics, making it a genuine management approach.

Given the importance of the flows (information, financial, merchandise) involved in logistics, information systems and technologies have grown in number, and above all in data processing capacity. The benefits of these systems are manifold: error management, speed and fault-finding in the event of problems.

3.3. Scope of the social component :

This type of objective has become a strategic issue for the company - the quest for greater social justice (workers' rights and child labor in developing countries, working conditions and remuneration, North-South relations). All of this enables the company to position itself advantageously in its market, depending on how it responds to society's diverse and sometimes contradictory expectations (especially in globalized markets).

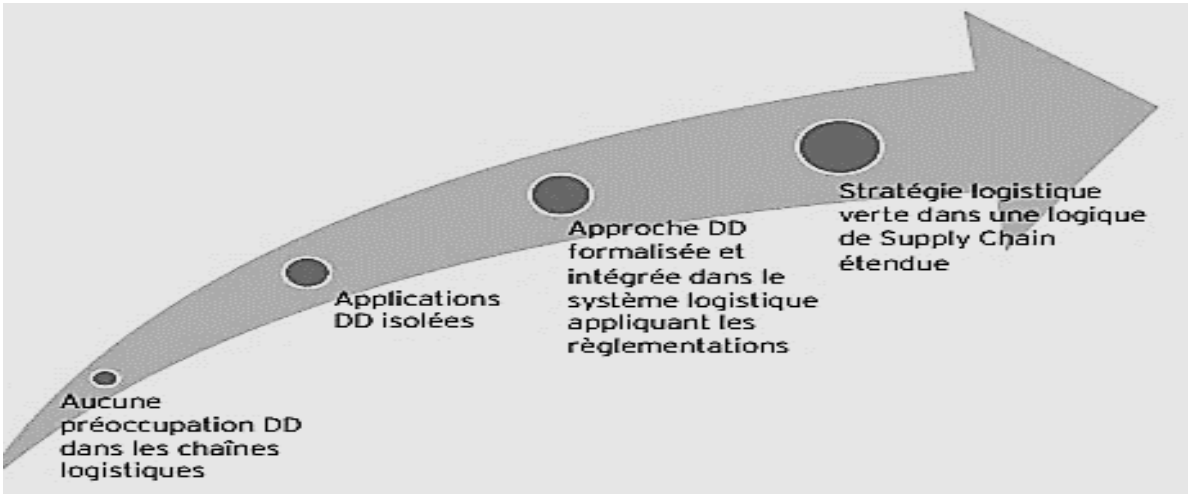
Absenteeism and accidents are causes of delays in the production of goods and services. As a result, replacements have to be trained, sometimes at additional cost (temporary staff). But the social aspect also includes brand image, the attractiveness of the company, and so on.

It should be noted that the social aspect of logistics appears in the literature on SCM (suggestion boxes, cooperation, etc.) and Green SC (safety). As a result, there is no real social/societal SCM "concept" as there is for SCM and GrSCM. In the spirit of sustainable development, but also for the sake of clarity, we now need to clearly specify this third aspect of Green logistics.

In line with the work of Gond (2006), who advises that human resources management in a sustainable development context should be considered on two levels: internal and external; we propose to examine human resources in logistics from this dual angle too:

- Internally, four factors are considered: justice, involvement, satisfaction and identification. Justice covers all employee rights (SA8000 standard, for example). With regard to involvement, it's the recognition and enhancement of skills that are observed. Job satisfaction is reflected in reduced absenteeism and even accident rates. Identification can be seen in reduced staff turnover;
- On the external front, we'll be looking at attractiveness, image and support from external players. An attractive company, including in terms of its logistics, is a guarantee of contracts, and therefore of longevity. This goes hand in hand with brand image, for which good traceability can be a key factor. Finally, it is agreed that logistics is linked to many direct players (suppliers, distributors, etc.). In addition to these, there are "secondary" players such as trade unions and non-governmental organizations.

→The logistics approach is therefore intrinsically "green" and respectful of the environment, as the key objective of optimization is to minimize the mobilization and consumption of resources in order to produce the right level of service. All logistics is therefore virtuous in terms of sustainable development, and there is no contradiction between the objectives of lowering energy costs, increasing productivity and improving customer service, and respect for the environment. Beyond this approach, however, there are complementary solutions that need to be identified through active monitoring and pilot projects to test these innovations. Reducing the environmental footprint of a product throughout its life cycle is not just a regulatory constraint, but a genuine opportunity to gain a competitive edge and develop a positive image with all stakeholders, both internal and external to the company.



Source: Scholarvox

Figure 2: Maturity levels of green logistics and sustainable development (SD) logistics

4. METHODS AND MATERIALS

The approach of this research is of qualitative type, since it emphasizes the importance of the environmental phenomenon, giving cavity to the green logistics highlighting its context, functionality and meaning in the real environment; at the same time this will allow contextualizing and describing the problem from the different theoretical positions, managing to characterize it with the objective of being able to understand this problem that at the moment is priority in the international agendas of the countries. Starting from specialized bibliography (books-articles) related to logistic issues, it allows to handle a type of documentary research, in which a review of the subject can be carried out, managing to extract information that can show in the light of real facts, how this phenomenon acquires greater relevance at world level at the sustainable development. Therefore, the level of research will be descriptive / analytical, since it is intended to make an approach about the importance of the sustainable development in green logistics in trading companies and in those that provide logistics services.

This work is a measurement of scientific production in the area of sustainability in logistics. The main objective of this bibliometric review is to quantify and evaluate the studies published on the subject of green logistics and to analyze them in order to identify ways of applying them in case studies that have already been carried out. The review consisted of searches in databases available on the internet, using certain keywords. With the data found, it was necessary to analyze whether or not to include the material found. Initially, the title of the publication and its abstract were considered for classification. The complete contents of the papers that were available in their entirety and required more in-depth study were analyzed. Studies were excluded from the list if they only mentioned the terms searched for or if they did not relate in any way to the main objective of the work, the study of green logistics. It is important to note that only papers in English were analyzed, so all papers in other languages were also disregarded.

The following keywords were used to search for files relevant to the work: “green logistics”, with combination with “Sustainable development”, The survey was carried out. In the first stage, which took place in 2010, the terms “green logistics” AND “Sustainable development”, and their combinations were consulted, resulting in a total of 1027 publications found.

To carry out the bibliometric search, we considered articles, books, reports and theses found on the Scopus databases. It is important to note that it is impossible to access the full content of some publications. Chart 1 shows the research protocol used to plan the study. Once this protocol had been drawn up, the work and investigations began.

Criteria	Justification
Inclusion Criteria	▪ English language. ▪ The article deals with “green logistics” AND “Sustainable development. ▪ Article published in 2010-2024.
Exclusion Criteria	▪ Non-academic articles. ▪ Duplicate items.

5. Results of bibliometric analysis

Bibliometric analysis is an essential step in the exploration of a research field, enabling scientific production to be quantified and mapped. Once our data has been collected from Scopus databases, it needs to be organized. This involves eliminating duplicates, standardizing authors' names and affiliations, and classifying publications according to theme.

It also enables general trends to be identified. This involves examining the volume of publications per year, the most influential journals, and the institutions and countries most active in the field. This first level of analysis provides an overall view of research dynamics and highlights the main contributors to the subject under study. We used VOSviewer and Bibliometrix to visualize thematic clusters and connections between concepts.

Finally, the interpretation of the results enables us to draw relevant conclusions. This phase consists of synthesizing the trends observed, identifying gaps in the literature and suggesting avenues for future research. Bibliometric analysis is therefore more than just a quantitative description; it is a powerful tool for guiding research and anticipating future developments in a field.

5.1. Evolution of scientific production

The figure shows the evolution of scientific output in the form of a spiral diagram, visualizing the distribution of publications over the period 2010-2024. The radial axis shows the number of papers published each year, while the circular axis follows the progression over time.

There is a general upward trend, with a gradual increase in the number of publications from 2015 onwards. Between 2010 and 2015, scientific output remains relatively low, with fewer than 40 documents published per year. From 2016 onwards, there is a more marked increase, reaching 69 publications in 2019. This growth continues in 2020 and 2021, with 92 papers published per year, indicating a growing interest in the field under study.

A significant increase is visible in 2023 and 2024, when the number of publications rises from 106 to 170, reaching its highest peak. This increase can be attributed to several factors, such as the rise of new scientific issues, the increased interest of researchers in the subject, or the impact of technological advances facilitating research.

To sum up, the figure shows an upward trend in scientific output over the years, with a notable acceleration from 2016 and a peak in 2024. This trend underlines the booming research momentum and the growing importance of the subject in the scientific community.

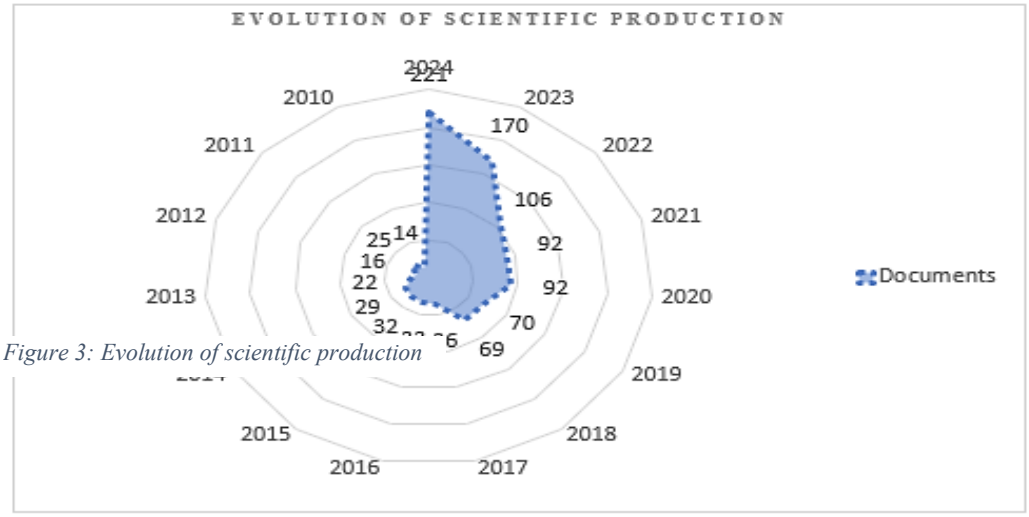


Figure 3: Evolution of scientific production

Source : Scopus via Excel

5.2. Evolution in sources of scientific publications

The figure 4 illustrates the application of Bradford's Law to the identification of the main sources of scientific publications in a given field. The shaded area highlights the "Core Sources", i.e. the most prolific journals that concentrate the majority of articles published on the subject. These include "Sustainability (Switzerland)", "Journal of Cleaner Production" and "Energies", which publish a significant number of articles. There is then a rapid decline in the number of publications as one moves away from the main journals, confirming the uneven distribution of scientific publications according to Bradford's law. Finally,

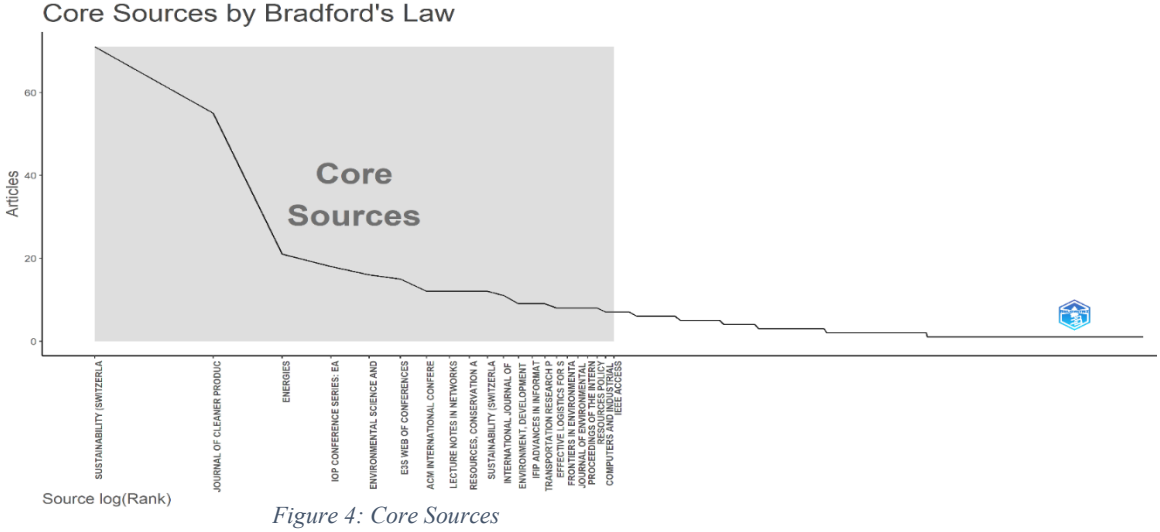


Figure 4: Core Sources

the lower, flatter part of the graph represents the long tail of secondary sources, i.e. journals that occasionally publish on the subject but which can nevertheless make interesting contributions. This analysis highlights the importance of focusing primarily on the main journals for an effective literature review, while considering other sources for a broader and more diversified perspective.

Source : Bbilometrix

5.3. Production of Tree Map

The figure shows a Tree Map of keyword mapping, highlighting the frequency of appearance of terms associated with a search domain. Each rectangle corresponds to a keyword, its size being proportional to its importance in the corpus analyzed.

We can see that "sustainable development" is the dominant term, accounting for 17% of occurrences, underlining the importance of sustainable development in the theme studied. Other important keywords include "logistics" (6%), "supply chain management" (5%) and "sustainability" (3%), indicating a strong concentration of research on supply chain management in relation to sustainable development.

Other recurring themes include "decision making" (3%), "carbon" (3%) and "green logistics" (3%), suggesting that optimizing logistics processes for sustainability is a major concern. Terms such as "climate change" (2%), "carbon dioxide" (1%) and "greenhouse gases" (1%) testify to the environmental impact at the heart of scientific discussions.

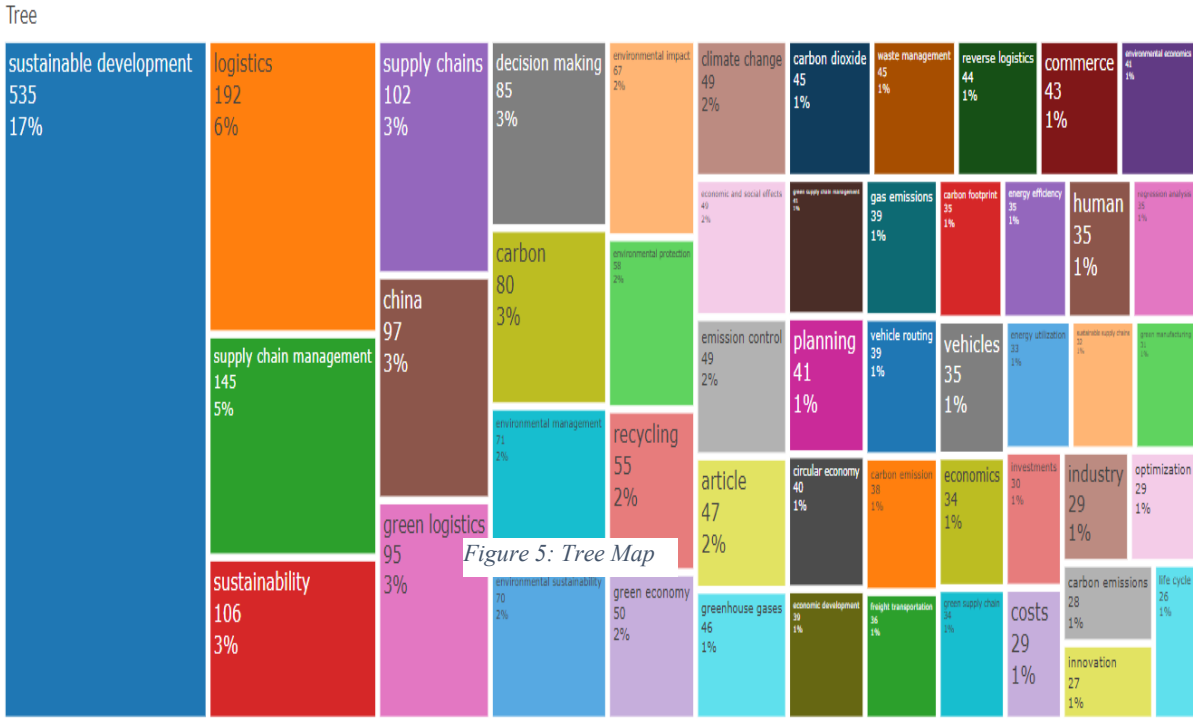


Figure 5: Tree Map

Source: R, Studio

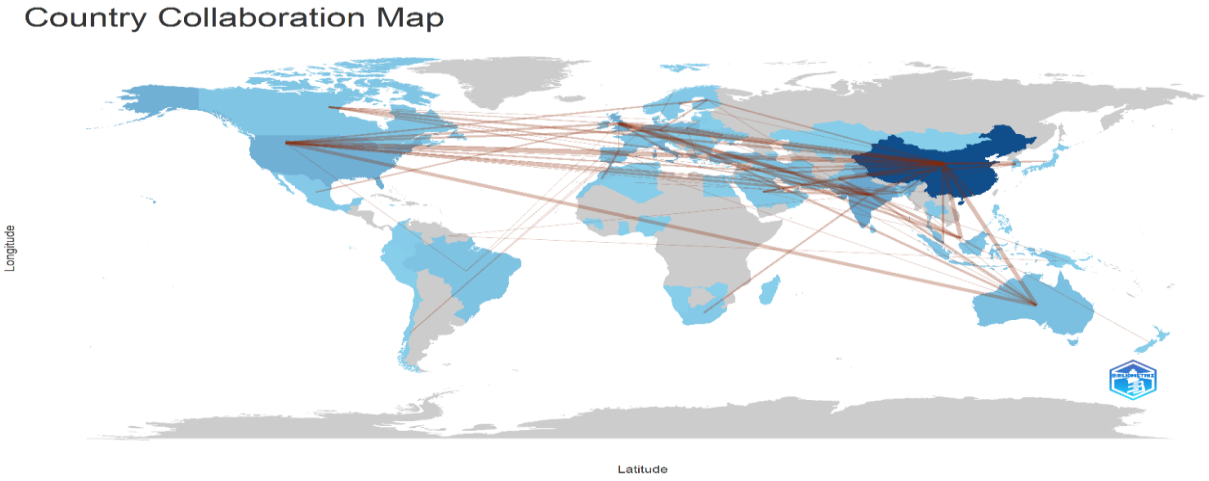
5.4. Scientific productions by country

Green logistics publications and sustainable development reveal interesting trends concerning the growing importance of sustainability in global supply chains. China leads the way with 308 publications, reflecting its central role in manufacturing and logistics management, with a focus on reducing carbon emissions. India and the USA follow with 88 and 73 publications respectively, indicating a strong interest in sustainable logistics solutions in these growing economies. European countries such as the UK and Germany also stand out for their efforts to integrate green practices into logistics, supported by strict regulations on emissions. On the other hand, emerging countries such as Pakistan, Brazil and South Africa are showing increasing interest, although their contributions are still modest.

Countries with a low number of publications, such as Tunisia or Chile, are only just beginning to explore the challenges of green logistics, but should see an increase in their research output as the importance of sustainability in the logistics sector intensifies on a global scale.

Country	Pub	Country	Pub	Country	Pub
China	308	South Africa	6	Austria	2
India	88	Belgium	5	Greece	2
United States	73	Brazil	5	Israel	2
United Kingdom	69	Japan	5	Norway	2
Italy	61	Switzerland	5	Singapore	2
Poland	44	Bahrain	4	Sri Lanka	2
Australia	41	Ghana	4	Tanzania	2
Germany	40	Portugal	4	United Arab	2
France	27	Taiwan	4	Emirates	1
Pakistan	23	Bangladesh	3	Barbados	1
Canada	17	Hungary	3	Bosnia and	1
Malaysia	17	Jordan	3	Herzegovina	
Russian	14	Nigeria	3	Brunei	1
Netherlands	13	Sweden	3	Darussalam1	1
Indonesia	11	Thailand	3	Chile1	1
South Korea	11	Tunisi	3		
Hong Kong	11				

Source: Scopus.



Source: Bbliometrix

Figure 6: Country's collaboration Map

CONCLUSION

Companies are becoming increasingly interested in and motivated to commit to a sustainable development approach, in search of economic, social and environmental performance. Indeed, the dimensions of sustainable development can be found throughout the supply chain process. Today, it is essential for organizations to take sustainable development issues into account within their supply chains.

The literature review presented in this article bears witness to the relevance of research into sustainable development as applied to green logistics. The introduction of both environmental and social objectives to the traditional economic goals of companies, and the integration of SD, will strongly change the nature of green logistics. Even if current practices are essentially environmental. The sustainable development approach to logistics will lead to a better understanding of the company's extended social responsibility, and its diffusion throughout the supply chain process.

Green logistics, as an essential component of sustainable development, has evolved significantly in recent years, according to the results of a bibliometric study carried out. The study highlighted the main trends and most prolific areas of research, while underlining the growing importance of integrating green practices into the supply chain.

The results show that green logistics focuses primarily on optimizing processes to reduce the ecological footprint of logistics activities, particularly in terms of managing CO2 emissions, reducing energy consumption, and managing waste. Emerging technologies such as the Internet of Things (IoT) and artificial intelligence (AI) are also playing a key role in improving the sustainability of logistics processes.

However, despite the progress made, several challenges remain, including the integration of green practices into global supply chains and the harmonization of environmental policies and standards. The study also revealed that while many companies have adopted sustainability initiatives, there is still considerable variability in terms of actual implementation and observed results.

In conclusion, green logistics represents a strategic opportunity for companies wishing to make an active commitment to sustainability.

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