

Exploring the Solutions of Sustainable Product Design: An ESG Perspective

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Abstract. In order to achieve "peak carbon emissions and carbon neutrality" in 2030 and 2060, every Chinese enterprise needs to take practical actions. However, for most manufacturing enterprises, the use of recyclable resources faces problems such as high costs, low acceptance, and information asymmetry, resulting in an unsatisfactory actual utilization rate. This article applies the perspective of ESG evaluation to explore how enterprises can develop sustainable development approaches that are in line with their own culture and current situation from three aspects. After comparing and summarizing different kinds of experiences of foreign and domestic companies, it is pointed out that Chinese enterprises cannot directly replicate foreign experience. Instead, they should explore a unique cooperative product design strategy by adopting modular design, building recyclable material data platforms, and constructing innovative usage scenarios.

Keywords. ESG sustainability innovation modularity information platform

1. Introduction

Since the global agreement on the United Nations Sustainable Development Goals (SDGs) in 2015, sustainable development has become a global consensus and a key demand of the international community. In the business field, the concept of sustainable development is summarized as more a specific ESG framework. Actually, the concept of ESG (Environment, Society, and Governance) was jointly proposed by the United Nations Environment Programme (UNEP) and Social Responsibility International (SRI) in 2005. It is an evaluation system that covers the comprehensive consideration of environmental protection, social responsibility, and corporate governance by enterprises¹. In today's corporate development process, ESG involves not only ethical obligations for achieving sustainable development, but also key factors for investors, consumers, and regulatory agencies to evaluate company performance. The development of a company cannot be separated from the innovation of business models and core products, so ESG, as an evaluation system, also needs to revolve around these two factors. On the path of ESG implementation, due to differences in resource endowments, institutional policies, and cultural environment, and so on, there will be significant differences in the strategic positions and action plans of foreign and domestic companies in carrying out business models and product innovation design. Some companies prioritize environmental protection and use recyclable materials to reflect ESG, while others focus on social responsibility and collaborate with upstream and downstream enterprises to reflect ESG.

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Numerous scholars have gradually realized that ESG can play a very important role in mitigating corporate risks, enhancing reputations, and attracting a broader investment combination². Notably, it also opens doors to innovative opportunities and a competitive edge in the market. Especially for Chinese enterprises in the transitioning period, they are facing many new challenges including cost factors, technical barriers, consumer culture, and supporting policies³. Of course, challenges mean difficulties and also opportunities. In the overseas market, ESG has emerged as an evaluation system and a philosophy of growth based on public awareness and market consciousness, developing gradually from the grassroots level. Conversely, in the Chinese market, ESG, as an imported concept, has traversed the path from non-existence to establishment, representing a transformative force that has taken hold from the outside and is now influencing the inside. Initially, Chinese companies were compelled to adopt and respond to this concept in a passive manner. However, with the widening acceptance of ESG in the Chinese market, an increasing number of enterprises have begun to embrace it, implementing it while also reflecting on it. These companies have come to recognize the true value of ESG. Since the ESG ecosystem in China is still in the early stages of construction, for many Chinese companies, how to effectively integrate ESG into operations and explore commercial and social value from it is a challenge that lies ahead. Therefore, this article will explore the product design strategies which are the basic practices within the ESG framework by analyzing and comparing foreign and domestic experiences.

2.Product Design in the ESG Context

Product design methodology determines the underlying logic of enterprise product research and development. Traditional product design starts from meeting the needs of consumers in the market, but may neglect the public's demand when there is a conflict. In 1971, American designer Papanech published "Design for the Real World"⁴, strongly criticizing design solely for commercial gain, advocating that designers abandon fancy, unsafe, immature, and useless products, save limited resources, and assume the responsibility of rational design. As a result, sustainability oriented design emerged and became a hot topic of debate in the field of product design. Over time, scholars such as Don Norman have further expanded the concept of sustainable design and proposed "ecological design"⁵, emphasizing the importance of product life-cycle analysis and reducing resource consumption. It is pointed out that design should consider the entire life-cycle of the product, including the stages of manufacturing, use, and disposal, in order to minimize the impact on the environment as much as possible⁶. This laid the foundation for the rise of transition design. Transition design was first proposed by British design scholar Stuart Walker in the early 2010s. He elaborated how design can serve as a tool for gradually transition to a more sustainable approach⁷, with a particular emphasis on the cultural and social background of design, as well as the relationship between design and social values.

Although sustainable design, ecological design, and transition design may have slightly different approaches and objectives, they all share a common focus on the sustainability of enterprise and society. Often requiring interdisciplinary cooperation, these concepts span multiple fields and consider a range of influencing factors. In this trend, ESG has emerged as a global consensus in response to concerns about a range of sustainability challenges facing our planet. With the escalating urgency to address issues such as climate change, environmental degradation, and social inequality, ESG has

become an integral framework for sustainable development and responsible investing. More importantly, ESG has evolved into the current important language system for international cooperation. As the demand for sustainable business practices grows, ESG has become a common denominator that enables businesses, governments, and other stakeholders to work together towards a more sustainable future. By incorporating ESG factors into decision-making processes, organizations can take a comprehensive approach to managing risks, improving reputation, and creating long-term value. With the globalization of ESG, it has also opened up new opportunities for cross-border cooperation and knowledge sharing. Therefore, it is essential for organizations to integrate ESG perspectives into their daily operations, strategic planning, business models and product design to stay relevant in today's fast-paced business environment. By embracing ESG, organizations can contribute to a more sustainable future while also mitigating risks, enhancing reputation, and creating long-term value for all stakeholders. In a country like China, with a large population and limited resources, these concepts are particularly important. ESG has emerged as a set of quantifiable evaluation indicators, particularly for listed companies, with over 60% of Fortune 500 companies releasing ESG reports each year. In this context, enterprises need to integrate ESG perspectives into the product design and development process not only to meet certain regulations but also to explore more immense markets.

3. Dilemma and chances in ESG context

At present, due to factors such as geopolitical, trade frictions, technological iteration, and evaluation standards, the concept of ESG itself has been discussed continuously, but its sustainable development proposition remains the core value of certainty. Moreover, in terms of capital, products, supply chain, technology, and other aspects, the characteristics of globalization are still significant, and an international perspective is the key to achieving long-term sustainable development for enterprises. Even for Chinese companies that have not been directly involved, their products, services, and solutions may still enter the global market through China's vast industrial manufacturing chain. Therefore, it is necessary for Chinese enterprises to consider the ESG value and direction of action from a global perspective. Currently, as China's development model is gradually shifting from one based on scale and speed to one based on quality and efficiency, the Chinese economy is entering a new stage of development. In this context, the core values of ESG—economic prosperity, environmental sustainability, and social equity—are highly aligned with important strategies such as high-quality development, common prosperity, and achieving the "Dual Carbon" goals (peak carbon emissions and carbon neutrality). With this trend, the development objectives of enterprises have also shifted from pursuing economic benefits alone to pursuing the co-development of both economic and social benefits⁹.

At present, for Chinese A-share listed companies, the disclosure of ESG reports is not a mandatory task. However, in line with the mainstream requirements of the developing trends of domestic and international ESG, an increasing number of listed companies are preparing to release ESG information. It is often referred to as "Environmental, Social and Governance Report (ESG)", "Social Responsibility Report (CSR)", "Sustainable Development Report (SDR)" and the combination of relevant keywords when such information is disclosed. A total of 581 listed companies in A-shares have issued ESG reports, 947 listed companies have issued CSR reports, 82 Shanghai companies have issued SDRs, and 104 listed companies are named after

keyword combinations such as "ESG", "social responsibility", and "sustainable development". according to the data from the "2022 ESG Action Report of Chinese Listed Companies" released by the International Research Institute of Green Finance at the Central University of Finance and Economics, 1455 out of all 4917 A-share listed companies have disclosed ESG or the related reports in 2022. Among these, 869 out of 2174 companies are from the Shanghai Stock Exchange and 586 out of 2743 companies are from the Shenzhen Stock Exchange.

Table 1. Disclosure of ESG Reports for All A-share Listed Companies in 2022

Stock Market	Disclosure Number	Disclosure Ratio
A-share listed companies	455	29.6%
Shanghai Stock Exchange	869	40.0%
Shenzhen Stock Exchange	586	21.4%

It seems that not all listed companies have yet paid attention to ESG, but the proportion of companies in the Shanghai and Shenzhen 300 that publish ESG reports is 86%. It can be seen that the actively traded and liquid corporate securities reflect the trend of ESG practice. Unfortunately, the information disclosed in existing ESG reports is still incomplete. In the 2023 ESG index of The Economist Intelligence Unit/EIU, China ranks 120th out of 150 countries/regions.

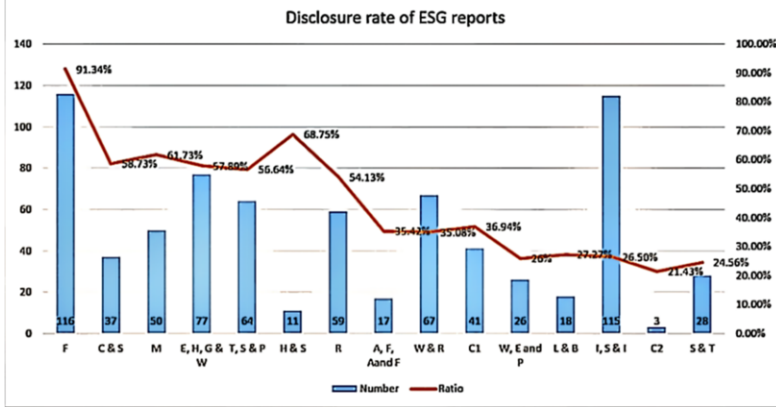


Figure 1. Disclosure rate of ESG reports for A-share listed companies

F:Finance.C&S:Culture&sports.M:Mining.E,H,G&W:Electricity,heat,gas&water.T,S&P:Transportation,storage&postal services. H&S:Health&social work. R:Real estate. A,F,A&F:Agriculture, forestry, animal husbandry&fishery. W&R:Wholesale & retail. C1:Construction. W,E&P:Water conservancy, environment & public facilities management. L&B:Leasing & business services. I,S&I:Information transmission, software & information technology services. C2:Comprehensive. S&T:Scientific research & technology services.

From the above figure, it can be seen that the top three industries in China with good ESG report disclosure are as follows: the finance industry, culture&sports industry, and mining industry. These data from the "2022 ESG Action Report of Chinese Listed Companies" shows the number and ratio of ESG reports released in China's fifteen major industries in 2022. The data of manufacturing industry isn't shown in the picture. Since 1005 manufacturing companies had released ESG related reports which was far higher than the other industries, but the disclosure ratio is only 28.86%. The low ratio may caused by the cost of using recyclable materials, technological limitations, market demand, and cultural factors¹⁰. Besides, ESG evaluation system may bring changes in corporate culture and management systems, as sustainable design requires comprehensive organizational adjustment and employee training. Furthermore, for listed

companies, short-term market performance will be directly and quickly reflected in the company's market value. Therefore, many sustainable development projects that require long-term and large-scale investment will inevitably encounter many difficulties.

When ESG disclosure becomes mature, companies may fall into a dilemma of "business as usual". For companies, ESG reports are only a microcosm of ESG work, requiring rich practical cases and excellent performance data as support. If ESG report writing is regarded as the core or even the entire ESG work, and internal management and practical actions remain unchanged, the quality of ESG disclosure will be low and unable to meet the needs of stakeholders. For example, ESG reports lack quantitative and comparable data, and lack support from ESG cases, which makes it difficult for them to be recognized by investors and other stakeholders. In addition, with stricter regulation, the requirements for the quality of ESG disclosure and the credibility of disclosed information will become higher and higher. Therefore, more and more Chinese companies urgently need to improve the quality of ESG disclosure through internal ESG transformation and actual programs. Especially, the design of business model and the related products or services should be combined with the ESG factors to bring multiple user experiences, new opportunities and long-term competitiveness. In a word, it is hard but necessary to take ESG strategy as the lead.

4.Product Design in the ESG Context

4.1. ESG Paradigm overseas: Apple's story

Apple was once under heavy social pressure due to the report "The Other Side of Apple". But it has taken a series of measures to change this situation and has since become a leading example in the field of ESG following several years of practices. Based on the analysis of Apple's 2022 ESG report, it is evident that the company's ESG action is a systematic and comprehensive solution.

On the one hand, Apple has set a goal of achieving carbon neutrality by 2030, which is more proactive than most companies around the world. This goal covers all facets of the company, including research and development of recyclable materials, product design, supply chain management, product manufacturing, product logistics, product maintenance, energy usage, and the like. Apple is also promoting renewable energy in its global operations, such as through the use of solar and wind energy. As a company where over 80% of its total revenue is generated through hardware products, it needs to pay more attention on supply chain management, procurement of raw materials, product cycle management, as well as user privacy, data security, and so on. It reduces carbon emissions by carefully selecting materials, improving material utilization, and enhancing product energy efficiency. Additionally, it pursues various opportunities to improve energy efficiency and reduce energy consumption in its facilities and supply chain, including renovations. For example, Apple has gradually expanded the use of recycled aluminum in product material selection through research on aluminum metallurgy. Currently, according to Apple's ESG report, the casings of Apple's Apple Watch Series 7, MacBook Air, MacBook Pro, iPad, and other products are made of 100% recycled aluminum metal. Therefore, Apple will achieve its carbon neutrality goal by 2030 through the design and application of new technologies, flexible financing using innovative financial structures, and rapid deployment of renewable energy. Moreover, Apple places significant emphasis on data privacy and security. The company has implemented strict data protection measures globally to ensure the security and privacy

of user data. Additionally, Apple actively engages in global data privacy standard development and regulatory activities, promoting the continuous improvement of data privacy and security levels across the industry.

On the other hand, Apple emphasizes economic inclusivity. The company supports small businesses and startups worldwide through investment and collaboration, with a focus on ethnic minorities and female entrepreneurs. Furthermore, Apple also helps people improve their skills and access to education. It has also formulated corresponding measures in terms of employee welfare and support for employee development. In its ESG report, it not only provides a detailed R&D process for sustainable materials but also elaborates on multiple training and support projects conducted by Apple around the world, fully reflecting the company's social responsibility and corporate governance level. The company has also implemented a range of practices to ensure pay equity at the intersection of race, ethnicity, and gender. To create a better work environment, Apple encourages open and honest communication among team members, managers, and leadership. The company also conducts regular surveys to gather feedback from employees, which serve as a valuable tool to assess how Apple is performing. In addition, Apple has built inclusion and diversity measures into its candidate assessment framework to promote a more inclusive workforce. In its report, Apple seems to have done a lot of efforts to reflect its social responsibility and corporate governance.

In conclusion, Apple's practices have shown a standard ESG framework and set a model to other listed companies. Consequently, Apple's ESG report has received widespread recognition and praise in the financial market. Investors appreciate the company's sustainable development strategy and diversification plan, believing that these measures aid in improving the company's long-term value and performance. At the same time, consumers also acknowledge and support Apple's performance in environmental, social, and governance aspects. Generally speaking, Apple's path is a self-driven, self-defined standard path. It can establish guidelines to require relevant suppliers and partners to jointly achieve the sustainable goals that Apple has set. This may seem idealistic and difficult to achieve for many Chinese companies. Apple is unique and hard to replicate directly because its position in the global industry chain determines its voice in the system. It can view itself as an externally compatible system and incorporate the resources it needs to acquire into its system. Just like the "big pig" in the game of intelligent pigs. Apple has pricing power, initiative, and can determine the timing of action. It can construct system rules and transfer risks through the system to obtain systematic benefits. In this context, product design has been assigned a more prominent leadership role, empowered by social responsibility and supported by organizational structures, and the avenues that product design can explore are also more diverse. However, most Chinese enterprises have not yet gained such competitive advantages in the industrial chain, and are in a relatively loose and diverse supply chain system. It's hard to implement the above approaches not because the willing but because the context. On the contrary, the product design strategy of the environmentally friendly suitcase project jointly developed by companies in China has to some extent solved the problems faced by ordinary enterprises and can become a highlight of ESG information disclosure.

4.2. ESG Paradigm in China: Runmi's story

As the world's largest manufacturing economy and commodity exporter, Chinese listed companies occupy a significant position within these supply chains. To maintain their

competitive edge in the export market, it is essential that they prioritize enhancing their ESG reporting and data transparency. However, the lack of specific implementation measures, especially a product or supply chain system that can reflect ESG factors, poses a significant challenge. In the process of Chinese path to modernization, ESG has enormous development potential. With the evolution and maturity of the ESG ecosystem, Chinese enterprises are gradually shifting from a "reactive" to a "proactive" mindset and moving beyond the "voluntary" disclosure phase. That's exactly the story of Runmi. Runmi Technology Ltd Company which is a Xiaomi Ecological Chain Company and produces high-tech tourism products. Its parent company is a listed company. As a leading e-commerce enterprise in the field of suitcases, Runmi is facing with a severe competitive environment and seeking market opportunities from different aspects persistently. Reducing costs and increasing efficiency is a common practice among Chinese enterprises such as Runmi. Using recyclable materials according to customary practices will inevitably lead to increased production costs and weakened market competitiveness. Runmi's designers solved this problem by sorting proper recyclable material, redefine the usage scenario and expand the application market of the material with the two other leading supplies. This process involves various stakeholders in the supply chain. For example, it needed to collaborate with upstream raw material suppliers such as Costron, one of the world's leading producers of high-quality polymers and their components. Moreover, it also required the cooperation of NONGFU Spring which is a packaging and drinking water & beverage enterprise in the upstream supply chain. Costron has the ability to purify the recyclable material to the new one. NONGFU Spring focuses on recycling the water barrels. In this default scenario, the cost of recyclable materials is likely to be higher than that of new materials. So in this way, whoever adopts the purified recyclable material will have a pressure of high material cost. So manufacturers' enthusiasm for using recyclable materials is bound to be low. However, Runmi finds a new market and a new usage for such materials. If there is a new definition and innovative application of the use of recyclable materials, the corresponding standards for recyclable materials will also change. Recyclable materials are only need to be suitable for new scenarios. The characterization of impurities can be a distinctive feature in product design, which can assist companies in developing new product styles and brand narratives without increasing the cost of cleanliness. In result, one blue ocean market is opened up.

Another crucial aspect of the process is the information flow. This collaborative process involves many companies, with each company's decisions and actions being influenced by the previous one. To enhance collaborative efficiency, it is imperative to establish a transparent and traceable recycling value chain jointly. In this process, it is essential for companies to collaborate seamlessly in terms of system, personnel, and communication. In particular, the project leaders, designers in this case, must play a pivotal role in clarifying material standards and synchronizing relevant data information to ensure the achievement of project goals. This is significantly distinct from Apple's global approach, as it fully embodies corporate social responsibility and demonstrates corporate governance by engaging with the local community. Additionally, further exploration and editorialization of the aforementioned information can elevate it to a prominent feature in the company's ESG report. As a result, Runmi utilized the material derived from the recycled water barrels of NONGFU Spring. Covestro transformed the recycled materials into the specific standards required by Runmi. On this basis, Runmi developed a range of low-carbon and environmentally friendly suitcases. This move is highly compatible with the travel and lifestyle of the new generation of consumers under

the Runmi brand, enriching the brand image and helping Runmi open up new markets while garnering attention and profits in the capital market. This is not only a culmination of corporate brand enhancement, but also an illustration of companies fulfilling their social responsibility. If the seeds of utilizing recyclable materials can be sewn into consumer awareness through product iteration, it is also a means to implement environmental protection strategies.

Table 2. Tasks of each company during the innovation process

RUNMI	↔	COVESTRO	↔	NONGFU
Set material requirements		Process the material		Build recycling systems
Define product concept		Test material properties		Collect water barrels
Produce "ESG" suitcases		Provide related certificates		Transport recycled materials

By refining the design strategy of this suitcase with distinct ESG attributes (as illustrated in Figure 2), it was discovered that in this sustainable design endeavor, particularly the collaborative process, the modularity of product design thinking serves as the foundation. Designers can select materials based on distinct modules. For instance, although the performance of PC materials recycled by Costron from NONGFU Spring may not be as good as the original PC or PCR materials (such as cleanliness, particle size, and other standards), these "non-standard" features can also become a distinctive form of travel suitcases that caters to the novel and specific needs of its target customers. In this way the recycling approach itself is not the key problem.

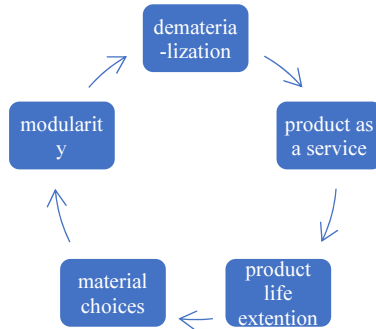


Figure 2. Design Strategy in ESG context

Furthermore, due to the significant risk of data loss in enterprise-to-enterprise information exchange, the establishment of digital industry frameworks and platforms holds paramount importance. Organizations need to leverage digital discourse structures and systems to achieve information transparency and efficient integration. When designers collaborate with diverse departments of different enterprises in research and development, they must be able to discern stakeholder requirements and offer innovative solutions to meet product design objectives in the ESG context. Ultimately, collaborations between companies also involve a clash and reconciliation of distinct governance structures, necessitating more standardized operational procedures. Hence, it is imperative for companies to recognize the importance of such cooperation and allocate the necessary resources to facilitate it. In particular, robust communication is essential to confirm comprehension and implementation of the standards. Especially designers need to integrate business strategies to achieve goals.

5. Conclusion

ESG is not just an evaluation system, but a set of thought tools. The core components of these are consistent, but the implementation approach varies, as there are many roads leading to Rome. According to the SCP theory of industrial economics, the industrial structure determines corporate behavior and corresponding performance. The paths taken by different enterprises in implementing ESG for their own product design and development depend on their respective backgrounds and structural locations. It is not advisable to blindly copy the so-called advanced experiences when implementing ESG. Instead, they need to carefully analyze their own situations and explore distinctive roads. As the environment rapidly changes for many Chinese companies, there are significant differences in industrial foundations. There are many obstacles to implementing the ESG concept and adopting the method of independently building closed systems. Therefore, taking the path of collaborative innovation with other enterprises is a worthwhile direction to explore.

Firstly, it is imperative to bridge the professional expertise of upstream and downstream participants and implement recycling strategies through essential knowledge and technological transactions. Additionally, the value-added aspirations of enterprise production activities must be seamlessly integrated with sustainable development objectives (such as environmental protection, social responsibility, and organizational governance, and so on), thereby constructing a mechanism and standard for the involvement of diverse stakeholders. This can be achieved by exploring sustainable value opportunities and value exchange relationships at various stages of the product life-cycle. In a word, the core evaluation indicators need to be unified. To truly unlock the potential of ESG value, enterprises must abandon opportunism, adhere to first principles, and focus on creating social value. By making continuous investments and refinements, they can reap the benefits that ESG brings.

Secondly, it is necessary for enterprises to expedite the digital transformation. The digitization of enterprises reflects a shared, open, and co-creative approach to digital thinking. By employing the aforementioned mechanism, enterprises can interface with digital platforms and establish specific digital sharing among collaborative organizations, facilitating consensus-building and decision-making. Since collaborative partners are interconnected, data from upstream companies directly affects product decisions in downstream companies. Especially in the consumer market, the agility and readiness of data platforms also determine an enterprise's accurate feedback to market information. Apart from physical information sharing, a fair and amicable cooperation atmosphere is necessary. In particular, data security is a concern since each company's data contains its own trade secrets. Therefore, a collaborative platform must ensure data fluidity while maintaining the most basic level of reliability and traceability. Establish an ESG digital management system within the enterprise. Besides, the application of ESG digital management system can improve the efficiency of enterprise ESG management, especially the smoothness and timeliness of ESG information and data flow within the enterprise, and high-quality ESG data is also a prerequisite for high-quality ESG reports. In this regard, ESG digitization can provide important support for the formulation, execution, supervision, optimization, and transparency of ESG strategies for enterprises.

Thirdly, modularity becomes the initial layout logic of the design. By dematerializing and modularizing the design, the standards for material selection, application scenarios, and traceability paths can be addressed at the source. However, it is worth noting that the level of granularity in modularity determines the efficiency of

information flow between enterprises and the cost of management. This requires designers involved not only to have a product-oriented mindset but also to adopt a systemic, project-oriented mindset. They need to consider a product not only as a standalone product but also as a service system; and then explore a sustainable product design path that aligns with the company's actual situation and reflects the company's various values amidst complex information. While design may not be omnipotent, it can be transformed and enhanced through training. Especially in the age of AI, designers need to utilize tools to improve efficiency while continuously improving the self-awareness, expanding their boundaries and tapping into resources to drive enterprise innovation.

Currently, while ESG information disclosure remains a focal point for the majority of Chinese companies, an increasing number of Chinese enterprises are realizing that ESG information disclosure needs to be founded on high-quality ESG management and practice. Furthermore, outstanding ESG performance can assist companies in establishing competitive advantages in areas such as financial connectivity, market competition, talent attraction, and brand influence. This transformation arises from the company's deep understanding of the essence of ESG, as well as from learning from global best-practice cases. For the Chinese market, ESG is an imported concept that showcases global universality while also exhibiting discontinuities, such as environmental protection, low-carbon, circular economy, fairness, inclusiveness, data privacy, and corporate governance rationality. When ESG takes root and grows in China, it is necessary to fully consider China's unique cultural background and social foundation, as each country is at a different stage of development and attaches importance to different issues. Therefore, enterprises should consider both the global market and localization when implementing ESG practices.

Acknowledgment

This article is sponsored by the campus research initiation project of Shanghai Publishing and Printing College.

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