Review

The Application and Challenges of Environment, Social and Governance in the Global Carbon Neutrality Vision

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Received: 11 March 2025; Revised: 26 March 2025; Accepted: 14 April 2025; Published: 21 April 2025

Abstract: In the urgent context of global warming, this paper comprehensively examines the application and challenges of environmental, social, and governance (ESG) frameworks in achieving the global carbon neutrality vision. ESG, encompassing environmental, social, and governance factors, serves as a critical tool for evaluating the sustainable development performance of enterprises. ESG ratings provide essential data for research and strategic decision-making on ESG initiatives. Originating from socially responsible investment in the 1960s, the concept of ESG has evolved through four distinct stages: origin, development, establishment, and rapid development. This paper begins by outlining the concept of carbon neutrality, detailing its emergence, timeline, and current status. It then traces the evolution of ESG. Through an extensive review of literature and detailed case studies, this paper synthesizes existing research to offer actionable insights for stakeholders, reflecting on past practices, analyzing current applications, and forecasting future challenges and opportunities in the journey towards global carbon neutrality.

Keywords: environment society and governance (ESG); carbon neutrality; sustainability; green development

1. Introduction

The advancement of our civilizations from the humble beginnings of humankind has created the Industrial Revolution that opened a Pandora's box of dependence on using fossil fuels, leading to the destructive greenhouse gases release and global warming [1]. Their influence could be felt in all aspects of the natural and man-made environment and can be expressed in a variety of ways, such as rising temperatures, melting ice and rising sea levels, changes in precipitation patterns, biodiversity loss, oceanic impacts, impacts on agriculture and food security, human health risks, and socioeconomic consequences [2]. If human beings do not intervene in the phenomenon of global warming, it will bring great challenges to the natural environment and human life. For more than 200 years, carbon emissions had been produced with the vigorous development of global industrialization, making it very difficult for us to control carbon emissions and restore clean and beautiful living environments. In view of the current energy and resource crisis in the world, as well as the call for environmental protection, it was imperative to achieve balanced economic, social and environmental development.

As we all know, climate change was a global challenge that transcends national borders. Addressing this would require coordination at all levels and international cooperation to help countries transition to a low-carbon economy. In response to climate change and its negative effects, the 21st session of the Conference of the Parties (COP21) was held in Paris on 12 December 2015, where world leaders made important progress and jointly reached the historic Paris Agreement. It entered into force on 4 November 2016, and is a legally binding international treaty. 194 parties (193 countries plus the European Union) were now party to the Paris Agreement. However, since the entry into force of the Paris Agreement, global warming has continued to accelerate, with global greenhouse gas emissions (including from land use changes) reaching 5.53×10^{10} t of CO_2 eq in 2018, of which emissions from fossil fuels use and industrial activities reached 3.75×10^{10} t of CO_2 eq, an increase of 2% over 2017.Therefore, the Paris Agreement proposed to achieve net zero greenhouse gas emissions in the second half of the 21st century, that is, to reduce man-made carbon emissions to a level that forests and oceans can absorb

after 2050 [3].Carbon neutrality generally referred to the total carbon dioxide or greenhouse gas emissions directly or indirectly generated by countries, enterprises, products, activities or individuals within a certain period, through afforestation, energy conservation and emission reduction forms to offset their own carbon dioxide or greenhouse gas emissions to achieve relative "zero emissions" [4]. In simple terms, carbon neutrality was a state in which an economy achieves net zero carbon emissions over a certain period of time. It was encouraging to see that since 2016, many economic entities around the world have published carbon neutral targets and action plans to 2050. Such as Chinese government says its CO_2 emissions would peak by 2030 and achieve carbon neutrality by 2060 [5], European Union's overall goal is to achieve carbon neutrality by 2050 whose member states also have national plans in line with this goal [6], Canada introduced a draft law in November 2020 that explicitly aims to achieve carbon neutrality by 2050 [7].

1.1. Environmental, Social, and Governance (ESG)

The concept of ESG originated from the socially responsible investment in the 1960s for using to measure a company's sustainability performance [8]. Figure 1 showed the general development of ESG over the past 60 years, which can be roughly divided into four periods of origin, development, establishment, and rapid development. ESG ratings were the data basis for ESG-related research and decision-making, and a large number of academic studies and industry evaluations have used ESG ratings as a measure of ESG performance [9]. We can see that it has always been closely related to environmental and social changes and has gradually become standardized.

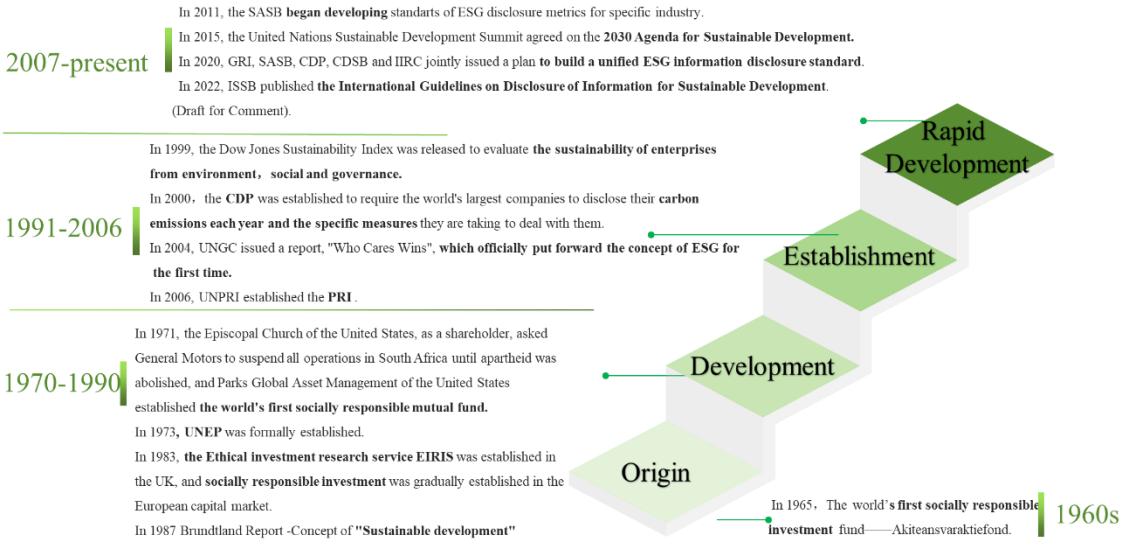


Figure 1. The development of ESG over the past 60 years.

The term "ESG" became popular in the 21st century and often comes up in the same conversations as sustainability and corporate social responsibility (CSR). The ESG framework is based on three dimensions: environmental, social, and governance. The environmental dimension includes issues such as climate change, greenhouse gas emissions (GHG), deforestation, biodiversity, carbon emissions, waste management, and pollution. The impact of organizations on people, culture, and communities also looks at the social dimensions of diversity, inclusion, human rights, and the social impact of supply chains, and how organizations are guided, and at the jurisdictional dimensions of corporate governance factors such as executive compensation, succession planning, board management practices, and shareholder rights [8]. Among them, the environmental criteria include how a company used renewable energy in its operations, how it evaluated and managed industrial waste, how it manages air and water pollution, how it optimized supply chain management, and how it viewed biodiversity conservation. Of course, corporate agendas and business models related to climate change mitigation and decarbonization are increasingly becoming ever more important [10].

Social criteria focus on social relationships between employees and stakeholders, including wage equity, employee benefits, retirement plans, and policies on diversity, equity, and sexual harassment. In general, it concerns the human right to survival and development.

Governance standards include the various actions of the Board of Directors, executive management and stakeholders. For example, corporate directors should prioritize the best interests of shareholders, the degree of

employee participation in governance, customer satisfaction, and so on. At the same time, financial reporting and transparency in finance and accounting are also important standards.

With the increasing importance of sustainable development in countries around the world, the continuous improvement of ESG evaluation standards, and the deepening of global ESG practice, ESG concept had become the focus of common attention of enterprises, investors, governments, international organizations, and other stakeholders. ESG was expected to become a key force to promote the development of the global economy in a more green, fair and transparent.

1.2. Carbon Neutrality

Carbon neutrality generally refered to the total carbon dioxide or greenhouse gas emissions directly or indirectly generated by countries, enterprises, products, activities or individuals within a certain period of time, through afforestation, energy conservation, and emission reduction, to offset their own carbon dioxide or greenhouse gas emissions, to achieve positive and negative offset, to achieve relative "zero emissions" [11,12]. Currently, carbon neutrality had become a major global action, which might have a profound impact on the future of society and economy. More than 130 countries, which account for 73% of global CO_2 emissions and 70% of global GDP, have adopted carbon neutrality targets. As the largest developing country, China was also taking active actions to achieve carbon neutrality [13], and the Chinese government said China will acheive carbon neutrality by 2060.

China said that to achieve the goal of peaking carbon neutrality, it was necessary to plan and coordinate, clarified the path and adopted comprehensive policies. Reform of the energy system was the fundamental approach, transformation in key areas was an important starting point, technological innovation was a key engine, carbon sink capacity improvement was an important supplement, and governance system reform was the basic guarantee. For each industry, there were different measures to achieve the strategic goal of carbon neutrality. For example, the key to achieving carbon neutrality in the power sector was to promote clean electricity and reduce reliance on traditional fossil fuels [14]. Tourism-related industries (such as hotels, transportation, and recreational facilities) should be more energy efficient and use renewable energy sources such as solar and wind as much as possible [15]. In the sewage treatment industry, photovoltaic power generation, cogeneration, and water source heat pump can be used to offset the energy consumption and carbon emissions in the sewage treatment process [16]. For companies, ESG was the best way to advance carbon neutrality and achieve sustainable development.

1.3. Links between ESG and Carbon Neutrality

In fact, ESG could effectively and comprehensively measure the sustainable development ability of the industry in tackling climate change and achieving carbon neutrality targets and provided the basic conditions for the realization of its own carbon neutrality targets. It was obvious that ESG is intrinsically consistent with carbon neutrality goals and Sustainable development Goals, and ESG can be used as a key variable to promote the realization of the global carbon neutrality vision and stimulate the subjective initiative of market players. It is precisely because the ESG framework has built-in issues related to climate change and carbon neutrality, with comprehensive coordination, flexible framework, and strong practical characteristics, it can be used as an effective comprehensive measure of enterprises to achieve carbon neutrality vision and sustainable development [17]. Environment of ESG involvef climate change, natural resources, pollution and consumption, environmental governance, green development, and other aspects, which coincides with the national strategic layout of "carbon neutral and sustainable development". Therefore, ESG investment was a "living water" to achieve the goal of carbon neutrality. Foreign capital markets had widely included climate change in the investment scope of ESG, becoming the most core concept of the environmental dimension in ESG, and thus forming a subsector of climate investment and financing.

Building an ESG framework in the market can also enable more entities such as governments and international organizations to efficiently utilize ESG as a tool to better assume their social responsibilities in terms of carbon neutrality. At the same time, we also note that carbon neutrality will also have an impact on ESG, such as increasing the weight of the environment in the environment, society, and management, expanding the scope of ESG practice, and enhancing the recognition and influence of ESG on a global scale.

2. The Application of ESG in the Global Carbon Neutrality Vision

In order to mitigate global warming, governments and international organizations must strive to achieve the goal of carbon neutrality. Many country's governments usually adopt means such as setting up green development funds and promulgating policies and regulations [9]. Taking China as an example, CICC Public Energy Group

proposed a three-step pathway for China's energy development of "High Carbon–Low Carbon–Zero Carbon". (1) From now to 2028, the era of new energy parity will come, coal and oil consumption will peak, and carbon emissions will peak in 2028; (2) From 2028 to 2040, oil and coal will be replaced by natural gas in the non-electricity sector, new energy in the power sector will gradually shift from incremental replacement to stock replacement, and China's carbon emissions will move from high carbon to low carbon; (3) 2040–2060, with the further reduction of power generation costs, hydrogen energy towards parity, and complete energy carbon neutrality. In this process, the realization of new energy, energy storage, and hydrogen energy balance costs that continue to decline will be the key.

In addition, the application of ESG provides a reliable way to achieve this goal Made the ESG concept truly contributed to the achievement of carbon neutrality goals, as shown in Figure 2. In particular, it should be noted that the realization of the three pathways is not only a great benefit to the ecology, but also injects more stability factors into the real economy and the financial industry. Next, there will provide a detailed introduction on how ESG achieve carbon neutrality goals.

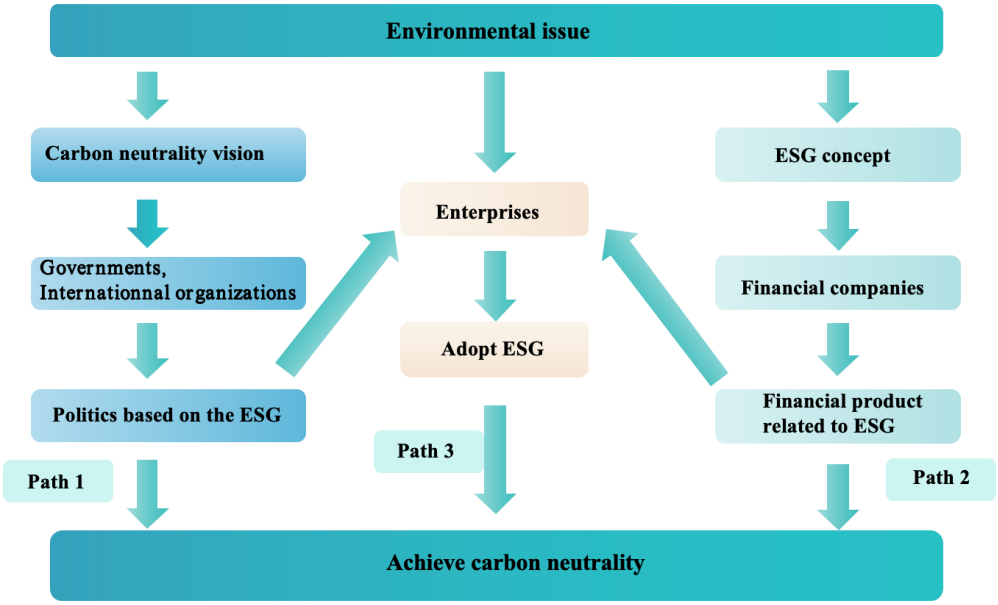


Figure 2. The pathway of ESG promoting carbon neutrality.

2.1. First Pathway

On 15 July 2020, the National Green Development Fund Co., Ltd. was inaugurated in Shanghai, raising 88.5 billion yuan in the first phase. According to the industrial and commercial registration data, the fund was managed by the Shanghai Municipal Government entrusted by the Ministry of Finance and takes the form of a company, with a registered capital of 88.5 billion yuan and 26 shareholders. Among them, the Ministry of Finance, PRC was the largest shareholder with a shareholding ratio of 11.30%; China Development Bank, Bank of China, China Construction Bank, Industrial and Commercial Bank of China and Agricultural Bank of China each hold 9.04%, while Bank of Communications holds 8.47%.

The National Development Green Fund has always adhered to the concept of ESG, especially highlighting the weight of its environmental part, reflecting China's strategic guiding role at the national level. The Fund continued to play a leading role in the concept, industry, capital, and technology of green development. The Fund takes collaborative governance as the starting point and water as the link, it focused on the comprehensive management of major lakes and major tributaries of the Yangtze River and invested in water pollution control, river, and lake ecology, wetland protection and restoration, and biodiversity conservation from point to line and surface, and it also closely focusing on the "new three" investment directions such as electric vehicles, lithium batteries, and photovoltaic products, we will promote new production relations to serve new quality productivity, and fully promote the implementation of high-quality green industrial transformation in the Yangtze River Economic Belt [18,19]

Figure 3 showed the flow of China's National Green Development Fund (NGDC), and the inflow of funds in the dual carbon sector had reached 72%, which clearly demonstrated a successful case of the country

implementing ESG concepts through the issuance of funds and other means to promote the achievement of carbon neutrality.

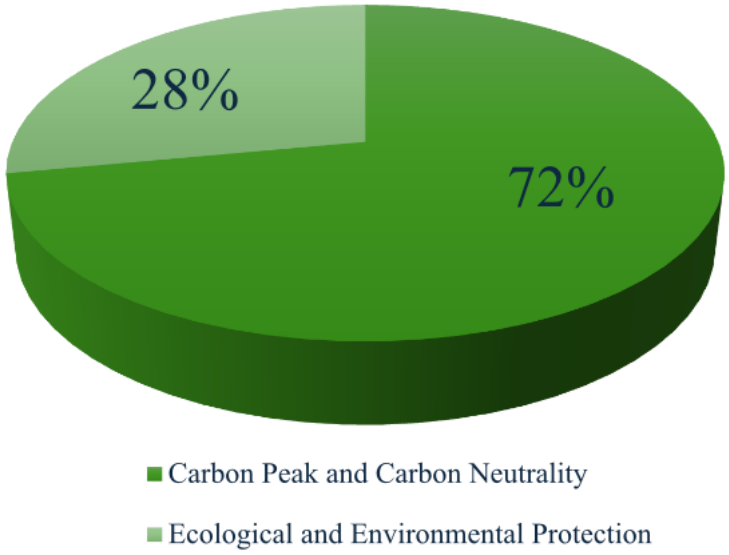


Figure 3. The proportion of investment direction of the NGDF.

At the same time, it was worth noting that the Chinese government has issued many policies and regulations to regulate the development of ESG. Governmental efficiency and regulations on reporting were bound to affect a company's activity companies operating in countries characterized by formal rules, constitutional constraints, and other political constraints might feel a less impellent need to produce information beyond the formality required from institutions [20]. The following would take the greening of its tax system as an example. Improving the green taxation system, based on the principle of "polluters pay", is an inevitable measure to promote green development and harmonious coexistence between humans and nature [21].

For example, the State-owned Assets Supervision and Administration Commission of the State Council of China formulated and issued the Guiding Opinions on Central Enterprises' High Standards for Fulfilling Social Responsibility in the New Era to make arrangements for central enterprises' social responsibility work in the new era. It was pointed out that ESG work should be integrated into the overall management of social responsibility work, and the opportunities and challenges brought by the development of ESG should be actively grasped and dealt with. Promote the holding listed companies to implement environmental management requirements with high standards around ESG issues, actively fulfill social responsibilities, improve corporate governance, strengthen high-level ESG information disclosure, constantly improve ESG governance capabilities and performance levels, and enhance value recognition in the capital market. Encourage overseas operating institutions to take ESG work as an important content in overseas operation management and the implementation of major projects, actively adapt to the requirements of ESG norms in the countries and regions where they are located, strengthen ESG governance, practice and information disclosure, and continue to improve the competitiveness of the international market. The environmental provisions of this guideline undoubtedly greatly promote the goal of carbon neutrality and promote the sustainable development of China's economy and environment [22].

2.2. Second Pathway

While the ESG concept promotes the financial industry to make greater contributions to carbon neutrality, financial products guided by the ESG concept tend to attract more customers with more stable and sustainable characteristics, that is to say, the second path can achieve both the brand image and good returns of financial institutions and brokerages–take Huatai Securities and Standard Chartered Bank as examples.

Huatai Securities had established and improved the ESG governance structure and implementation system, incorporated ESG into the scope of due diligence, actively practiced responsible investment, explored cutting-edge issues such as ecological environment access in ESG investment, and set ESG as an important consideration criterion for investment and financing business. And promote wholly owned subsidiary Huatai Securities Management to join the United Nations Principles for Responsible Investment Organization (UNPRI) [23]. In 2021, Huatai Securities Asset Management launched the first Huatai Yixin series of public welfare theme asset management products, which will not only provide financing support for the green industry, but also donate part

of the management fee to support the conservation of biodiversity, integrate and connect high-quality capital and asset resources, and focus on the development of green and low-carbon industries. Select ESG outperforming targets as underlying assets. "One Yangtze River" was one of Huatai Yixin's key projects, selected as the "Global Special recommended case", the project took the Yangtze River Basin as the key region to support ecological environmental protection work, provides continuous momentum for the development of environmental public welfare industry talents, was committed to ESG as a link, promote dialogue and cooperation between the ecological protection community and the capital market, and guide capital and finance to the good.

In 2019, Standard Chartered Bank developed the ESG Select evaluation framework, which forms a scientific and rigorous evaluation system based on the ESG concept, and then selects high-quality solutions to help customers achieve sustainable and stable investment goals with the organic combination of products. The evaluation system can be generally divided into two levels, and the second level has two review procedures. First of all, the prerequisite for becoming an ESG Select Fund is to be assessed as a Fund Select Fund by Standard Chartered Bank. And then the fund can then enter the ESG Select review process including (I) In line with Standard Chartered's position statement and sustainable products framework, companies that have a negative impact on the environment and society are eliminated. (II) In the process of communicating with fund managers and the other ESG team, Standard Chartered reviews the product using a self-developed evaluation framework to assess the breadth and depth of its ESG strategy integration through five key indicators: company status, ESG strategy, ESG expertise, ESG integration, and effectiveness and measurement.

As of June 2022, Standard Chartered China has around 20 products in its portfolio that are identified as sustainable investment products by the Group, and a number of products meet the Standard Chartered Group's ESG Select Fund framework and criteria. To be sure, because ESG-compliant companies tend to have more potential to attract financing and more sustainable development, these products are more robust and bring good market feedback to Standard Chartered.

2.3. Third Pathway

The third path is mainly about the government, financial institutions and securities brokerages to form a joint force, forcing enterprises to embed ESG concepts in the business framework, take the initiative to conduct ESG reports to adapt to the social green change, and seek long-term development.As key players in economic and social development, enterprises are not only the core driving force for economic activities but also the main bearers of social responsibility. As the far-reaching impacts of climate change and environmental challenges on global economic structure and social well-being have become increasingly prominent, enterprises have been given a series of responsibilities and missions to pay attention to environmental protection, mitigate carbon emissions, and ensure long-term and sustainable development [24].

Firms aligning their operational strategies to ESG considerations undeniably stand to be the biggest beneficiaries as ESG initiatives may not only be financial relevance, but also will create business value [25].This is especially the case in today's fast-changing business environment where businesses have to respond to the diverse needs and changing expectations of various parties, including regulators, consumers, and communities on sustainability issues while remaining competitive [26].

Under the vision of global carbon neutrality, enterprises had to face not only the pressure of the government on carbon reduction policies, but also the expectation of the society for them to actively fulfill their responsibilities. An unsatisfactory ESG report disclosure will bring a series of cascading harms to the company, which makes it more important and urgent for enterprises to embed ESG into the corporate structure and future planning.

Research by Zhang et al. [27] found that (1) Businesses with strong ESG performance can foster the development of corporate value and improve their capacity for bi-dimensional innovation. The conclusion hold truly even after running a number of robustness tests, including lag regression and proxy variable measurement. (2) The results of mechanism testing indicated that the relationship between company value and ESG performance was mediated by dual green innovation. Because of its low R&D expenses and low innovation difficulties, exploratory green innovation played the most significant mediation role among these.

2.4. Explore the Application Paradigms of ESG in Practice

Based on the application examples of the three paths mentioned above, we can delve deeply into the application paradigms of ESG in practice. Firstly, the first path, through the establishment and operation of funds at the national level, clearly demonstrates the guiding role and financial support of the government in promoting the ESG concept. This path emphasizes the guiding role of national policies, which can effectively drive the concentrated allocation of green development resources. The operation of national-level ESG funds not only

provides strong financial support for green projects but also guides the green development trend of the entire society through the selection of investment directions.

Secondly, the second path leverages the power of the market through the practices of financial institutions and securities brokerages in ESG to promote the ESG concept. The cases of Huatai Securities and Standard Chartered Bank illustrate that financial institutions can attract more customers concerned about sustainable development and achieve brand enhancement and economic benefits for themselves by establishing and improving ESG governance structures, developing ESG evaluation frameworks, and launching ESG-themed products. This path emphasizes the spontaneity and flexibility of market mechanisms. The innovation of financial products not only meets the needs of investors but also promotes the development of green projects and the spread of the ESG concept through the flow of capital.

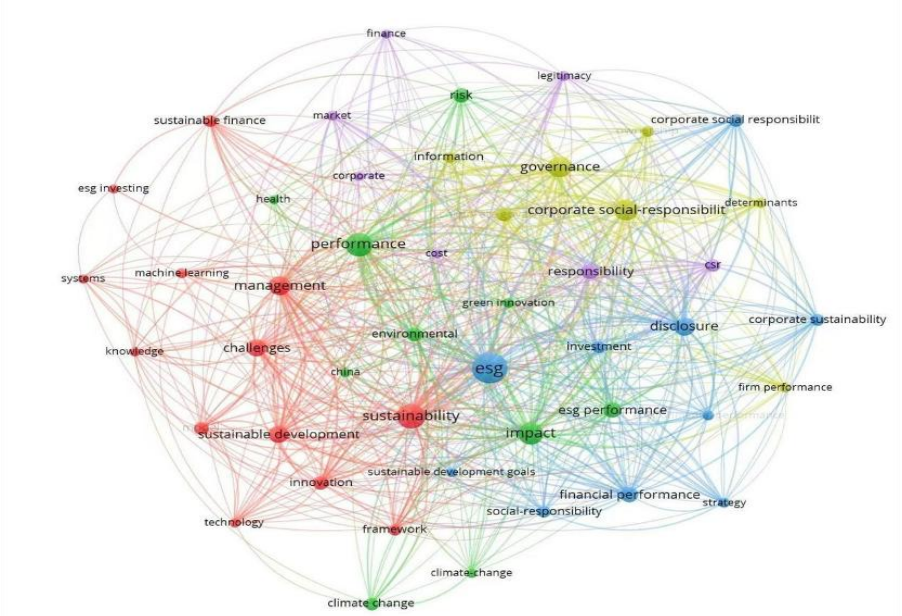
Lastly, the third path, through the collaborative efforts of the government, financial institutions, and enterprises, showcases the importance of multiple stakeholders jointly pushing enterprises to proactively engage in ESG reporting and practice. This path emphasizes the importance of embedding ESG in the long-term operations of enterprises. Enterprises need not only to respond to government policy requirements and societal expectations but also to enhance their social value and market competitiveness through their own ESG reporting and practice. The integration of enterprises with the ESG concept has significantly boosted their own green innovation capabilities.

Overall, these three paths together form a comprehensive application paradigm of ESG. The first path provides policy support and financial guarantees, the second path achieves widespread dissemination and application of the ESG concept through market mechanisms, and the third path emphasizes the central role and initiative of enterprises in ESG practice. Through the coordinated efforts of these three paths, a complete chain of ESG promotion in the field of carbon neutrality can be formed, from national policies to market mechanisms, and then to enterprise-led actions. This comprehensive application paradigm not only effectively promotes the implementation of the ESG concept but also advances the sustainable development of the economy, society, and environment, achieving a win-win situation for all parties.

3. The Challenges of ESG in the Global Carbon Neutrality Vision

3.1. The Necessity to Analyze the Challenges of ESG

We performed a co-occurrence analysis using VOSviewer on a dataset of 477 articles retrieved from a Web of Science database. The analysis focuses on the co-occurrence of key words, (Figure 4a), and we can clearly see that ESG is facing risks and challenges that cannot be ignored in the field of carbon neutrality. The risk and challenge of negative public sentiment towards ESG concept caused by inconsistent scores, the occurrence of greenwashing behavior, and the misjudgment of enterprise greenwashing caused by different levels of data skew are increasingly more obstacles for ESG practice. If these issues are ignored, it is unrealistic to drive global carbon neutrality through ESG.



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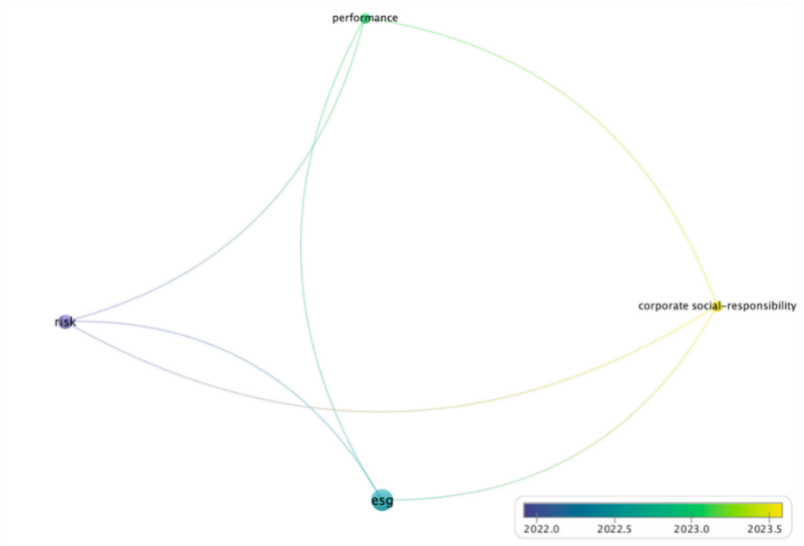

(**b**)

Figure 4. (**a**) Co-occurrence analysis of keywords that appear nine times or more in 477 authoritative papers (Source from web of science via keywords "ESG"). (**b**) Co-occurrence analysis of keywords that appear four times or more in 8 authoritative papers (Source from web of science via keywords "ESG" and "risk") [28–35].

Through further searching and reading of relevant authoritative papers in the field of ESG, we find that the inconsistency of ESG evaluation system was the main reason that brought great challenges to ESG. The challenges in ESG application include misrepresentations, greenwashing, confusion in ESG disclosures and so on [36].

3.2. Differences in ESG Evaluation System

There were a variety of ESG evaluation systems in the world, such as MSCI ESG evaluation system, FTSE Russell ESG evaluation system, Sustainalytics ESG evaluation system, S&P Global ESG score, S&P Global ESG score, and so on. The complex and varied evaluation system meant that despite the significant investment in the accumulation of ESG data and the construction of rating methods, it was unlikely that every evaluation will accurately reflect the true ESG profile of a company [37].

There were various reasons for the inconsistent ESG ratings. From a technical point of view, differences in evaluation methods and indicator selection among rating agencies could lead to differences in rating results. Different rating agencies had different ESG evaluation frameworks and weight allocations, resulting in inconsistent ratings of the same company by different agencies. Rating agencies rely on publicly disclosed data and information to make their assessments, and differences in the level and quality of data disclosure between different companies could lead to inconsistent ratings results [38].

3.3. The Greenwashing

3.3.1. Overview of Greenwashing

Greenwashing is the deceptive practice of presenting a misleadingly positive image of a company's environmental efforts to stakeholders, while the reality often falls short of these claims. This practice has become more prevalent as responsibility and sustainability issues receive increasing attention. Many companies resort to false ESG reporting in order to attract market favor. As a result, while ESG evaluations could play a crucial role in addressing global sustainable development challenges, such as achieving carbon neutrality, they are sometimes used by the capital market as a tool for profit-seeking rather than genuine progress.

The co-occurrence analysis of 956 literatures on the topic of greenwashing was made, and it was found that the research on greenwashing was developing rapidly（Figure 5）, which reflected the more and more frequent occurrence of greenwashing. This phenomenon is concerning. Research by Biju, A.V.N. and others demonstrated a linear relationship between perceptions of ESG and "greenwashing". For example, the rate of "greenwashing" increased in step with the rate of ESG growth [39].

In other words, from the perspective of global carbon neutrality, the challenge posed by greenwashing to ESG is not only that the company cannot take environmentally friendly actions as it has disclosed, wasting social

investment, but also that it will greatly reduce people's social expectations for ESG, so that the so-called role of ESG in promoting carbon neutrality will only become an empty concept.

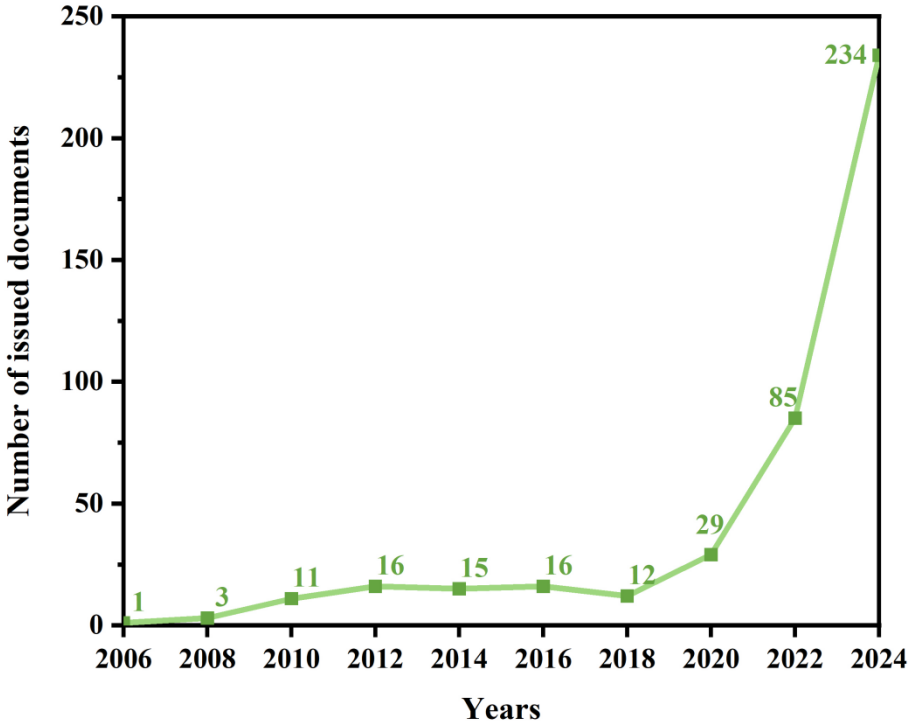

Figure 5. The co-occurrence analysis of 956 literatures on the topic of greenwashing.

3.3.2. Examples about Greenwashing

(1) Decathlon

Decathlon claims that since its establishment in 1976, the brand has provided high-quality, sustainable development principles and cost-effective products, so that the broadest public, with the desire to exercise, to share the benefits of sports. We always regard sustainable development as an important strategic direction and are committed to creating a new circular business model. However, in 2022, an investigation by the Netherlands Consumer and Market Supervision Authority (ACM) found that Decathlon had misleading sustainable labels and used generic terms with broader meanings such as "eco-design" for products, but did not immediately provide a clear explanation and explanation. After being accused, Decathlon promised to adjust or stop the use of sustainable labels and advertising on its clothing and website, and stipulated in its sustainability report that products that meet relevant standards in terms of carbon reduction, pollution reduction, durability, repairability, recycled materials, etc., can be defined as "eco-design". Obviously, Decathlon misled consumers, using vague concepts to create an environmentally friendly green image to win favor.

(2) Lufthansa

In July 2023, Lufthansa placed an AD on Google that referred to "flying in a more sustainable way". At the same time, on the Lufthansa Chinese website, clicking on "Fly more sustainably" will show that Lufthansa plans to be carbon neutral by 2050, reducing aviation emissions as much as possible. One of the results of this strategy is green fares, which make sustainable travel possible. In December 2023, the UK's Advertising Standards Authority concluded that Lufthansa's Google ads describing its products as being able to fly more sustainably, without explaining how "flying more sustainably" would work in practice, gave consumers the misconception that Lufthansa had less of an impact on the environment than other airlines. In the end, the Advertising Standards Authority ruled that the AD must not appear in this form again.

3.4. Another Issues

Another important issue we have overlooked in the discussion of corporate ESG reporting and the potential for greenwashing is how ESG standards should be defined. The lack of consistency in these standards can create a barrier between scholars, the media, and businesses, leading to misjudgments of "greenwashing." This, in turn,

undermines the positive environmental actions of companies, such as efforts toward carbon reduction. Additionally, it can erode public confidence in ESG evaluations, ultimately hindering progress in the sustainability field.

Take Tesla as an example, Tesla's environmental performance is more prominent, especially its innovation in the field of electric vehicles and its contribution to reducing carbon emissions. However, in some ESG evaluation systems, Tesla's overall score is not high due to the relationship between factor weights. For example, Standard & Poor's Global Ratings has given Tesla a relatively low score in its ESG score, due to Tesla's relatively weak performance in the "social" and "corporate governance" parts, such as the racial discrimination controversy, overstating the effectiveness and safety of autonomous driving allegations. But from Tesla's positive impact on the environment and the promotion role in the field of sustainable transportation, such a low score may lead some people to believe that it has been misjudged in ESG performance, and may even be misunderstood as "greenwashing", when in fact Tesla has a lot of substantive initiatives and contributions in sustainability.

4. Recommendations for the Development of ESG in the Carbon Neutrality Vision

4.1. Improve Regulations Related to ESG

It is necessary to formulate mandatory requirements and norms for some enterprises that may not be interested in sustainable development and long-termism and are not active in the disclosure of ESG reports. The following is an example of what happened in the Hong Kong Stock Exchange.

In 2012, Hkex issued the "Environmental, Social, and Governance Reporting Guidelines" and incorporated them into the Appendix of the Listing Rules. These guidelines were amended in 2019 to include key ESG performance indicators, broaden the scope of mandatory disclosures, and introduce requirements for "disclosure or interpretation," thereby further strengthening the overall disclosure requirements.

From 2012 to 2014, as this reporting guideline had just been issued, there is not much data to support it, so this paper chooses the data of 2015, 2019, and 2023 to make a rough estimate and statistics on the number of disclosed ESG reports of enterprises listed on the Hong Kong Stock Exchange, as shown in Figure 6. We can intuitively feel that the formulation of relevant policies is conducive to the wider application of ESG and can effectively force enterprises to innovate in the direction of sustainable development, which will undoubtedly greatly promote the realization of the vision of carbon neutrality.

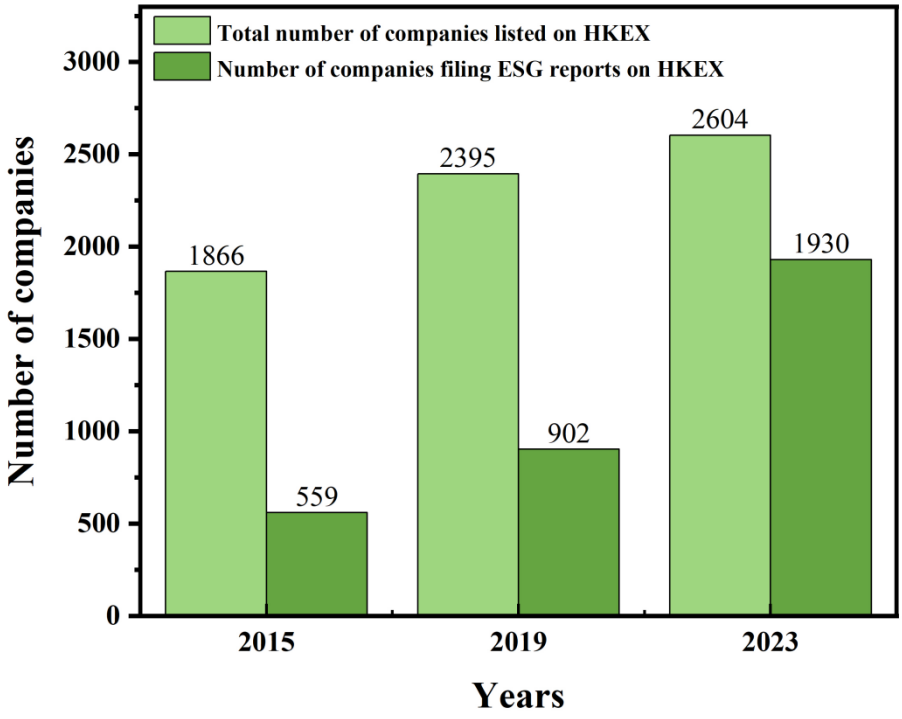

Figure 6. Number of companies filing ESG reports on HKEX compared with the total number of companies listed on HKEX.

4.2. Public Participation

Globally, a significant proportion of the general public is still unfamiliar with the concept of ESG. For many people, the focus of daily attention is more focused on the, daily concerns, consumer products themselves, etc., and the lack of in-depth understanding of the comprehensive considerations of enterprises in the environmental, social and corporate governance levels. And they may be less focused on carbon neutrality, an important goal that will affect the future of humanity.

Building a complete ESG society requires the active participation of all parties, but the public is often overlooked. Only enterprises, institutions, governments and other large social machines cannot form an organic ESG cycle. The public is often the consumer, the communicator of public opinion and the source of government power. They are small chains in the huge structure of ESG society. Therefore, deepening public awareness of sustainable development concepts such as ESG and carbon neutrality is a direction that all parties need to work towards so that the chain can participate in the operation of the machine.

4.3. Media Supervision

As ESG stakeholders, media and journalists can shape public perception and influence a company's reputation through their views and reports on ESG . Therefore, if ESG is to continue to exert influence in the field of carbon neutrality, media supervision and encouragement are necessary. As a relatively independent stakeholder, the media should strive to objectively and impartially track and report the ESG implementation of enterprises, so that ESG is truly conducive to the realization of carbon neutrality goals.

The following section examines the impact of media coverage on the ESG performance of heavy-polluting enterprises in China. Based on panel data covering 390 Chinese listed companies from 2011 to 2021, Li, S. et al. investigated the potential impact of media coverage on the environmental, social, and governance (ESG) performance of heavy polluters. In their study, they found that positive media coverage significantly contributes to an enhanced ESG performance among heavy-polluting enterprises, particularly those in eastern and western China and those entrenched within highly competitive industries. Positive media coverage predominantly amplifies these enterprises' environmental and social performance dimensions, while intriguingly, negative media coverage unexpectedly positively impacts their environmental performance. Green total factor productivity and green innovation emerge as crucial facilitators in bolstering the relationship between positive media coverage and the ESG performance of these enterprises.

However, while seeing the supervision and incentive effect of media reports on enterprises' ESG practice, we should also pay attention to the fact that the pressure of public opinion caused by excessive negative media reports may induce managers to adopt short-sighted behaviors such as ESG greenwashing.

5. Route Optimization

Based on the research on the application and challenges of ESG concepts in the context of carbon neutrality, and combined with the case analysis and development suggestions mentioned earlier, we have constructed a more detailed and quantitative path optimization framework for the interaction and collaboration among government, financial institutions, and enterprises in ESG practices, grounded in stakeholder theory, institutional theory, and resource dependence theory.

5.1. Goal Setting

For governments of various countries, the first step should be to actively formulate and implement ESG laws and regulations, aligning them with national carbon neutrality or carbon reduction policies, striving to improve the country's ESG policies or regulations within the context of carbon neutrality. Additionally, they should issue related funds to support the ESG efforts of financial institutions and enterprises. Lastly, governments should also focus on the extent of dissemination, actively conducting training and educational activities across different regions, covering government officials and the public, to create a collaborative environment for the widespread application and compliance monitoring of ESG. Financial institutions and enterprises should actively respond to government initiatives. Financial institutions should support enterprises' ESG practices through financial tools and investment strategies, while enterprises should enhance their ESG performance from multiple perspectives.

5.2. Building Collaborative Mechanisms

It is essential to establish a dialogue platform for government, financial institutions, and enterprises, in the form of tripartite ESG-themed forums or summits. Each year, at least one global multi-party ESG action plan

should be promoted, along with various forms of regional ESG cooperation. Influential financial institutions and enterprises should lead the initiation of ESG joint projects across different sectors, particularly emphasizing their connection to carbon neutrality goals, with sustainable development as the foundation.

5.3. Resource Allocation

Firstly, governments should actively promote tax incentive policies in their fiscal expenditures, covering over 90% of enterprises, and consider establishing a dedicated ESG regulatory body. Secondly, both financial institutions and enterprises should set up specialized ESG departments in terms of human resource allocation and increase budget investments in ESG, especially in sustainable development. Lastly, for financial institutions in particular, increasing investment products related to environmental protection and carbon neutrality should be a priority, striving to ensure that over 80% of their investment portfolios meet ESG standards.

5.4. Monitoring, Evaluation, and Feedback Mechanisms

Consistently collect and analyze data by establishing an ESG data collection and analysis system to monitor the effects of tripartite cooperation. Collect and analyze ESG data quarterly, ensuring a coverage rate of over 98%, and release a detailed annual ESG data analysis report for public and stakeholder oversight and reference. Based on this data and reports, evaluate the effectiveness of ESG practices, reflecting the outcomes of tripartite collaboration, and establish a regular practice feedback mechanism.

6. Conclusions

ESG (Environment, Society, and Governance) was inherently aligned with the global vision of carbon neutrality and could serve as a key driver for its realization. In the context of the global carbon neutrality goal,, ESG had ushered in faster and better development. Through extensive literature review and case studies, this study not only summarizes the basic application path of ESG, points out that the challenges and risks in the implementation process of ESG are objective, but also proposes a complete set of path optimization schemes. In order to promote the sustainable development of human society and the better practice of ESG in the field of carbon neutrality, it was necessary to cooperate with multiple forces, stimulate the enthusiasm of stakeholders, and collectively build an organic and advanced ESG operation model under the global framework.

Author Contributions

R.M.: data curation, writing—original draft preparation, methodology, software; H.J.: conceptualization, writing—reviewing and editing; G.L.: writing—reviewing and editing; F.L.: supervision, conceptualization, software, visualization, investigation. All authors have read and agreed to the published version of the manuscript.

Funding

The authors acknowledge the funding support from the Harbin Institute of Technology, China, grant Number FRFCU5710053121, from National Engineering Research Center for Safe Sludge Disposal and Resource Recovery, China, grant Number Z2024A019 and from the National Key R&D Program of China, grant Number 2024YFE0116800.

Conflicts of Interest

The authors declare no conflict of interest.

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