Journal of Infrastructure, Policy and Development 2024, 8(6), 4519.
https://doi.org/10.24294/jipd.v8i6.4519

Article

Mechanism of strategic remoulding of high-dimensional industrial eco-economy and the reconstruction of carbon neutral industrial chain

Zizhen Shen[1,2,*], Gennian Tang[3], Zhenpao Lin[1], Jinggang Wang[4], Yueting Gao[5]

[1] School of Architectural Engineering, Zhejiang College of Construction, Hangzhou 311325, China
[2] School of Civil Engineering and Transportation, South China University of Technology, Guangzhou 510641, China
[3] Zhijiang School of Business, Zhejiang University of Technology, Hangzhou 310014, China
[4] Beijing Peking University Management Consulting Co., LTD, Beijing 100032, China
[5] Institute of New Rural Development, Yunnan Agricultural University, Kunming 650000, China
*** Corresponding author:** Zizhen Shen, hzhgjgc123@126.com

CITATION

Shen Z, Tang G, Lin Z, et al. (2024). Mechanism of strategic remoulding of high-dimensional industrial eco-economy and the reconstruction of carbon neutral industrial chain. Journal of Infrastructure, Policy and Development. 8(6): 4519. https://doi.org/10.24294/jipd.v8i6.4519

ARTICLE INFO

Received: 2 February 2024
Accepted: 23 February 2024
Available online: 1 July 2024

Abstract: Considerable changes in the international society, fierce international competition and unpredictable economic changes are currently observed. Since then, the epidemic has had a far-reaching impact, and many industrial and supply chains have suffered from 'broken chains', 'blocked chains' and 'poor chains'. The European Union (EU) has also sounded the alarm on China's 'card neck' restrictions and 'entity list'. Therefore, pursuing the integration of dual carbon landscape planning and industrial chain and addressing the key high-dimensional ecological economy 'neck-choking' problem path have become important tasks. National ministries and commissions have issued a number of documents to promote the integration and innovation of the industrial chain, high-, medium- and low-dimensional enterprises, and guide such industries to take the road of 'high dimensional' development. This paper takes eco-economic strategy as the starting point to reshape the systematic theoretical analysis framework of economic strategy mechanism. In response to the high-dimensional industrial transformation adaptation path and carbon neutral industry chain development model of the academic inquiry, the 'profit model' is set as the core and configuration complementary, alternative management thinking analysis path and model. Simultaneously, the high-dimensional industrial eco-economic industrial chain adaptation path is identified. The effects of high-dimensional industry 'five forces', 'colouring map' and 'new tools' are explored and then integrated and refined to improve the implementation efficiency of the carbon neutral industrial chain. Finally, focusing on the high-dimensional ecological economic strategy reshaping mechanism, the formation of sustainable development of the 'carbon neutral' industrial chain, unified standards and the realisation of the chain length system is investigated.

Keywords: high-dimensional industry; ecological economy; carbon neutrality; industrial chain

1. Overview and status of the 'carbon neutral' industry

On June 26, the World Energy Statistical Yearbook 2023 was released in the United Kingdom. The yearbook noted that global energy demand grew by 1% last year. However, recorded renewable energy growth did not change the dominance of fossil fuels, which still account for 82% of the global energy supply (Tang, 2021; Gu and Xia, 2023; Liu, 2022; Elmobarak et al., 2023). The report indicates that the turmoil in energy markets following the outbreak of the conflict between Russia and Ukraine has led to record highs in gas and coal prices in Europe and Asia. By contrast, the dominance of oil, gas and coal products was further consolidated in 2022 despite the record growth of 266 Gigawatts (GW) of renewable energy installed capacity. The Information Technology (IT) House previously reported that one of the goals of the

Paris Agreement is to limit the rise in global temperatures this century to less than 2 ℃, which would be lower than pre-industrial warming. However, scientists have recently indicated that global greenhouse gas emissions by 2030 should be reduced by approximately 43% compared with 2019 to achieve this goal (Gu and Xia, 2023).

All industries in China should switch from resource attributes to manufacturing attributes. Every node of any commodity industry chain should achieve carbon neutrality and form a new layout of the industry chain. Therefore, under the remarkable balance of carbon neutrality, the global manufacturing industry chain will realise new international cooperation and international division of labour and form a new industrial pattern.

2. 'Carbon neutral' industrial chain analysis: The industrial chain is very large

The current core high-dimensional industrial structure of China's carbon neutral industrial chain can be roughly divided into three ends from carbon emissions to carbon absorption (**Figure 1**). Carbon neutrality is generally a 'three-carriage'. The first is the energy supply end, where non-carbon energy is maximised to replace fossil energy for power generation and hydrogen production, and a 'new power or energy supply system' is built. The second is the energy consumption end, which strives to realise the substitution of non-carbon energy, such as electricity, hydrogen energy, geothermal energy and solar energy, for fossil energy consumption in most fields, such as residential life, transportation, industry, agriculture and construction. The third is the artificial carbon sequestration end, which is realised through ecological construction, soil carbon sequestration, carbon capture and storage and other combined projects to remove the carbon dioxide that must be emitted. In short, appropriate technical means for 'carbon reduction and carbon fixation' need be adopted to gradually achieve carbon neutrality.

In addition, carbon trading is an innovative link in the development of carbon neutrality, thus playing a pivotal role. The basic principle of carbon trading is as follows: one side of the contract pays the other side to obtain greenhouse gas emission reduction credits, and the buyer can use the purchased emission reduction credits to reduce the greenhouse effect and achieve its emission reduction targets.

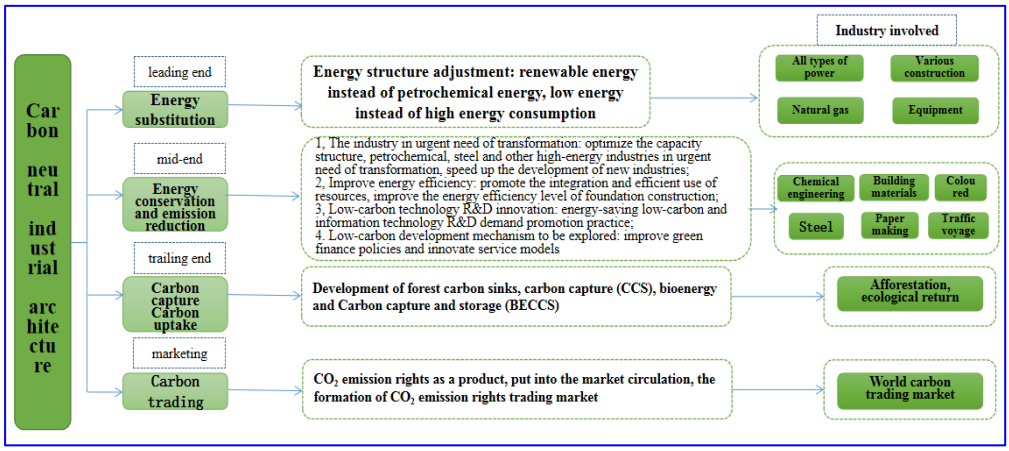

Figure 1. Carbon neutral and high-dimensional industrial chain.

2.1. China's ecological economy 'carbon neutral' high-dimensional industry background

China is the world's largest carbon emission country, wherein high-dimensional industries emit additional carbon (**Figure 2**). Carbon neutrality aims to limit carbon emissions. Scientific studies show that excess carbon emissions will lead to global warming, the greenhouse effect and extreme weather. Amongst them, the greenhouse effect is the most direct and serious problem. The concentration of carbon dioxide in the atmosphere in 2022 exceeded 432 ppm, and the global average surface temperature was 1.52 ℃ higher than the 19th century baseline. From the perspective of global carbon emissions, China is the world's largest carbon emission country; from 2009 to 2022, its carbon emissions increased from 77.1 billion tons to 11.477 billion tons, ranking first in the world. Amongst them, the energy sector has the most carbon emissions, accounting for 77% of the country's total carbon emissions (Liu, 2022; Lambert and Enz, 2017; Erboz et al., 2022). Therefore, controlling carbon emissions has long-term and important development significance.

Figure 2. Panorama of carbon neutral and high-dimensional industries.

2.2. Development history of China's 'carbon neutral' industry

China's responsibility is to achieve the medium- and long-term goals of carbon peak and carbon neutrality to respond actively to climate change and promote the building of a community with a shared future for mankind. An inevitable requirement for China is also to implement the new development concept and promote high-quality development.

In recent years, the leaders of the Communist Party of China (CPC) Central Committee have repeatedly proposed the goals of 'carbon peak' and 'carbon neutrality' before 2030 and 2060 (Elmobarak et al., 2023; Chen et al., 2022; Zou et al., 2021; Su, 2022; Wang, 2022), respectively, which is the first time that China has launched 'carbon neutrality'. In March 2021, the '2021 Government Work Report' proposed to realise carbon peak and carbon neutrality, and the '2023 Government Work Report' recommended promoting green and low-carbon transformation development. Thus, the concept of 'carbon neutrality' has been in top-level layout planning (**Figure 3**).

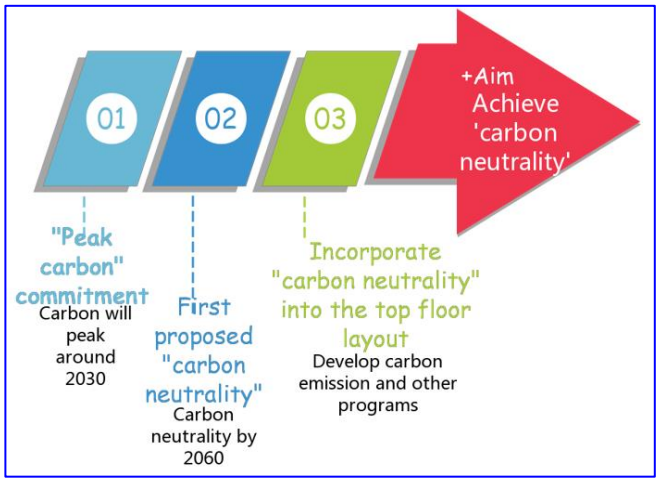

Figure 3. Development of China's carbon neutral industry.

3. Mechanism of strategic reshaping adopts the development strategy of 'two development paths and three steps'

According to the distribution of high-dimensional carbon emission industries in China, the majority of carbon emissions come from power generation and industry, followed by transportation and aviation, whilst agriculture and commerce account for a relatively small proportion (Zou et al., 2021; Su, 2022; Wang, 2022). The path to carbon neutrality can be broken down into the following two parts: avoidable and unavoidable emissions (**Figure 4**).

In the direction of avoidance, the state initially proposes to prioritise the solution of carbon emissions in the power production process, complete the transformation of fuel vehicles to electric vehicles and finally realise deep decarbonisation. In areas where emissions cannot be completely avoided, carbon neutrality can be achieved through carbon capture, utilisation and storage technology or natural absorption through forests and oceans.

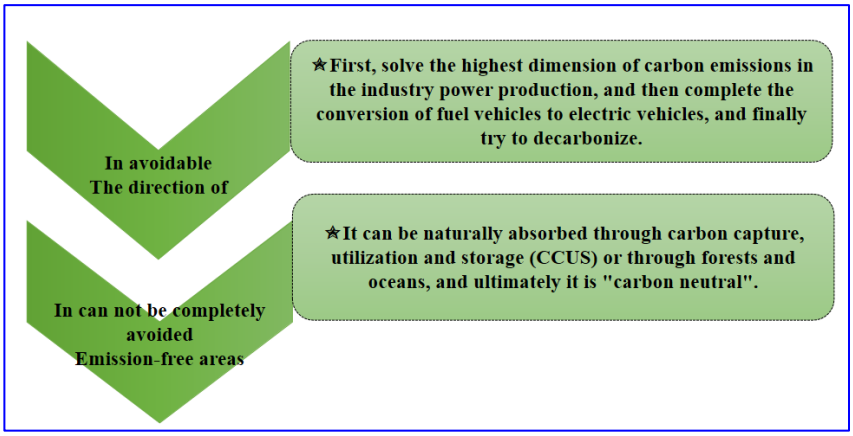

Figure 4. Path to carbon neutrality.

From the current development of China's carbon emissions, the 'carbon neutrality' of China has determined a three-step strategy (**Figure 5**). Firstly, the carbon peak must be completed in 2030. Secondly, carbon emissions must be rapidly reduced by 2045. Lastly, deep decarbonisation and carbon neutrality must be achieved by 2060

(Bai, 2021). This strategy also focuses on four key technological pathways to 'carbon neutrality' (**Figure 6**). The two development paths, three steps' development strategy aims to achieve the unity of economic development and carbon neutrality, and defines the long-term goals and development path of China's development.

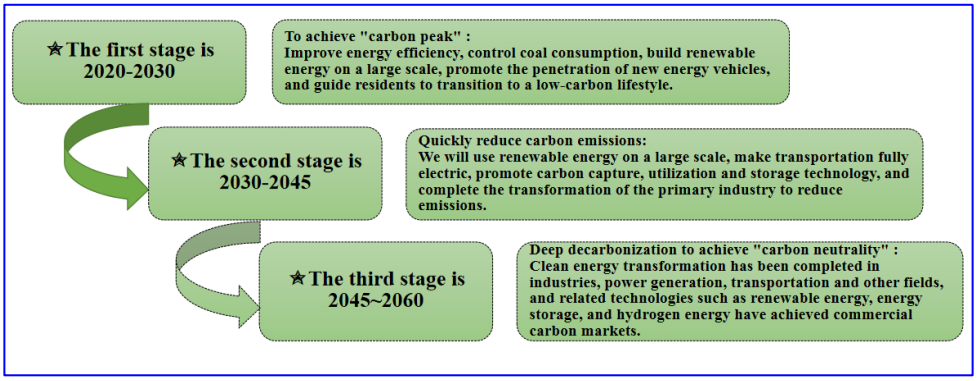

Figure 5. China's three-step 'carbon neutral' development strategy.

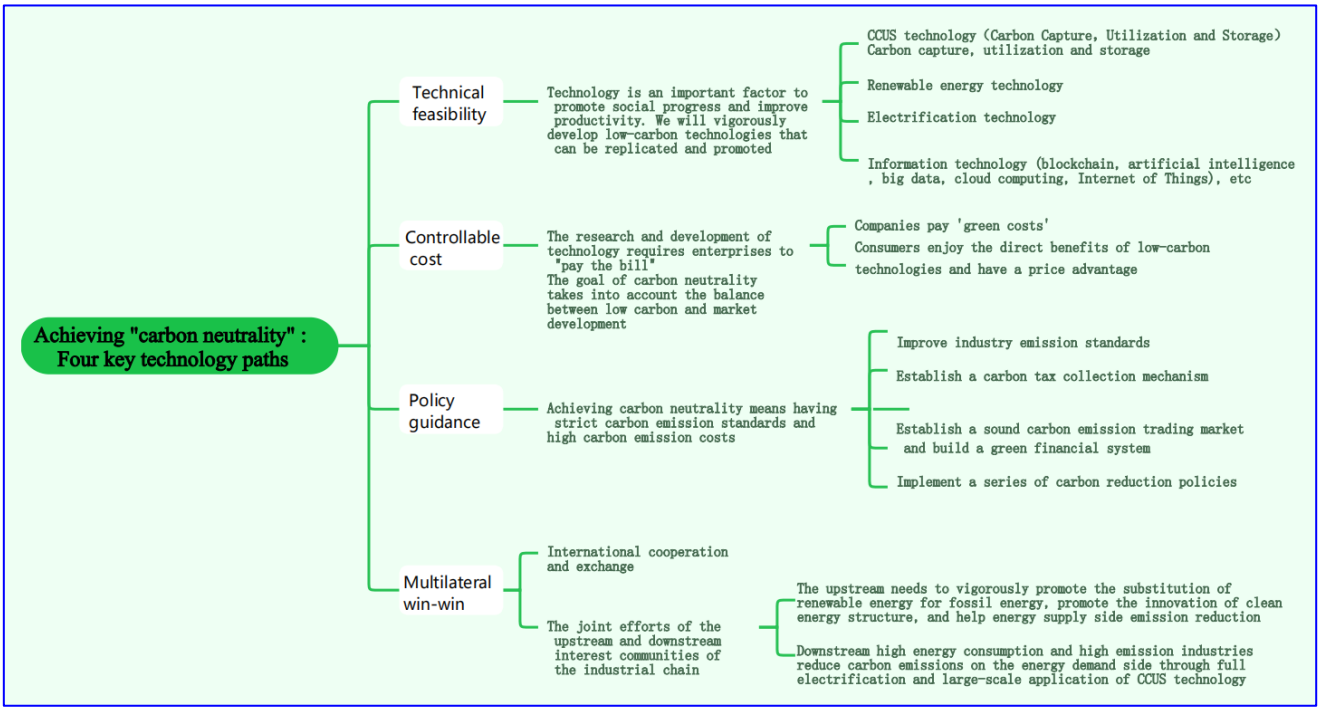

Figure 6. Four key technology paths to achieve 'carbon neutrality'.

4. Set 'profit model' as the core and configuration CAM idea to analyse the mechanism path and model of high-dimensional industrial ecological economy reshaping

The circular economy concept and profit model form the core of various ecological economic systems. These systems complement each other and cascade their usage, adopting complementary, alternative management (CAM) integration and polygeneration. This approach promotes the integrated development of industries within the "carbon neutral" industrial chain (Xue and Xiao, 2020; Yang, 2021; Uehara, 2013; Ulucak and Khan, 2020; Blomsma and Brennan, 2017; Temper et al., 2018;

Lüdeke-Freund et al., 2019). As a result, overall energy utilization efficiency is improved, the energy supply-demand contradiction is alleviated, the environmental impact of energy utilization is reduced, and ecological economic benefits are enhanced (Velenturf and Purnell, 2021; Bag et al., 2021; Remko, 2020). The integration and development paths of related industries within the chain are illustrated in **Figure 7**.

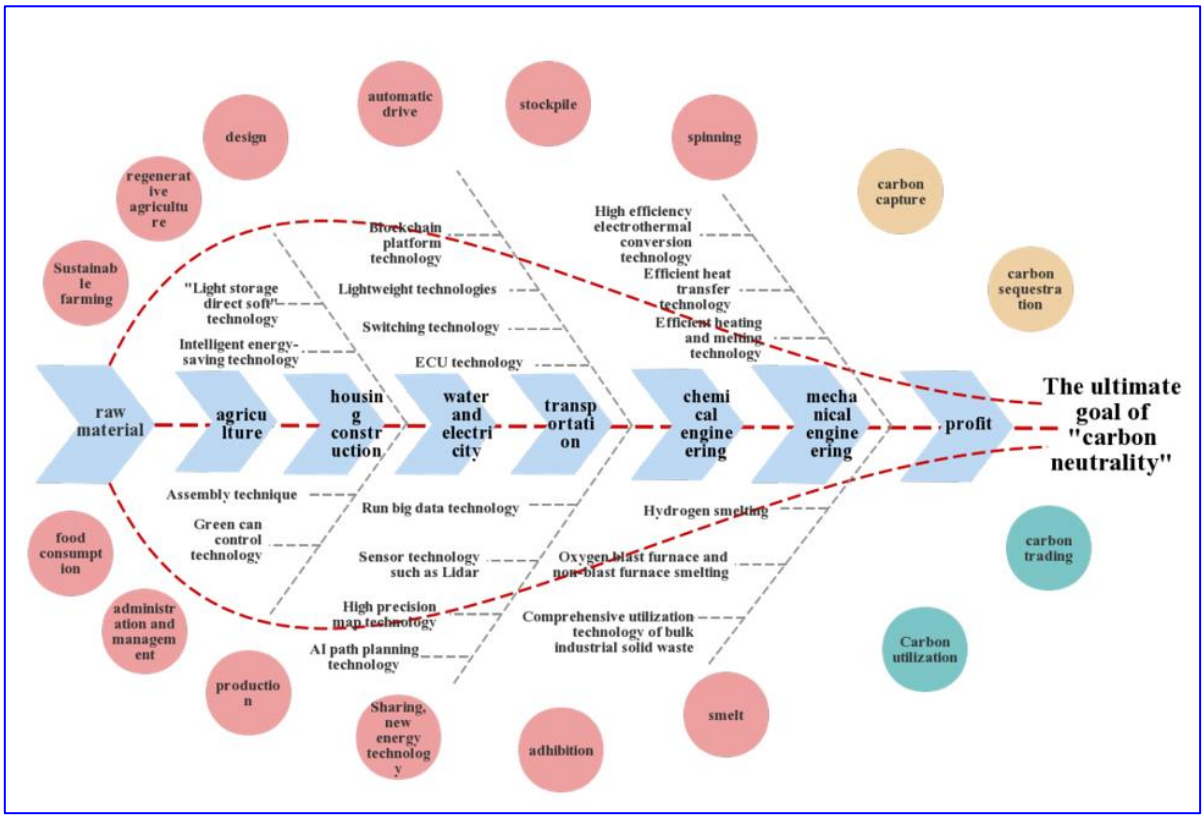

Figure 7. Integrated development path of related industries in the chain.

5. High-precision analysis of high-dimensional industry ‘five forces’, ‘colour map’ and ‘new tools’ efficacy and integral efficacy

‘Carbon neutrality’ is a new ecological economy, and its industrial chain is bound to be closely related to the environment of the new era, such as the Internet of Things, various emerging technologies introduced by the intelligent Internet and the transformation of the industrial chain structure. Therefore, finding a new way to build an industrial chain is necessary to establish a carbon neutral industrial chain, and the five industrial chain forces are currently the most effective methods.

5.1. Series product ecological strength: Interlinked upstream and downstream industries

The concept of the “series product ecological force” is described in the book “Gray Wolf Effect” and the almanac of China’s economy. It refers to the potential or existing digital ecosystem in the upstream and downstream industries related to a target industrial chain market (Manavalan and Jayakrishna, 2019; Masi et al., 2017; Ehie and Ferreira, 2019). This digital ecosystem can significantly impact the industrial

structure of the target market. In other words, it represents the interconnection and influence of various products within a series.

In industries beyond serial product ecosystems, the concept of a carbon-neutral industry chain can be explored. Taking new energy batteries as an example, new energy battery companies manufacture and sell batteries to automobile manufacturers through various intermediary links, forming the primary industrial chain (Dolgui et al., 2019; Attia and Salama, 2018; Herczeg et al., 2018). If we consider this link as the target market, the upstream industrial chain consists of entities providing materials for new energy batteries, such as cobalt, nickel, lithium, graphite, and manufacturing machinery suppliers. This upstream industry chain creates a network of interconnected products. Looking at the supply chain of cobalt, nickel, lithium, graphite, and manufacturing machinery as the target market, the upstream industry chain includes activities related to cobalt mining, nickel mining, lithium mining, and recycling enterprises.

5.2. Parallel product ecological force: Interconnection of industries in different locations

The book 'Gray Wolf Effect' explains the ecological power of combined products: 'Based on the target chain industry market (Wibowo et al., 2018; Lambert and Enz, 2017), the industrial chain market of different customer groups of the same type of products in the industrial chain market is closely related, or the industrial chain market of different purchase categories of products in the same type of customer group, the potential digital ecology appears or has already appeared, and the ecological impact on the target industrial chain industry has formed'.

The first parallel product, ecological force, comprises the following: the chain group ecology according to the tea industry chain market based on the tea shop, and the chain group digital ecology based on the coffee shop, hotel, milk tea shop and entertainment place industrial chain market. The two ecosystems are in different industrial chain markets, but they can provide the same type of product, 'tea'. Therefore, they are likely to enter each other's industrial chain market.

The second parallel product, ecological power, is explained as follows. Customers in the tea industry chain will purchase different products, such as packaging boxes, and then combine them into a complete product to sell to consumers. No sequence of procurement exists; thus, you can purchase tea whilst purchasing packaging boxes, all belonging to the same procurement. At this time (Nasir et al., 2017; Masi et al., 2017), the 'chain group' in the tea industry chain market can enter the tea packaging box tea industry chain market.

5.3. Internal product ecological power: The birth of a new ecology in the industrial chain

As explained in the book 'Gray Wolf Effect': 'After the digital ecology represented by the gray Wolf group appears within the target industrial chain, the ecology has an impact on the market structure of this industrial chain, that is, the internal product ecological force'.

For example, the tea industry chain market comprises 'tea farmers (tea raw material providers) (Parida et al., 2019), tea manufacturers (tea raw materials are manufactured into tea and supplied to distributors) and tea distributors (purchase finished tea products from tea manufacturers and sell them to major terminal sellers, such as major tea shops)' (Herold et al., 2021; Erboz et al., 2022; Benzidia et al., 2021). At this time, if tea farmers, manufacturers and distributors cooperate, then a chain ecology will be created within the tea industry chain. The frequently observed 'original direct sales, no middlemen' belongs to this model.

The emergence of 'chain ecology' in the target industry chain market will cause fluctuations in the original industry chain market due to the involvement of several enterprises. For example, after tea farmers or manufacturers cooperate with tea shops, the first two can obtain a high wholesale price, and tea shops can omit the dealer premium cost and obtain the lowest product purchase price. In cases of mutual benefit, industrial dealers may reduce or sell directly.

In the waste treatment industry chain, the structure typically consists of upstream sanitation machinery and equipment, middle stream domestic waste collection and transportation, and downstream waste disposal and resource utilization. Due to the complexities and high costs associated with waste collection and transportation, downstream enterprises may opt to enter the middle stream. They can choose to collaborate with upstream sanitation machinery and equipment providers or directly purchase equipment to establish their sanitation service enterprises, offering an integrated one-stop service to eliminate unnecessary costs (Strange and Zucchella, 2017; Majeed and Rupasinghe, 2017; Dev et al., 2020).

5.4. Basic change role force: Change the boundary elements of the target industrial chain

According to the book 'Gray Wolf Effect', altering any of the three main elements of the industrial chain boundary—the target customer side, the target producer side, and the target product category—will result in changes to the industrial chain boundary and the supply and demand structure.

Moreover, certain factors, such as the emergence of regional production enterprise clusters in the industrial chain, may lead to the integration of production by local chain owners (often the government), resulting in an oligopoly (Vendrell-Herrero et al., 2017; Al Humdan et al., 2020). The concept of a 'chain master' could then become a fundamental force in reshaping roles within the chain.

In the white tea industry chain market of Fuding, Fujian Province, a cluster of tea producers such as Pinpinxiang, Tianhu, Guangfu, Liumiao, Yuda, and Ruida has emerged. The production enterprises in Fuding have formed a production cluster, with the Fuding Municipal Government playing a dominant role. The government has implemented supportive policies to bolster these enterprises (Helo and Hao, 2019; Strandhagen et al., 2022; Govindan, 2018; Genovese et al., 2017), making it the key factor influencing the supply and demand dynamics of the Fuding white tea market and driving the development of the Fuding white tea industry chain.

The concept of 'basic role change force' emerges in the carbon neutral industry chain, where advancements in technology can disrupt traditional markets. For instance,

in the construction industry, new green building technologies that align with carbon emission goals and offer comparable costs to traditional methods with longer service life can transform the market. This disruptive technology acts as the fundamental force driving change in the construction industry chain.

5.5. Scene service ecological power: As long as a scene exists, a new ecology can be created

In the book 'Gray Wolf Effect', it is explained that in the target market of an industrial chain, there are two types of scene services for both customers and producers. The first type is scene services related to the products of the industry chain's market. The second type is high-frequency rigid demand scene services that are not directly related to the market products of the industry chain.

In real life, the most common scenario is the first one, where a specific service provider offers support services to customers purchasing products in the industrial chain market. These services vary based on procurement times and geographical locations, ensuring successful product delivery. This service can be categorized into pre-sale and after-sales scenes based on the purchase timing.

Scene services are ubiquitous across industrial chains, including the tea industry. For example, tea farmers require various production materials like weeders, hoeing machines, pesticide watering cans, and fertilizers (Hong et al., 2018). Specific service providers are crucial for offering scene services such as maintenance, installation, and debugging of these tools. Similarly, tea manufacturing enterprises rely on production machines and need service providers for maintenance, installation, and debugging. Lastly, tea shops provide services like consultation, tea tasting, and packaging to customers.

Connecting a specific service role in the tea industry chain creates an ecosystem that not only offers scene services but also enters the market of the original target customers (Masi et al., 2017). This impacts the structure of the industrial chain and generates a scene ecological force. For instance, service providers offering machine maintenance to tea manufacturing enterprises may collaborate with machinery enterprises to enter the tea manufacturing market. This collaboration alters the role of tea manufacturing enterprises in the chain, ultimately creating an ecological force within the tea industry chain.

5.6. Industrial chain strategy is the base colour for outlining the five industrial chain forces

Corporate strategy encompasses various aspects, including marketing, development, brand, and talent strategies (Parida et al., 2019; Tönnissen and Teuteberg, 2020), leading to its continual expansion. This expansion is driven by aligning the corporate strategy with the enterprise's current environment and long-term development objectives. In response to market demands, enterprises must adopt strategic approaches, with industry chain strategy remaining crucial for navigating competition and fostering win-win industrial cluster environments.

Type 1: Network-centric strategy

This type of business strategy maintains the health of its ecosystem by having specific behaviours that affect the entire system (Marić and Opazo-Basáez, 2019). In the business ecosystem, the core network enterprise acts as the regulator. They connect individual members of the ecosystem and provide a stable and predictable development platform to improve the diversity and productivity of the entire system. The importance of core network enterprises is self-evident: their healthy operation represents the health of the entire ecosystem, and their disappearance will directly lead to the collapse of the ecosystem.

Web core enterprises must perform the following three things (**Figure 8**) to promote ecosystem health.

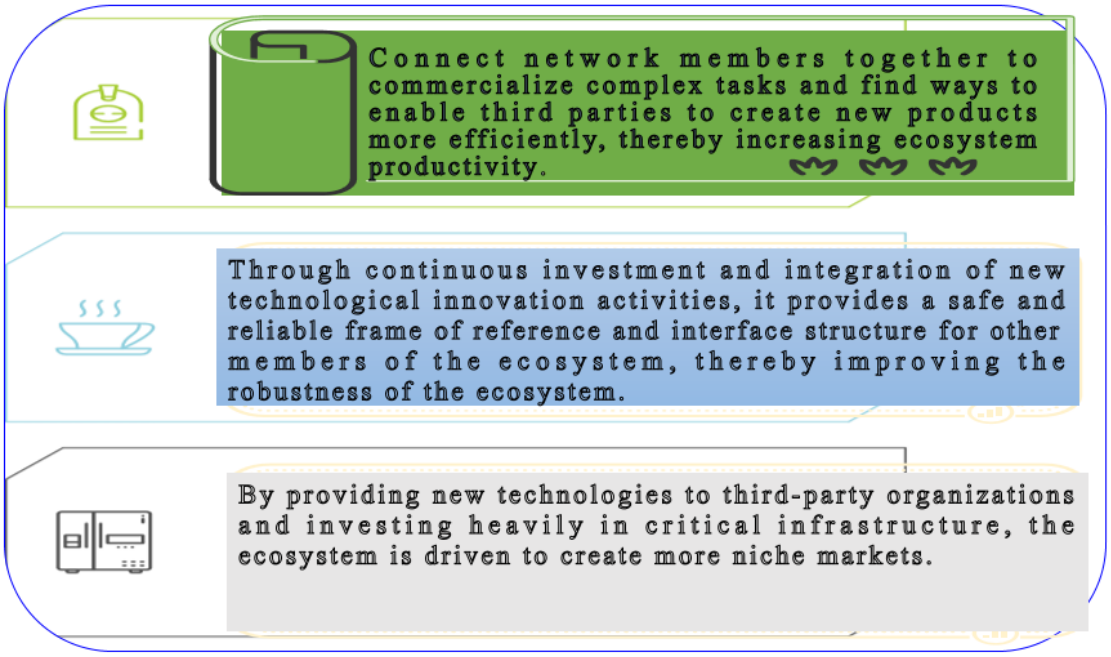

Figure 8. Top three steps that network-centric enterprises take to promote ecosystem health.

Consider the computer ecosystem, which is a network of thousands of hardware manufacturers, software developers, consultants and IT departments. Microsoft has a pivotal position in this ecosystem and is undoubtedly the core of this network (Maddikunta et al., 2022; Ehie and Ferreira, 2019). Microsoft Corporation has the following key strategic characteristics:

(1) Productivity. (a) Improve the productivity of software manufacturers as the core of the strategy: Microsoft's first product is a tool to help develop other products, namely the basic shrink for the Multimedia Interactive Telelearning System (MITS) Altair computer, which was quickly adopted by all the major microcomputer manufacturers at the time; (b) Continuous product innovation and product feature improvement: from P-code progressive programmer to the introduction of Visual Forms, which is the advent of programming components; (c) Promote the high utilisation and reuse of solutions created by other developers in various methods, such as the development of Visual Basic controls and ActiveX technologies, and integrate these techniques into the development of highly available tools.

(2) Robustness. The stability of the application programming interface is crucial because it can reduce the cost of software programming work and ensure that the software can run on different operating systems. To this end, Microsoft aims to not only broaden and innovate the application programming interface but also to ensure that the old instincts are unaffected. In addition, Microsoft supports and develops more than 50 other different standards, such as Bluetooth technology (Bluetooth), Universal Plug-n-Play(UPnP) (Ehie and Ferreira, 2019; Pellegrino et al., 2019).

(3) Niche market creativity. A firm with an effective network core strategy searches for numerous ways to create new niche markets that enhance diversity in the ecosystem. Microsoft actively joins the Internet ecosystem through a neutral language, as well as through Hyper Text Transfer Protocol (HTTP) and Simple object Access protocol (SOAP) standards to set up firewalls, and uses Extensive Markup Language (XML) to promote data exchange and help enterprises and products avoid the threat of networking. Therefore, Microsoft can create niche markets in the computing ecosystem.

The network core strategy has two core key elements, which can only be successfully created in the basic operating strategy of the enterprise (**Figure 9)**.

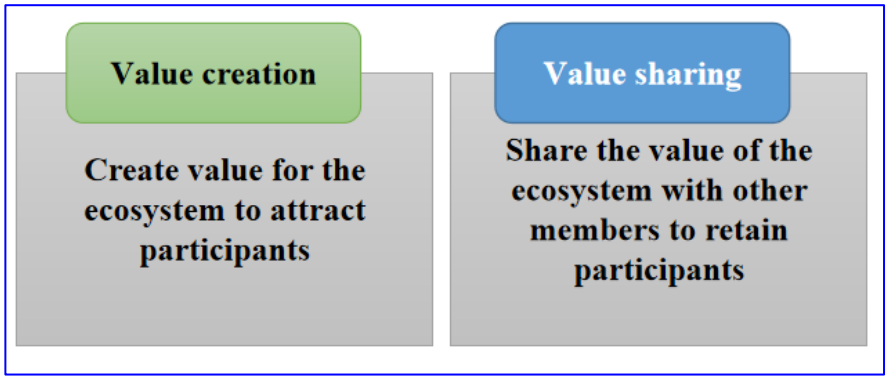

Figure 9. Two key elements of a network-centric strategy.

Type 2: Dominance strategy

Enron's rapid decline serves as a cautionary tale for enterprises. To prevent a similar fate, adopting a dominant strategy can be key. This strategy involves managing and controlling a business ecosystem through vertical and horizontal integration to maximize internal value creation and acquisition (Pellegrino et al., 2019; Müller and Voigt, 2018; Mangla et al., 2017). By dominating both value creation and distribution activities, companies can secure a central position in the ecosystem. Dominant firms aim to eliminate competitors in their immediate ecosystem and gradually expand their control. Through market exclusion and expansion into new territories, they seek to establish dominance or eliminate rivals. Examples of dominant enterprises include Tencent and Alibaba.

Several similar enterprises, such as Jingdong, provide consumers with a full set of products and services to completely address their needs, leaving no opportunities for other enterprises to develop new products and services with the help of their own. When purchasing products on Jingdong, Jingdong provides all logistics and after-sales services, avoiding the opportunity for other logistics and after-sales service companies to enter the Jingdong ecosystem to obtain new business.

(1) Innovation and productivity. Dominant enterprises occupy most of the value of the entire ecosystem. However, they also bear the responsibility of creating most of the value in the ecosystem. Companies pursuing this strategy are typically vertically integrated and responsible for their innovation. Thus, high internal efforts and productivity in Research and Development (R&D) and operations increase the value that they can deliver and ultimately capture (Tönnissen and Teuteberg, 2020; Marić and Opazo-Basáez, 2019; Maddikunta et al., 2019).

(2) According to the discussion, dominant firms in a market either control all niche markets themselves or prevent other firms from creating them. This limits the emergence of creative diversity in niche markets within the ecosystem. While this suppression hampers diversity, it also assumes responsibility for value creation and dominates niche markets, albeit limiting diversity itself. As a result, the overall number of functions provided by the ecosystem remains unchanged, but the methods of providing these functions become less diverse. Eliminating unnecessary diversity from a productivity perspective ensures ecosystem stability and avoids issues like incompatibility or excess in products or technologies (Maestrini et al., 2017).

(3) Ensure robustness. In response, the dominant firm builds a stable ecosystem for which it is fully responsible. However, the firm can ensure the presence of only one core, which is borne by a single firm and guarantees the stability of the ecosystem. This method is relatively simple and easy to operate, and the possibility of external influence is low. However, disadvantages also exist; over time, resilience is lacking in the presence of shocks, such as disruptions in the product architecture, due to the lack of diversity.

Type 3: Slit strategy

The majority of Small and medium-size enterprises (SME) in the ecosystem employs an operational strategy focused on capability specialization, differentiating themselves within the ecosystem. For instance, in the carbon-neutral industry, various enterprises, including new energy batteries, photovoltaic, and hydropower companies, operate independently but with a focus on specialized niche processes like lithium battery manufacturing or wind power. These smaller enterprises, known as ‘slits,’ may not be as large as dominant firms but contribute to the ecosystem through their specialized expertise.

Slit enterprises have the following three characteristics (**Figure 10**):

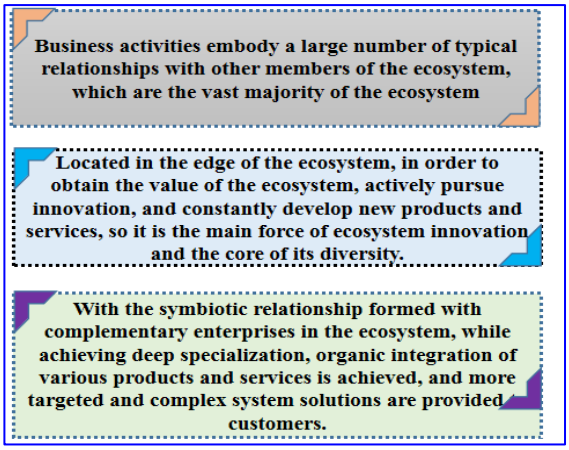

Figure 10. Three characteristics of a niche enterprise.

A niche business can gain a foothold in the ecosystem through the following three key elements:

(1) Improve productivity. A niche business can maximise the resources in the ecosystem built by the network core enterprises (Elmobarak et al., 2023; Ahmadi et al., 2017), solve problems in the production process and ultimately markedly improve their productivity.

(2) Form core competitiveness. The business allows its products to have differentiated characteristics and form a brand, which is achieved by deep specialisation in unique capabilities that support and complement other businesses in the ecosystem.

(3) Continuous innovation. Integrating various technologies available in the ecosystem facilitates constant innovation to avoid elimination by highly advanced niche enterprises and meet additional needs.

6. Promote multi-industry coupling and collaboration, reconstruct the 'carbon neutral' industrial chain and realise the entire chain and chain length systems

The integrated and coordinated development of multiple industries will be promoted. The core of multi-industry integration includes the incorporation of agricultural processes, engineering processes, product systems, energy systems, transportation systems and other industrial utilisation levels to achieve spatial coupling and integration of the entire chain, from small to large, from resources to recycling.

To achieve highly effective win-win cooperation, it is essential to start with the entire production chain, education, and government research. Concentric cooperation can establish an industrial base, create a layout for the entire industrial chain, and attract upstream and downstream enterprises for cluster development (Dujak and Sajter, 2019; Al Humdan et al., 2020). Activities like industrial partner conferences can promote industrial development, address key issues, and engage relevant enterprises. Establishing joint laboratories, industry alliances, and collaborations between industry, academia, government, and research institutions can drive innovation. Additionally, creating enabling platforms for industrial development, organizing exchanges, and setting up industrial funds based on successful cases can help achieve strategic goals and foster rapid industry growth.

7. Conclusion

In the context of 'double carbon', the high-dimensional industry must not only undertake the responsibility of breaking through the national high-quality field but also strive to focus on the industrial ecological chain of the main line of high-quality development (Tang, 2021; Hussain et al., 2018). Thus, the core competitiveness of the high-dimensional industry can be improved. Therefore, high-dimensional industries must initially perform the following: develop high-end, diversified and low-carbon industries; encourage the integrated development of multi-industries; accelerate the pace of pollution and carbon reductions; maximise the utilisation of resources; accelerate the carbon sequestration cycle and green low-carbon transformation of

digital enabling industries; lead the low-carbon development of high-dimensional industries; and promote the ecological development of the entire industrial chain. Therefore, promoting the formation and normal operation of modern industrial ecology at the institutional level is necessary. Secondly, encouraging ecological development from multiple levels, such as industrial layout optimisation and enterprise, industrial chain and industrial structure adjustment, enhancing the green development capability of high-dimensional industrial parks and ushering in technological innovation in the carbon neutral development of high-dimensional industries, are necessary. Thirdly, these industries must also perform the following: strengthen publicity and guidance; create a good public opinion atmosphere for the ecological development of high-dimensional industries; establish and improve the ecological evaluation system of high-dimensional industries; enhance the support policy for the development of the 'carbon neutral' industrial chain (Dolgui et al., 2019; Khan et al., 2018); and provide support for the green and low-carbon special equipment, technological transformation and comprehensive utilisation of resources for high-dimensional industries.

Through the research on the strategy remodeling mechanism of high-dimensional industry eco-economy and the reconstruction of carbon neutral industry chain, we draw the following conclusion: carbon neutral industry chain reconstruction is the key to promote the development of high-dimensional industry eco-economy. By reducing carbon emissions, improving resource utilization efficiency and promoting green transformation, the reconstruction of carbon neutral industrial chain can promote the sustainable development of high-dimensional industrial ecological economy, and achieve a virtuous circle of economic growth and ecological environmental protection. At the same time, the introduction of ecological values is the core of the strategic reconstruction of high-dimensional industrial ecological economy. In the process of carbon neutral industrial chain reconstruction, the introduction of ecological values and the emphasis on the importance of ecological environment can promote the optimization and upgrading of industrial structure, promote green technology innovation, and achieve a win-win situation between economic and ecological benefits. Most importantly, cooperation between government, business and society is the key to implementing carbon neutral industrial chain restructuring. The government should introduce policies and regulations, provide policy support and incentive measures; Enterprises should strengthen technology research and development, promote internal management innovation (Khan et al., 2018); Society should raise awareness of environmental protection and actively participate in carbon emission reduction actions. Only with the cooperation of all parties can we achieve the goal of reshaping the ecological economy strategy of high-dimensional industries and restructuring the carbon neutral industrial chain, and promote the realization of green and sustainable development.

Author contributions: Conceptualization, ZS and GT; methodology, ZS; software, ZL; validation, YG, JW and ZS; formal analysis, ZL; investigation, GT; resources, GT; data curation, YG; writing—original draft preparation, ZS; writing—review and editing, GT; visualization, ZL; supervision, JW; project administration, ZS; funding

acquisition, ZS. All authors have read and agreed to the published version of the manuscript."

Funding: This research was funded by [Major Humanities and Social Sciences Research Projects in Zhejiang higher education institutions], grant number [2023QN154]. The APC was funded by [Zhejiang Provincial Department of Education].

Conflict of interest: The authors declare no conflict of interest.

References

Ahmadi, H. B., Kusi-Sarpong, S., & Rezaei, J. (2017). Assessing the social sustainability of supply chains using Best Worst Method. Resources, Conservation and Recycling, 126, 99-106. https://doi.org/10.1016/j.resconrec.2017.07.020

Al Humdan, E., Shi, Y., Behnia, M., & Najmaei, A. (2020). Supply chain agility: a systematic review of definitions, enablers and performance implications. International Journal of Physical Distribution & Logistics Management, 50(2), 287-312. https://doi.org/10.1108/ijpdlm-06-2019-0192

Attia, A., & Salama, I. (2018). Knowledge management capability and supply chain management practices in the Saudi food industry. Business Process Management Journal, 24(2), 459-477. https://doi.org/10.1108/bpmj-01-2017-0001

Bag, S., Telukdarie, A., Pretorius, J. C., & Gupta, S. (2021). Industry 4.0 and supply chain sustainability: framework and future research directions. Benchmarking: An International Journal, 28(5), 1410-1450.

Bai Q. (2021). Building a green, low-carbon and circular economic system is a key measure to achieve carbon peak and carbon neutrality. China Energy, 3, 52-54.

Benzidia, S., Makaoui, N., & Subramanian, N. (2021). Impact of ambidexterity of blockchain technology and social factors on new product development: A supply chain and Industry 4.0 perspective. Technological Forecasting and Social Change, 169, 120819. https://doi.org/10.1016/j.techfore.2021.120819

Blomsma, F., & Brennan, G. (2017). The emergence of circular economy: a new framing around prolonging resource productivity. Journal of industrial ecology, 21(3), 603-614. https://doi.org/10.1111/jiec.12603

Chen, L., Msigwa, G., Yang, M., et al. (2022). Strategies to achieve a carbon neutral society: a review. Environmental Chemistry Letters, 20(4), 2277-2310. https://doi.org/10.1007/s10311-022-01435-8

Dev, N. K., Shankar, R., & Qaiser, F. H. (2020). Industry 4.0 and circular economy: Operational excellence for sustainable reverse supply chain performance. Resources, Conservation and Recycling, 153, 104583. https://doi.org/10.1016/j.resconrec.2019.104583

Dolgui, A., Ivanov, D., Sethi, S. P., & Sokolov, B. (2019). Scheduling in production, supply chain and Industry 4.0 systems by optimal control: fundamentals, state-of-the-art and applications. International journal of production research, 57(2), 411-432.

Dujak, D., & Sajter, D. (2019). Blockchain applications in supply chain. SMART supply network, 21-46.

Ehie, I., & Ferreira, L. M. D. (2019). Conceptual development of supply chain digitalization framework. IFAC-PapersOnLine, 52(13), 2338-2342. https://doi.org/10.1016/j.ifacol.2019.11.555

Elmobarak, W. F., Almomani, F., Tawalbeh, M., et al. (2023). Current status of CO2 capture with ionic liquids: Development and progress. Fuel, 344, 128102. https://doi.org/10.1016/j.fuel.2023.128102

Erboz, G., Yumurtacı Hüseyinoğlu, I. Ö., & Szegedi, Z. (2022). The partial mediating role of supply chain integration between Industry 4.0 and supply chain performance. Supply Chain Management: An International Journal, 27(4), 538-559. https://doi.org/10.1108/scm-09-2020-0485

Genovese, A., Acquaye, A. A., Figueroa, A., & Koh, S. L. (2017). Sustainable supply chain management and the transition towards a circular economy: Evidence and some applications. Omega, 66, 344-357. https://doi.org/10.1016/j.omega.2015.05.015

Govindan, K. (2018). Sustainable consumption and production in the food supply chain: A conceptual framework. International Journal of Production Economics, 195, 419-431. https://doi.org/10.1016/j.ijpe.2017.03.003

Gu, M., Xia, X. (2023). The "Carbon neutral" theme warming organization focuses on the new energy industry chain. China Business Journal, B03.

Helo, P., & Hao, Y. (2019). Blockchains in operations and supply chains: A model and reference implementation. Computers &

industrial engineering, 136, 242-251. https://doi.org/10.1016/j.cie.2019.07.023

Herczeg, G., Akkerman, R., & Hauschild, M. Z. (2018). Supply chain collaboration in industrial symbiosis networks. Journal of cleaner production, 171, 1058-1067. https://doi.org/10.1016/j.jclepro.2017.10.046

Herold, D. M., Ćwiklicki, M., Pilch, K., & Mikl, J. (2021). The emergence and adoption of digitalization in the logistics and supply chain industry: an institutional perspective. Journal of Enterprise Information Management, 34(6), 1917-1938. https://doi.org/10.1108/jeim-09-2020-0382

Hong, J., Zhang, Y., & Ding, M. (2018). Sustainable supply chain management practices, supply chain dynamic capabilities, and enterprise performance. Journal of cleaner production, 172, 3508-3519. https://doi.org/10.1016/j.jclepro.2017.06.093

Hussain, M., Ajmal, M. M., Gunasekaran, A., & Khan, M. (2018). Exploration of social sustainability in healthcare supply chain. Journal of Cleaner Production, 203, 977-989. https://doi.org/10.1016/j.jclepro.2018.08.157

Khan, S. A. R., Zhang, Y., Anees, M., et al. (2018). Green supply chain management, economic growth and environment: A GMM based evidence. Journal of Cleaner Production, 185, 588-599. https://doi.org/10.1016/j.jclepro.2018.02.226

Lambert, D. M., & Enz, M. G. (2017). Issues in supply chain management: Progress and potential. Industrial marketing management, 62, 1-16. https://doi.org/10.1016/j.indmarman.2016.12.002

Liu, Q. H. (2022). The development of Hengli chemical fiber industry chain under the background of "dual carbon". Modern Silk Science and Technology, (Z1), 22-24.

Lüdeke-Freund, F., Gold, S., & Bocken, N. M. (2019). A review and typology of circular economy business model patterns. Journal of Industrial Ecology, 23(1), 36-61. https://doi.org/10.1111/jiec.12763

Maddikunta, P. K. R., Pham, Q. V., Prabadevi, B., et al. (2022). Industry 5.0: A survey on enabling technologies and potential applications. Journal of Industrial Information Integration, 26, 100257. https://doi.org/10.1016/j.jii.2021.100257

Maestrini, V., Luzzini, D., Maccarrone, P., & Caniato, F. (2017). Supply chain performance measurement systems: A systematic review and research agenda. International Journal of Production Economics, 183, 299-315. https://doi.org/10.1016/j.ijpe.2016.11.005

Majeed, A. A., & Rupasinghe, T. D. (2017). Internet of things (IoT) embedded future supply chains for industry 4.0: An assessment from an ERP-based fashion apparel and footwear industry. International Journal of Supply Chain Management, 6(1), 25-40.

Manavalan, E., & Jayakrishna, K. (2019). A review of Internet of Things (IoT) embedded sustainable supply chain for industry 4.0 requirements. Computers & industrial engineering, 127, 925-953. https://doi.org/10.1016/j.cie.2018.11.030

Mangla, S. K., Govindan, K., & Luthra, S. (2017). Prioritizing the barriers to achieve sustainable consumption and production trends in supply chains using fuzzy Analytical Hierarchy Process. Journal of cleaner production, 151, 509-525. https://doi.org/10.1016/j.jclepro.2017.02.099

Marić, J., & Opazo-Basáez, M. (2019). Green servitization for flexible and sustainable supply chain operations: A review of reverse logistics services in manufacturing. Global Journal of Flexible Systems Management, 20, 65-80. https://doi.org/10.1007/s40171-019-00225-6

Masi, D., Day, S., & Godsell, J. (2017). Supply chain configurations in the circular economy: A systematic literature review. Sustainability, 9(9), 1602. https://doi.org/10.3390/su9091602

Müller, J. M., & Voigt, K. I. (2018). Sustainable industrial value creation in SMEs: A comparison between industry 4.0 and made in China 2025. International Journal of Precision Engineering and Manufacturing-Green Technology, 5, 659-670. https://doi.org/10.1007/s40684-018-0056-z

Nasir, M. H. A., Genovese, A., Acquaye, A. A., et al. (2017). Comparing linear and circular supply chains: A case study from the construction industry. International Journal of Production Economics, 183, 443-457. https://doi.org/10.1016/j.ijpe.2016.06.008

Parida, V., Sjödin, D., & Reim, W. (2019). Reviewing literature on digitalization, business model innovation, and sustainable industry: Past achievements and future promises. Sustainability, 11(2), 391. https://doi.org/10.3390/su11020391

Pellegrino, R., Costantino, N., & Tauro, D. (2019). Supply Chain Finance: A supply chain-oriented perspective to mitigate commodity risk and pricing volatility. Journal of Purchasing and Supply Management, 25(2), 118-133. https://doi.org/10.1016/j.pursup.2018.03.004

Remko, V. H. (2020). Research opportunities for a more resilient post-COVID-19 supply chain–closing the gap between research findings and industry practice. International Journal of Operations & Production Management, 40(4), 341-355. https://doi.org/10.1108/ijopm-03-2020-0165

Strandhagen, J. W., Buer, S. V., Semini, M., et al. (2022). Sustainability challenges and how Industry 4.0 technologies can address them: a case study of a shipbuilding supply chain. Production Planning & Control, 33(9-10), 995-1010. https://doi.org/10.1080/09537287.2020.1837940

Strange, R., & Zucchella, A. (2017). Industry 4.0, global value chains and international business. Multinational Business Review, 25(3), 174-184. https://doi.org/10.1108/mbr-05-2017-0028

Su, L. T. (2022). Research on the path of bilateral collaborative high-quality development of energy supply and demand under the background of carbon neutrality. Journal of Jiamusi Vocational College, 10, 52-54.

Tang, J. (2021). Accelerating the transformation and upgrading of key industries to help "carbon neutrality" step into the fast lane. Leadership Science Forum, (04), 106-114. https://doi.org/10.19299/j.cnki.42-1837/C.2021.04.013

Temper, L., Demaria, F., Scheidel, A., et al. (2018). The Global Environmental Justice Atlas (EJAtlas): ecological distribution conflicts as forces for sustainability. Sustainability Science, 13(3), 573-584. https://doi.org/10.1007/s11625-018-0563-4

Tönnissen, S., & Teuteberg, F. (2020). Analysing the impact of blockchain-technology for operations and supply chain management: An explanatory model drawn from multiple case studies. International Journal of Information Management, 52, 101953. https://doi.org/10.1016/j.ijinfomgt.2019.05.009

Uehara, T. (2013). Ecological threshold and ecological economic threshold: Implications from an ecological economic model with adaptation. Ecological Economics, 93, 374-384. https://doi.org/10.1016/j.ecolecon.2013.06.014

Ulucak, R., & Khan, S. U. D. (2020). Determinants of the ecological footprint: role of renewable energy, natural resources, and urbanization. Sustainable Cities and Society, 54, 101996. https://doi.org/10.1016/j.scs.2019.101996

Velenturf, A. P., & Purnell, P. (2021). Principles for a sustainable circular economy. Sustainable Production and Consumption, 27, 1437-1457. https://doi.org/10.1016/j.spc.2021.02.018

Vendrell-Herrero, F., Bustinza, O. F., Parry, G., & Georgantzis, N. (2017). Servitization, digitization and supply chain interdependency. Industrial Marketing Management, 60, 69-81. https://doi.org/10.1016/j.indmarman.2016.06.013

Wang, C. (2022). Solving the dilemma of high energy consumption of data centers and realizing the goal of carbon neutrality in the whole industrial chain. 21st Century Business Herald.

Wibowo, M. A., Handayani, N. U., & Mustikasari, A. (2018). Factors for implementing green supply chain management in the construction industry. Journal of Industrial Engineering and Management (JIEM), 11(4), 651-679. https://doi.org/10.3926/jiem.2637

Xue, L., Xiao, L. (2020). Understanding and Suggestions for formulating the 14th Five-Year Plan and medium and long term development plan of China's energy low-carbon. International Petroleum Economics, 12, 1-10.

Yang, J. (2021). Energy industry chain and supply chain need to be reshaped to achieve carbon peak carbon neutrality. China Energy, 9, 14-19.

Zou, C., Xiong, B., Xue., H, et al. (2021). The role of new energy in carbon neutral. Petroleum exploration and development, 48(2), 480-491. https://doi.org/10.1016/S1876-3804(21)60039-3