Research on the Challenges and Strategies of Carbon Neutral Transition for Small and Medium-Sized Clothing Manufacturing Enterprises in China

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Abstract. Driven by global carbon neutrality goals, the clothing industry, as a high-emission manufacturing sector, is facing transformation pressures. This paper systematically explores the practices, challenges, and social implications of SMEs in achieving carbon neutrality through case studies of three representative companies—Apple, ANTA, and Bosideng—combined with in-depth interviews with a medium-sized clothing factory and a survey of 100 consumers. This paper finds that carbon neutrality is not only policy-driven but is gradually becoming an important source of corporate competitiveness; consumers show a certain willingness to pay for low-carbon products, but their awareness needs to be enhanced through clear and visible information. Considering the realistic constraints of SMEs in terms of funding and technology, this paper proposes strategies to promote the transformation and upgrading of clothing enterprises from contract manufacturing to a green value chain, thereby contributing to sustainable development goals.

Keywords: Small and medium-sized clothing enterprises, carbon neutral transition, green supply chain, consumer awareness, low-carbon premium.

1. Introduction

Given the changes in the climate of China and the growing need for resources and protection of the environment worldwide, many countries have established the aim of carbon neutrality in the future. By 2030, China will peak carbon emissions and strive for carbon neutrality by 2060; at the same time, it will promote green development of all sectors in the economy. Oil is a source of greenhouse gases; otherwise, the textile and clothing industry is the main source of emissions around the world, and it has released about 230 million tonnes of carbon dioxide each year in China and accounts for roughly 2% of China's total carbon emissions. Reduce carbon emissions in the transition period for the "dual carbon" goals. The clothing industry is an essential part of China's real economy, one of the largest in the world with more than 70 billion items produced annually and accounting for over half of global output, and it is mainly carried out by small and micro enterprises at a rate of 99.8%. Although these enterprises are relatively small in scale, their total carbon emissions are considerable; generally speaking, they face problems such as a lack of advanced technology, insufficient funds and weak environmental awareness, and thus their transformation needs and opportunities have a certain degree of overlap.

At the same time, people are more concerned about environmental protection now. Research has shown that 63% of consumers want brands with a strong environmental image, 51% would avoid companies engaged in greenwashing, and abroad, such as in the EU, carbon tariffs and supply chain due diligence have been implemented to reduce emissions from suppliers. Under the pressure of both domestic and foreign factors, small and medium-sized clothing enterprises are now required to achieve carbon neutrality in their transition; otherwise, they will be unable to meet the needs of the market and develop sustainably. Small and medium-sized enterprises in the industry do not have clear paths or replicable models at present. At present, some transformation paths that align with the specific circumstances of these groups have not been explored, and consumer insights need to be collected [1-2].

Transformation paths for small and medium-sized clothing enterprises under the goal of carbon neutrality are the subject of this paper. These companies will proactively achieve carbon neutrality in

advance of the leading enterprises around the world, rather than being compelled to reduce emissions by laws and regulations; instead, in light of the changing times, they can set a carbon-neutral goal and develop corresponding strategies. Based on the consumer research data above, this paper will explore the public's awareness and demand for carbon-neutral products, as well as their willingness-to-pay, to offer reference for adjustments in the enterprise's strategy due to changing market conditions. Given the limited funds and weak technology of small and medium-sized apparel enterprises, this paper proposes specific low-cost, feasible strategies that can help small and medium-sized apparel enterprises achieve emission reduction and improved profitability simultaneously, based on case studies and consumer insights, addressing a deficiency in the current industry.

2. Research Methods and Data Sources

This paper employs a mixed-methods approach, combining qualitative case analyses with quantitative surveys to enhance both the depth and reliability of the research. Firstly, three companies-Apple (a benchmark in cross-industry technology), Anta (a leading sports brand in China), and Bosideng (a representative in the down jacket industry)—were selected for case studies. Through publicly available reports (such as ESG reports) and literature, their practices in carbon neutrality strategies, technological innovation, supply chain management, and market communication were systematically examined. Secondly, semi-structured interviews were conducted with the owner of a medium-sized clothing factory in Guangdong Province, China, focusing on their understanding of carbon neutrality, existing environmental measures, challenges faced, and future plans, to gain firsthand industry insights. Thirdly, 100 valid questionnaires were collected online from consumers, covering their awareness of carbon neutrality, environmentally conscious consumption preferences, willingness to pay, and attitudes toward corporate environmental actions. This diversified data sourcing ensures that the research findings are both theoretically robust and closely aligned with industry realities.

3. In-depth analysis of enterprise cases

As a leader in the technology industry, Apple’s practice in carbon neutrality transformation provides an important reference for other industries. Apple has achieved 100% renewable electricity in all its facilities around the world and is heavily using recycled materials in its product design, with 24% of its products coming from recycled or renewable sources in 2024. What is more noteworthy is that Apple has promoted the use of clean energy by more than 300 suppliers through its supply chain clean energy project, achieving emission reductions across the value chain. This transformation model, with technological innovation at its core and supply chain collaboration, demonstrates how large enterprises can turn environmental requirements into competitive advantages.

As a representative of the domestic sporting goods industry, ANTA Group has adopted a step-by-step, pragmatic and feasible strategy in the transformation of carbon neutrality. ANTA has set a strategic goal of ‘1+3+5’ to increase the proportion of sustainable products to 50% by 2030. In actual operation, ANTA has achieved a balance between product cost and environmental performance through technological innovations such as carbon capture technology and recycled PET materials. For example, although the cost of quick-drying clothes using carbon capture technology has increased by 22%, through the technical label of carbon reduction of 28.4%, the product price is 15% higher than that of ordinary models, which still becomes a market hit, which fully proves consumers’ willingness to pay for environmentally friendly products. ANTA has also established a comprehensive supplier management system and conducted ESG audits for more than 800 suppliers to promote the overall green transformation of the supply chain.

As a leading enterprise in China’s down jacket industry, Bosideng has made significant breakthroughs in material innovation. The company’s self-developed 100% bio-based nylon fabric has a 23% lower carbon footprint than traditional materials and won the ISPO Global Trend Award.

Bosideng has proposed a '1+3+X' sustainability framework with the goal of achieving net-zero emissions at the operational level by 2038. Similar to Apple and Anta, Bosideng also focuses on transforming environmental protection attributes into market competitiveness through product certification and carbon labeling. Although the price of its down jacket made of carbon capture fabric is 15% higher than that of ordinary models, due to environmental labels and technical advantages, sales have exceeded expectations, exceeding 500000 pieces in 2024.

From the transformation practices of these three companies, it can be seen that successful carbon neutrality transformation requires integrating environmental protection concepts into various aspects such as corporate strategy, product design, supply chain management, and marketing. These companies have achieved a cognitive shift from treating environmental protection as a cost item to transforming it into a growth engine, and transforming environmental protection advantages into market competitive advantages through technological innovation, supply chain collaboration and brand building.

4. The Real Challenges for Small and Medium-sized Enterprises

In the interest of learning about the difficulties small and medium-sized apparel enterprises face in their pursuit of carbon neutrality, this paper has conducted in-depth interviews with one such medium-sized clothing factory. This enterprise has about 400 employees and is typical of other enterprises in the industry. Based on the above information, the transition will have many difficulties for small and medium-sized enterprises.

4.1. Awareness of Carbon Neutrality

At the level of cognition, business owners are generally unaware of carbon neutrality and do not consider reducing environmental pollution in such a manner. Although they are aware that the environment needs to be protected, they do not fully understand the reasons for the need, specific measures in action, and future benefits under carbon neutrality. Therefore, there is limited awareness of the changes at the top level.

4.2. Environmental Practices and Transformation Dilemmas

Small and medium-sized enterprises at the practical level are constrained by funds and equipment; therefore, only low-cost, simple measures such as installing LED lamps or using fabric scraps are feasible. Although the above measures will achieve some cost reductions and environmental benefits, they are still far from achieving carbon neutrality. The business owner indicated that eco-friendly materials are relatively high-cost; organic cotton is approximately 50% more expensive than traditional fabric, and downstream customers are generally unwilling to bear the additional cost, so the company has no incentive to use green materials [3].

The first is a financial shortage that prevents a reform. Equipment upgrades are worth several hundred thousand or even more than a million yuan and will be a significant expense for our company with a small profit margin. Although some subsidy policies have been introduced by the government, the application process is complicated and the requirements are too high; as a result, many small and medium-sized enterprises have not received practical support. The company does not offer professional guidance and technical support during the transition, so it must handle the process itself; thus, the risks and difficulties have increased.

The environment of the market has also changed in recent years for small and medium-sized enterprises. Foreign customers have high environmental standards; therefore, they are unwilling to sign a contract unless good environmental facilities are also available. Domestic customers pay less attention to the environment in their choices and, as a result, are less demanding in this regard. Therefore, the different markets will be operated in ways that differ greatly by the companies [4].

5. Consumer Awareness and Market Demand

5.1. Basic results of consumer survey

To understand consumers' attitudes toward carbon-neutral products and their willingness to pay, we conducted a questionnaire survey with 100 consumers. The survey results showed that 70% of respondents had heard of the concept of carbon neutrality, but their understanding of its specific connotations was limited, with scores concentrated between 1 and 3 (out of 5). This indicates that while the concept of carbon neutrality is relatively well-known, the depth of public understanding needs to be improved.

Consumers' Purchase behaviour is more likely to consider tangible and perceptible environmental indications, such as 'using 100% recyclable materials' and 'low-carbon production process', with mention rates of 31% and 37% respectively. On the other hand, the abstract label of a carbon-neutral company has a relatively small impact on purchasing behaviour. Therefore, to promote the image of environmental friendliness, the company needs to use more concrete and visually appealing ways, avoiding abstract language.

Among them, 63 per cent of the respondents are more likely to choose the product with a stronger environmental image in their comparison, and thus environmental factors have been exerting a pressure on their brand selection. However, due to their limited disposable income, the consumers' willingness to pay is relatively low; 73% of the respondents have monthly discretionary expenses of less than 1000 yuan and are more price-sensitive. The group of people who are willing to pay more for environmentally friendly products mainly consists of young people; they pay more attention to the social responsibility and environmental image of a brand.

Research shows that the public is now less likely to support environmental projects initiated by this enterprise; 36 per cent of the people surveyed would be more interested in purchasing products bearing a green label, while another 26 per cent do not view it as genuine advocacy and are uninfluenced by the initiative. As shown above, more than half of the people say they will no longer buy goods from environmentally conscious brands. Thus, the company needs to build the trust of the public; otherwise, these claims will fail to be convincing.

5.2. Insights from consumer survey on corporate carbon neutrality strategies

According to the survey results, young people are the main drivers of green consumption, but their acceptance of highly priced eco-friendly products is limited due to spending power constraints. Consumers pay more attention to concrete and verifiable environmental measures (such as recyclable materials and low-carbon processes) and have low trust in abstract concepts and marketing labels. Environmental integrity is crucial; greenwashing can significantly damage brand reputation and even provoke boycotts [5,6].

For companies, on the product side, a tiered eco-friendly product approach can be adopted: basic models with low-percentage recycled materials and controlled premium for the mass market, and premium models highlighting full-chain low-carbon certification to meet segmented demands. For consumer communication: use simple language to explain environmental measures (e.g., 1 T-shirt = recycled 3 plastic bottles) and enhance credibility through third-party certifications and public carbon footprint data. In marketing, avoid overpromotion and focus on small but concrete eco actions (such as waste recycling and energy-saving upgrades), and increase engagement through user participation activities (such as exchanging old clothes for discounts) to strengthen consumer recognition.

6. Transformation strategy and implementation path

Based on the analysis of enterprise cases and consumer surveys, combined with the actual situation of small and medium-sized enterprises, this paper proposes the following transformation strategies.

6.1. Transformation Strategy

SMEs should adopt a gradual transformation path, starting with measures with lower costs and faster results. First of all, projects with a short payback period can be carried out, such as lighting system transformation and equipment energy-saving upgrades, which can reduce operating costs while reducing energy consumption. At the same time, enterprises should establish a waste recycling system to convert production waste such as leftovers into secondary raw materials, which not only reduces waste treatment costs, but also creates new sources of value [7].

6.2. Certification and standardization

SMEs can give priority to applying for low-cost and highly recognized environmental certifications, such as OEKO-TEX® Standard 100 certification and GRS (Global Recycling Standard) certification. These certifications not only meet the environmental requirements of international customers but also enhance the market competitiveness of products. Especially for export-oriented enterprises, obtaining these certifications is a necessary condition for entering the European and American markets [8].

6.3. product strategy

Construct a product matrix with multiple tiers and introduce environmentally friendly products for all consumers at different levels. Use 15%-30% recycled materials in the production of basic products and maintain the original price to meet the demand for lower-priced goods by price-sensitive consumers. The upgraded product will use a relatively higher proportion of environmentally friendly materials and obtain carbon footprint certification to attract more environmentally aware consumers at a higher price. The layering strategy is used to enhance the environmental friendliness of products and increase market share gradually [9].

6.4. Market communication

The company can use a three-line label to inform consumers of the products' environmental protection features clearly and briefly. For example, the tag can indicate that 'this product uses 20% recycled fibre = 1.2kg less oil mined' to help consumers learn about the environmental protection effect of the product more intuitively. At the same time, the company can spread the environmental initiatives of its factories through short videos and other online media to boost public trust in the brand.

6.5. Supply chain coordination

SMEs can form a green procurement alliance jointly to reduce the cost of environmentally friendly materials through collective procurement. At the same time, the enterprise will set up a waste-exchange system and recycle resources. The cooperative mode can reduce the conversion expenses for individual enterprises and help promote the general improvement of the ecological quality of the area [10].

7. Conclusion

The carbon-neutral transformation of small and medium-sized clothing manufacturers in China is a systematic project that requires joint efforts from enterprises, the government, and consumers. By thoroughly analyzing the successful experiences of industry-leading companies and considering the practical challenges faced by SMEs as well as consumer demand characteristics, this paper proposes a series of feasible transformation strategies.

Research shows that successful transformation requires enterprises to integrate the concept of environmental protection into their overall development strategy, turning environmental requirements into market competitive advantages through technological innovation, supply chain collaboration, and brand building. For resource-limited SMEs, a gradual transformation path should be adopted, starting with low-cost, easy-to-implement measures and progressively improving environmental standards. At the same time, companies should make full use of policy support, strengthen industry cooperation, and reduce transformation costs.

Consumer surveys indicate that there is real demand for environmentally friendly products in the market, but enterprises need to convey the environmental value of their products in a transparent and visible manner based on integrity. Companies should avoid greenwashing and earn consumer trust through genuine environmental actions.

Looking ahead, with the implementation of international carbon tariff policies and the maturation of the domestic green consumer market, the carbon-neutral transformation of small and medium-sized clothing enterprises will face new opportunities. Companies that can adapt to trends and proactively transform will not only survive increasingly stringent environmental regulations but also gain new development opportunities in the wave of green consumption. From a broader perspective, the carbon-neutral transformation of SMEs is not only crucial for their own survival and development but also significant for achieving the national dual-carbon goals and promoting sustainable development in the industry.

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