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АНОТАЦІЯ

Є Цзяньфу. – **Управління стійкими бізнес-моделями Китаю в постпандемічний період.** – Кваліфікаційна наукова робота на правах рукопису. Дисертація на здобуття ступеня доктора філософії за спеціальністю 073 «Менеджмент». – Західноукраїнський національний університет, Тернопіль, 2025.

У дисертації відображено управління та практична еволюція моделей сталого розвитку в постпандемічному Китаї. Спираючись на теоретичні основи сталого розвитку та еталонні приклади з вітчизняних та міжнародних джерел, систематично побудувано комплексну систему оцінки, відібравши моделі сталого розвитку в управлінні транснаціональними інвестиціями в рамках ініціативи «Один пояс, один шлях» як типові приклади для всебічного дослідження того, як підприємства можуть подолати труднощі ринкового спаду та досягти довгострокового сталого розвитку в постпандемічний період. Це дослідження відповідає міжнародному консенсусу щодо інклюзивного зростання та зеленого розвитку, надаючи китайським підприємствам систематичну методологічну підтримку та практичні рекомендації для участі в глобальній конкуренції шляхом інтеграції передових концепцій та практичних інструментів управління еталонами.

Результати дослідження показали, що в постпандемічний період моделі сталого розвитку в різних регіонах та галузях промисловості Китаю демонструють чіткі відмінності в диверсифікації та структурні характеристики. З регіональної точки зору, східні прибережні райони, спираючись на зрілі ринкові механізми, сильний капітал та провідні переваги технологічних інновацій, сформували широкі, глибокі та надзвичайно ефективні різноманітні парадигми практики. Натомість, попри прориви в рамках просування національної політики, центральні та західні регіони стикаються з повільнішим прогресом через слабку економічну основу, єдині промислові структури та відставання у застосуванні технологій, що призводить до очевидних дисбалансів у регіональному розвитку. З галузевого виміру, високотехнологічні галузі, сучасні сектори послуг та сфери

цифрової економіки демонструють сильну інноваційну життєздатність, швидку ітерацію та високу адаптивність, тоді як традиційне виробництво та ресурсоємні підприємства стикаються з величезним трансформаційним тиском з численними структурними викликами у застосуванні моделей сталого розвитку. Дослідження показують, що поєднання моделей сталого розвитку та управління еталонами забезпечує реальні рішення для сприяння високоякісному економічному відновленню та структурній оптимізації в епоху після пандемії.

У дисертації інноваційно побудовано багатовимірну, тривимірну модель оцінки моделі сталого розвитку після пандемії, засновану на п'яти ключових вимірах: економічна стійкість, соціальна стійкість, екологічна стійкість, інноваційний рух та спеціальна співпраця «Один пояс, один шлях» для комплексної оцінки. Після стандартизації та нормалізації даних, всі значення основних показників рівномірно контролюються між 0 та 1, де координатна точка (0,0,0) представляє початковий стан, а (1,1,1) визначає ідеальний оптимальний стан. Ця модель утворює кубічну структуру в тривимірному просторі, поділену на вісім октантів, де статус розвитку підприємства або регіону точно представлений певними точками в просторі, а динамічні шляхи еволюції візуально представлені за допомогою кривих траєкторій, що складаються з різних часових вузлів. Завдяки широкому емпіричному аналізу даних дослідження показало, що шлях розвитку стійких бізнес-моделей демонструє загальну стабільну тенденцію до зростання, але демонструє періодичні коливання, на які впливають політична орієнтація, ринковий попит, технологічні інновації та фактори зовнішнього середовища, зі значними відмінностями в шляхах розвитку між різними суб'єктами. Поглиблений аналіз цих шляхів допомагає виявити вузькі місця в розвитку, удосконалити передовий досвід та забезпечити наукову основу для коригування стратегій підприємствами та урядами. За допомогою цієї моделі це дослідження збагачує теорію інновацій бізнес-моделей та створює теоретичну аналітичну основу та систему практичних рекомендацій з китайською специфікою.

Дослідження емпірично підтвердило, що створення наукових, комплексних та динамічних механізмів оцінки та управління є ключовим фактором для просування постпандемічної трансформації стійких бізнес-моделей для підприємств. Зокрема, кількісно визначені цілі розвитку, комплексні системи оцінки, ефективні механізми обмеження стимулювання та допоміжні політичні заходи можуть всебічно сприяти оптимізації бізнес-моделі підприємства та покращувати можливості сталого розвитку та конкурентні переваги. З точки зору управління бенчмарками, успішні глобальні приклади, такі як європейське управління зеленим ланцюгом поставок, північноамериканські моделі спільної економіки та японське бережливе виробництво, інтегроване з циркулярною економікою, у поєднанні з національними умовами Китаю, забезпечують багаті та практичні орієнтири для вітчизняних підприємств. Управління бенчмарками будує ефективні мости для китайських підприємств, щоб вони могли порівнювати свої показники з міжнародними стандартами та брати участь у глобальній конкуренції, встановлюючи міжкультурні стандарти оцінки та механізми обміну досвідом, допомагаючи покращити міжнародний імідж та голос китайських підприємств, сприяючи розвитку китайських рішень для глобального зеленого економічного відновлення.

Проведено емпіричні дослідження з використанням моделей сталого розвитку в управлінні транснаціональними інвестиціями в рамках ініціативи «Один пояс і один шлях» як ключових прикладів, виявляючи, що китайські підприємства стикаються з численними викликами, включаючи труднощі в комунікації через міжкультурні відмінності, ризики дотримання вимог через невідповідність екологічних стандартів у різних країнах, ризики порушення ланцюгів поставок та втручання геополітичних факторів. Однак вони також досягли значних проривів завдяки інноваціям у сфері технологічної співпраці, локалізованим операціям, розвитку талантів та участі громади. Дослідження вказує на те, що підприємствам необхідно постійно зміцнювати можливості та адаптивність інноваційних бізнес-моделей, балансувати економічні інтереси із соціальними та екологічними обов'язками, тоді як уряди повинні вдосконалювати політику підтримки для створення сприятливого зовнішнього середовища. Управління бенчмарками, як перевірений на практиці метод та інструмент оптимізації, забезпечує систематичну підтримку та керівництво для інноваційного проектування, впровадження та оптимізації моделей сталого розвитку.

Завдяки систематичному дослідженню розроблено моделі сталого розвитку підприємств після пандемії, що враховують мікро-, мезо- та макрорівні. На мікрорівні підприємства повинні зміцнювати системи внутрішнього управління та менеджменту, сприяти технологічним інноваціям та оптимізації процесів, а також створювати моделі сталого розвитку, орієнтовані на зелене виробництво та низьковуглецеві операції. На мезорівні необхідно створити відкриті та спільні платформи для співпраці в галузі, щоб сприяти обміну ресурсами та співпраці між підприємствами, що займають вищий та нижчий сегменти ринку, формуючи промислову екосистему з доброчесним циклом. На макрорівні уряди повинні вдосконалювати закони та нормативні акти, збільшувати фінансову підтримку та вдосконалювати механізми стимулювання для керівництва практиками сталого розвитку бізнес-моделей підприємств. Використовуючи методи та інструменти управління еталонами, підприємства можуть точно визначити свої сильні та слабкі сторони, вчитися на досвіді провідних підприємств для оптимізації бізнес-моделей, а також підвищувати адаптивність до ринку та довгострокові конкурентні переваги.

Запропоновано шлях інтеграції концепцій циркулярної економіки зі сталими бізнес-моделями та аналізується рушійна роль цифрової трансформації. Дослідження показали, що цифрові технології забезпечують технічну підтримку для сталих бізнес-моделей, знижуючи транзакційні витрати, оптимізуючи розподіл ресурсів, підвищуючи операційну ефективність та покращуючи обслуговування клієнтів. Тим часом концепції циркулярної економіки забезпечують стратегічний напрямок для реконструкції бізнес-моделі підприємств, заохочуючи підприємства переходити від лінійних моделей зростання до моделей циркулярного розвитку, досягаючи ефективного використання ресурсів та максимізації цінності. Поєднання цих двох концепцій допомагає підприємствам створювати унікальні конкурентні переваги, вирішувати ринкові виклики та ризики в постпандемічну епоху та досягати сталого високоякісного розвитку.

Запропоновано низку цілеспрямованих та практичних рекомендацій щодо системних питань розвитку сталої бізнес-моделі Китаю після пандемії, включаючи: посилення низхідного проектування на національному рівні, сприяння інноваціям та застосуванню зелених технологій, розвиток демонстраційних підприємств-еталонів та вдосконалення багаторівневих механізмів оцінки та нагляду. Вони забезпечують теоретичні основи та практичні рекомендації для китайських підприємств для досягнення високоякісного розвитку та підвищення міжнародної конкурентоспроможності після пандемії. Це дослідження має не лише важливу практичну цінність, але й значні теоретичні інновації, особливо в пропонуванні нових ідей та методів інтеграції концепцій циркулярної економіки, технологій цифрової трансформації та інновацій сталої бізнес-моделі, надаючи наукову підтримку для сприяння скоординованому економічному та соціальному розвитку та зеленій трансформації в Китаї.

Запропоновано комплексні, наукові та практичні контрзаходи та шляхи, включаючи: посилення проектування на вищому рівні та стратегічного планування, сприяння інноваціям та застосуванню зелених та низьковуглецевих технологій, розвиток демонстраційних підприємств-еталонів та вдосконалення стандартів оцінки та механізмів стимулювання нагляду. Вони забезпечують теоретичну основу та практичні рекомендації для китайських підприємств для досягнення сталого високоякісного розвитку. Це дослідження має важливу практичну цінність та теоретичні інновації, особливо в пропозиції нових проникливих методів інтеграції концепцій циркулярної економіки, технологій цифрової трансформації та інновацій у сфері сталого розвитку бізнес-моделей.

Концепція, що забезпечує міцну основу для сприяння скоординованому економічному та соціальному розвитку та зеленій трансформації в постпандемічному Китаї. Розглянуто адаптивні шляхи трансформації моделей сталого розвитку в різних культурних середовищах та інституційних середовищах з мультикультурної точки зору, надаючи практичні інструменти управління та стратегічні рамки для китайських підприємств, щоб виходити на глобальний рівень» та брати участь у глобальній конкуренції та співпраці.

Ключові слова: постпандемічний Китай, моделі сталого розвитку, стратегія управління, система оцінювання, ініціатива «Один пояс, один шлях», шлях розвитку, регіональні відмінності, відмінності в галузі, економічна стійкість, соціальна стійкість, екологічна стійкість, бенчмаркінговий менеджмент, трансформація підприємства, інвестиції, циркулярна економіка, цифровізація.

ANNOTATION

Ye Jianfu. – Management of China's post-pandemic sustainable business models. – Manuscript Qualification Research Paper. Dissertation for the Degree of Doctor of Philosophy in the Specialty 073 "Management". – Western Ukrainian National University, Ternopil, 2025.

This dissertation focused on the management and practical evolution of sustainable development models in post-pandemic China. Based on the theoretical foundations of sustainable development and reference examples from domestic and international sources, we systematically built a comprehensive evaluation system, selecting sustainable development models in the management of transnational investments under the "One Belt, One Road" initiative as typical examples for a comprehensive study of how enterprises can overcome the difficulties of the market downturn and achieve long-term sustainable development in the post-pandemic period. This study is in line with the international consensus on inclusive growth and green development, providing Chinese enterprises with systematic methodological support and practical guidance to participate in global competition by integrating advanced concepts and practical benchmark management tools. The results of the study show that in the post-pandemic period, sustainable development models in different regions and industries in China show clear differences in diversification and structural characteristics. From a regional perspective, the eastern coastal areas, relying on mature market mechanisms, strong capital and leading advantages in technological innovation, have formed broad, deep and highly effective diverse practice paradigms. In contrast, despite the breakthroughs in national policy promotion, the central and western regions face slower progress due to weak economic fundamentals, uniform industrial structures and lagging behind in technology application, leading to obvious imbalances in regional development. From the industry perspective, high-tech industries, modern service sectors and digital economy sectors show strong innovation vitality, rapid iteration and high adaptability, while traditional manufacturing and resource-intensive enterprises face huge transformation pressure with multiple structural challenges in the application of sustainable development models. Research

shows that the combination of sustainable development models and benchmark management provides real solutions to promote high-quality economic recovery and structural optimization in the post-pandemic era.

The thesis innovatively builds a multi-dimensional, three-dimensional evaluation model of the post-pandemic sustainable development model based on five key dimensions: economic sustainability, social sustainability, environmental sustainability, innovation movement and special cooperation of the Belt and Road for comprehensive evaluation. After data standardization and normalization, all the values of the main indicators are uniformly controlled between 0 and 1, where the coordinate point (0,0,0) represents the initial state, and (1,1,1) defines the ideal optimal state. This model forms a cubic structure in three-dimensional space divided into eight octants, where the development status of an enterprise or region is precisely represented by certain points in space, and the dynamic evolution paths are visually represented by curved trajectories consisting of different time nodes. Through extensive empirical data analysis, the study found that the development path of sustainable business models shows an overall stable upward trend, but exhibits periodic fluctuations influenced by political orientation, market demand, technological innovation, and external environmental factors, with significant differences in development paths between different entities. An in-depth analysis of these paths helps to identify development bottlenecks, improve best practices, and provide a scientific basis for enterprises and governments to adjust strategies. With this model, this study enriches the theory of business model innovation and establishes a theoretical analytical framework and a system of practical recommendations with Chinese characteristics.

Research empirically confirms that the establishment of scientific, comprehensive and dynamic evaluation and management mechanisms is a key factor for promoting the post-pandemic transformation of sustainable business models for enterprises. In particular, quantified development goals, comprehensive evaluation systems, effective incentive constraint mechanisms and supporting policy measures can comprehensively promote the optimization of the enterprise's business model and improve sustainable development capabilities and competitive advantages. From the perspective of benchmark management, successful global examples such as European green supply chain management, North American sharing economy models and Japanese lean manufacturing integrated with circular economy, combined with China's national conditions, provide rich and practical guidelines for domestic enterprises. Benchmark management builds effective bridges for Chinese enterprises to compare their performance with international standards and participate in global competition, establishing cross-cultural evaluation standards and experience sharing mechanisms, helping to improve the international image and voice of Chinese enterprises, and promoting the development of Chinese solutions for global green economic recovery. Empirical studies have been conducted using sustainable development models in transnational investment management under the Belt and Road Initiative as key examples, finding that Chinese enterprises face numerous challenges, including communication difficulties due to cross-cultural differences, compliance risks due to inconsistent environmental standards in different countries, supply chain disruption risks, and geopolitical interference. However, they have also achieved significant breakthroughs through innovation in technological cooperation, localized operations, talent development, and community participation. The study indicates that enterprises need to continuously strengthen the capabilities and adaptability of innovative business models, balance economic interests with social and environmental responsibilities, while governments should improve support policies to create a favorable external environment. Benchmark management, as a proven optimization method and tool, provides systematic support and guidance for the innovative design, implementation and optimization of sustainable development models.

Through systematic research, the post-pandemic sustainable development models of enterprises should consider the micro, meso and macro levels. At the micro level, enterprises should strengthen internal governance and management systems, promote technological innovation and process optimization, and create sustainable development models focused on green production and low-carbon operations. At the meso level, it is necessary to establish open and shared platforms for industry cooperation to promote resource sharing and cooperation between enterprises

occupying the upper and lower market segments, forming an industrial ecosystem with a virtuous cycle. At the macro level, governments should improve laws and regulations, increase financial support, and improve incentive mechanisms to guide the sustainable development practices of enterprises' business models. By using benchmarking methods and tools, enterprises can accurately identify their strengths and weaknesses, learn from the experiences of leading enterprises to optimize business models, and enhance market adaptability and long-term competitive advantages.

This thesis also examines the way to integrate circular economy concepts with sustainable business models and analyzes the driving role of digital transformation. Research shows that digital technologies provide technical support for sustainable business models, reducing transaction costs, optimizing resource allocation, increasing operational efficiency, and improving customer service. Meanwhile, circular economy concepts provide a strategic direction for the reconstruction of enterprises' business models, encouraging enterprises to move from linear growth models to circular development models, achieving efficient use of resources and maximizing value. The combination of these two concepts helps enterprises create unique competitive advantages, address market challenges and risks in the post-pandemic era, and achieve sustainable high-quality development.

A series of targeted and practical recommendations are proposed on systemic issues for the development of China's sustainable business model after the pandemic, including: strengthening top-down design at the national level, promoting innovation and application of green technologies, developing demonstration model enterprises, and improving multi-level evaluation and supervision mechanisms. They provide theoretical foundations and practical recommendations for Chinese enterprises to achieve high-quality development and enhance international cooperation.

Keywords: post-pandemic China, sustainable development models, management strategy, evaluation system, Belt and Road Initiative, development path, regional differences, industry differences, economic sustainability, social sustainability, environmental sustainability, benchmarking management, enterprise transformation, investment, circular economy, digitalisation.

СПИСОК ОПУБЛІКОВАНИХ ПРАЦЬ ЗА ТЕМОЮ ДИСЕРТАЦІЇ

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CONTENT

INTRODUCTION

Relevance of the topic. Relevance of the topic. In the post-pandemic era, the global economic landscape is undergoing profound adjustments. Market demand is shrinking, supply chains are being restructured, and consumption concepts are transforming—creating unprecedented challenges for business survival and development. Sustainable business models, with value co-creation at their core, balance social value and environmental responsibility while achieving economic growth. These models have become a key pathway for businesses to overcome difficulties and build long-term competitiveness. Benchmarking management, as a scientific tool for optimizing practices and enhancing efficiency, provides systematic methodological support for the innovative design and implementation of sustainable business models. Exploring the management of China's post-pandemic sustainable business models carries significant practical guidance value and theoretical innovation significance.

Sustainable business models and benchmarking management effectively address development problems in the post-pandemic period that have intensified due to dependence on traditional growth models. Sustainable business models help enterprises achieve resilient development during economic downturns by reconstructing value propositions, optimizing resource allocation, and innovating profit models. Benchmarking management identifies gaps and shortcomings by measuring against international best practices, extracts successful experiences, and promotes the adaptive application of sustainable business models across different industries and regions, accelerating enterprise transformation. The combination of these approaches provides a feasible solution for high-quality economic recovery in the post-pandemic era.

Theoretically, benchmarking management provides a fresh analytical perspective for sustainable business model research. As an emerging field, the theoretical system of sustainable business models remains incomplete, particularly lacking systematic interpretation for the post-pandemic context. The established theories of benchmarking management in performance evaluation and process optimization provide theoretical references for analyzing the components, operating mechanisms, and evolutionary patterns of sustainable business models. In-depth research on post-pandemic sustainable business model management can enrich business model innovation theory and construct a theoretical framework with Chinese contextual characteristics.

Benchmarking management offers practical guidance for governments and enterprises to advance sustainable business models. For enterprises, it precisely identifies strengths and weaknesses in sustainable development dimensions, facilitates learning from industry leaders to optimize business model design, and enhances market adaptability and risk resistance. For governments, benchmarking management identifies exemplary cases across regions and industries, informs differentiated policy measures, guides the formation of sustainable development ecosystems, and promotes industrial transformation and coordinated economic and social development.

From a global perspective, research on post-pandemic sustainable business model management responds to the international community's pursuit of inclusive growth. Sustainable development has become a global consensus, and Chinese enterprises need to develop adaptable sustainable business models in international initiatives like the "Belt and Road." Benchmarking management establishes cross-cultural evaluation standards and experience-sharing mechanisms, helping Chinese enterprises meet international standards and participate in global competition. This enhances China's international image and voice while contributing Chinese wisdom to global green economic recovery.

Many Chinese and foreign scholars have established foundations for sustainable business model theory and practice. Foreign scholars such as Sajid Amit et al. [1] examined sustainable business model construction in emerging economies through youth capability ecosystems; Juan Antonio Pavón Losada et al. [2] analyzed how business models drive sustainable development in food packaging; and Christian Tschiedel et al.[3] studied paradoxical tension management in cross-sector sustainable business models through urban energy transition cases. Among Chinese scholars, Zhou Linxie [4] explored sustainable business model innovation in digital-era news; Li Wei et and De Xiang Wu studied how developing countries achieve sustainability through business model innovation and climate finance; [5] and Xie Yi et al. [6] analyzed how sustainable orientation influences enterprise resilience. In "Belt and Road" research, Rebaka Sultana et al.[7] developed a value creation framework for sustainable e-learning business models in emerging markets, while Márcia Amado da Silva et al. [8] examined sustainable business model design in bioeconomy using Amazon rainforest enterprises as examples. These works provide important references for this research.

Among scholars studying sustainable business model evaluation systems, Fiza Amjad et al. [9] proposed an SME sustainable evaluation model based on crowdfunding and Industry 4.0; Ningshan Hao et al. [10] constructed a framework analyzing renewable energy and sustainable business models in the EU; and Roberto Cerchione et al. [11] established a classification system for sustainable crowdfunding business models. In circular economy integration research, Andra Teodora Gorski et al. [12] analyzed how circular economy drives sustainable business model transformation; and Iryna Zvarych et al. [13] situates the circular economy within the framework of alterglobalization, exploring how a more inclusive circular-economy paradigm can transcend the resource extraction and environmental externalities associated with conventional globalization, thereby enabling a regional-to-global transition toward sustainable development; Maryam Hina et al. [14] discussed circular economy business models as pillars of sustainable development; and Cemre Avşar et al. [15] studied how carbon emissions and waste management relationships affect business model design.

In post-pandemic context research, Haryati N [16] analyzed sustainable business model adjustments using the canvas model during the pandemic in Indonesia's mushroom industry; Yi Xie et al. [6] studied how digital business model innovation mediates between sustainable orientation and enterprise resilience; and Dipak Tatpuje et al. [17] proposed a sustainable entrepreneurship model addressing basic human needs. These studies reveal sustainable business model dynamics from different angles, but systematic research on China's post-pandemic context remains insufficient.

In post-pandemic research, Shvydka O. [1] examined sustainable development and business models by integrating ecological and social dimensions, highlighting challenges of adaptation in Ukraine’s wartime economy. Vysochan O. O. and Vasylyshyn T. V. [2] explored resilience management under the combined pressures of the COVID-19 pandemic and the full-scale war, emphasizing digital transformation, diversification, and supply chain sustainability. Pokhylko S., Hrytsenko L., and Martymianov A. [3] analyzed the impact of post-coronavirus transformations on digital business models, pointing to rapid digitalization trends. Shenderivska L., Huk O., and Mokhonko H. [4] investigated the transformation of publishing business models during pandemic and war, applying tools such as Canvas, Freemium, and dropshipping. Kyfiak V. [5] proposed strategies for innovative sustainable business development, focusing on adaptability under financial, geopolitical, and technological fluctuations. Smoliar L. and Holinko Yu. [6] developed approaches to innovatively improve business models in conditions of global instability, stressing flexibility and partnerships. Chornodid I., Fedotov O., and Pekin A. [7] addressed modern approaches to adapting business models under permanent external changes. Lishchynskyi I. O., Borysiak O. V., Monastyrskyi H. L., Yatsenko O. M., and Orlovska Yu. V. [8] contributed to the discussion on sustainable management by analyzing institutional and managerial aspects of business transformation in crisis conditions.

These Ukrainian studies provide valuable insights into sustainable and resilient business models in times of crisis, though systematic research on China's post-pandemic sustainable business management remains limited.

Connection of work with scientific programs, plans, topics. The connection of this research with scientific plans, planning, and projects. This thesis forms the core research content of the basic scientific research project "European inclucive circular economy: post-war & post-pandemic module for Ukraine" 101085640 — EICEPPMU — ERASMUS-JMO-2022-HEI-TCH-RSCH. Additionally, as part of "Enterprise Sustainable Business Model Transformation in Global Value Chain Restructuring" (International Cooperation Project Registration No. 2023-INT-089), it provides Chinese case support for international comparative research.

The purpose of the study is to construct a theoretical framework for managing post-pandemic sustainable business models in China, and to propose optimization strategies and implementation pathways with practical value through empirical analysis. The specific objectives are as follows:

- to reveal the mechanisms of benchmarking management in the design, implementation, and optimization of sustainable business models, providing theoretical guidance for enterprise transformation;

- to establish a multi-dimensional evaluation index system for sustainable business models to scientifically assess the development level of various industries in the post-pandemic period;

- to explore the adaptive evolutionary patterns of transnational sustainable business models based on empirical research of "Belt and Road" investment cases;

- to distill benchmark models from various regions and industries, summarizing successful experiences that can be replicated and promoted;

- to analyze bottleneck issues in the implementation of sustainable business models to provide empirical evidence for governments to formulate precise support policies;

- to construct dynamic monitoring mechanisms to achieve real-time tracking and feedback optimization of sustainable business model development trajectories;

- to explore the application methods of benchmarking management in cross-cultural contexts to enhance the model adaptation capabilities of Chinese enterprises in international cooperation;

- to study the influence pathways of value co-creation mechanisms on the stability of sustainable business models from the perspective of stakeholder collaboration.

The object of the study is sustainable business model management practices in post-pandemic China.

The subject of the study specifically addresses innovation pathways and practical optimization of China's post-pandemic sustainable business models through benchmarking management. It particularly emphasizes model adaptation and efficiency enhancement within the "Belt and Road" investment framework.

Research methods. To achieve the research objectives, this thesis uses a comprehensive strategy that integrates multiple scientific research methods: Theoretical analysis examines the development trajectory and connections between sustainable business models and benchmarking management, establishing conceptual models and analytical frameworks; Quantitative research collects secondary data from listed companies' financial reports, policy texts, and industry statistics, applying multivariate statistical analysis, structural equation modeling, and time series analysis to test theoretical hypotheses; Qualitative research conducts case studies, field observations, and interviews, analyzing benchmark enterprises' sustainable business model innovations to reveal their operational mechanisms and success factors; Comparative research compares sustainable business models between China and developed countries, across different regions and industries, extracting representative benchmark experiences and practical implications; Analytic Hierarchy Process (AHP) with principal component analysis constructs a multi-dimensional evaluation index system, ensuring objectivity in assessing sustainable business model development; SWOT analysis evaluates the internal strengths and weaknesses plus external opportunities and challenges of implementing sustainable business models across different contexts, providing a basis for differentiated strategies; Literature research reviews theoretical achievements and practical cases both domestically and internationally, establishing a solid theoretical foundation and experiential reference for this research.

The information base of the study. This dissertation draws on macroeconomic statistical data from institutions including the World Bank, United Nations Development Programme (UNDP), China's Ministry of Commerce, and National Bureau of Statistics. It integrates this with microeconomic data from listed companies' annual reports and corporate social responsibility reports. The research also leverages policy documents and academic literature from countries along the "Belt and Road" initiative to ensure scientific validity and reliability of the conclusions.

The scientific novelty of the obtained results is lies in creating a dynamic management framework for post-pandemic sustainable business models and developing evaluation systems and optimization tools tailored to the Chinese context. The key scientific contributions include:

First obtained：

- Construction of a post-pandemic sustainable business model evaluation model based on the "economic-social-environmental" three dimensions, combined with benchmark management methods to design an evaluation system containing 28 indicators, enabling quantitative comparison of development levels across different industries and regions;

- Development of a "benchmark-adaptation-innovation" three-stage evolution model for sustainable business models, revealing the dynamic evolutionary patterns from benchmarking imitation to independent innovation in the post-pandemic period; in the international cooperation dimension, creation of localization methods for sustainable models based on cultural sensitivity, addressing the adaptation challenges faced by Chinese enterprises in "Belt and Road" investments; design of a gradient advancement policy support system to address unbalanced development issues among eastern, central, and western regions, promoting regional coordination and balanced development;

Improved:

- Enhanced benchmark management application methods in cross-cultural contexts, establishing an adaptability assessment matrix for sustainable business models in "Belt and Road" investments;
- Development of real-time monitoring and early warning systems for sustainable business models using big data analysis technology, achieving precision and intelligence in management decision-making;

Further developed

- Stakeholder collaboration theory, constructing a stability analysis framework for sustainable business models based on value co-creation;
- Integration of digital transformation with sustainable development strategies, proposing a trinity model of "digital empowerment-green development-inclusive growth" providing differentiated paths for Chinese enterprises participating in international competition in the post-pandemic period.

The practical value of the results. The practical significance of this thesis lies in providing operational sustainable business model management tools that offer a scientific basis for enterprise transformation and policy-making. Specifically, it:

- Provides enterprises with comprehensive guidance from benchmarking to model innovation, enhancing sustainable development capabilities through evaluation diagnostics, path optimization, and performance assessment tools;
- Offers empirical support for government departments to develop differentiated policies, clarifying development priorities and support directions across various industries and regions;
- Delivers model adaptation guidelines for "Belt and Road" investment enterprises, reducing cross-cultural operational risks and improving international business effectiveness;
- Presents reference solutions for industry associations and intermediary organizations to build exchange platforms, facilitating the sharing of best practices and accelerating the formation of a sustainable industrial ecosystem.

Applicant's personal contribution. Literature review indicates that existing research is predominantly limited to single-industry studies or static evaluations, lacking systematic investigation of the unique post-pandemic context. There is a particular absence of research combining benchmark management with dynamic optimization mechanisms. Current evaluation systems suffer from incomplete dimensions and inappropriate weight allocations, preventing accurate assessment of sustainable business models' actual development levels. This research addresses these gaps by: constructing a more systematic and dynamic analytical framework through multidisciplinary theoretical integration; overcoming single-method limitations by employing mixed research methodologies that effectively combine macroeconomic trends with microeconomic case studies; and developing cross-cultural adaptability assessment tools specifically designed for "Belt and Road" investments. These contributions address deficiencies in existing international comparative research and provide fresh perspectives and methodologies for sustainable business model management research.

Approbation of the results of the dissertation. The main findings of this research have been presented at two international academic conferences: the 21st International Scientific and Practical Conference " Innovative processes of economic and socio-cultural development: domestic and foreign experience" (Ternopil, 2025) and the International Student and Youth Scientific and Practical Conference "International Economics in Climate Change: Post-Pandemic Transformation" (Ternopil, April 11, 2022) and International Student and Youth Scientific and Practical Conference "International Economics in Climate Change (Ternopil, April 24, 2022)

Publication of obtained results. The main insights of this dissertation have been published in 8 scientific publications: 5 papers in Ukrainian scientific specialized journals indexed in international scientometric databases, and 3 papers in academic conference proceedings.

Scope and structure of the dissertation. This dissertation comprises an introduction, three chapters, conclusion, references, and appendices. The complete work spans 175 pages, with 137 pages of main text, 55 tables, 10 figures, 169 references, and 2 appendices.

CHAPTER 1. THEORETICAL AND METHODOLOGICAL BASIS OF RESEARCH ON MANAGEMENT OF SUSTAINABLE BUSINESS MODEL

1.1 Overview of Management of Sustainable Business Model Theories

Sustainable business models represent the critical pathway for enterprises to overcome development challenges and establish enduring competitiveness in the post-pandemic era. Their theoretical evolution and management practices consistently center on value co-creation, resource integration, and multi-stakeholder collaboration. This section organizes the theoretical framework of sustainable business models across five dimensions: concept definition, theoretical foundation, core elements, evolutionary logic, and adaptability to the Chinese context, providing a solid theoretical foundation for subsequent research.

In academic research, the definition of sustainable business models shows multi-dimensional expansion. Its core concept can be summarized as: an innovation form centered on value co-creation that balances economic value with environmental responsibility and social value, fostering long-term symbiosis between enterprises and stakeholders through restructured value propositions, optimized resource allocation, and innovative profit models [1].

Scholars from different disciplines emphasize various aspects of sustainable business models.

From an economic perspective, Sajid Amit et al. (2025) view these models as the backbone of "youth capability ecosystems" in emerging economies. They emphasize efficient resource matching through market segmentation and balancing economic growth with social inclusion [1]. This perspective highlights how sustainable business models correct traditional linear growth models by addressing inequality through value chain extension and innovative benefit distribution.

From a management perspective, Juan Antonio Pavón Losada et al. (2025) studied the food packaging industry and define sustainable business models as "operational paradigms driving industry green transformation." They focus on reducing lifecycle environmental impact through product design innovation, supply chain collaboration, and recycling systems [2]. This definition emphasizes industry-specific adaptability, such as addressing plastic waste recycling and biodegradable material substitution in food packaging.

From a sociological perspective, Christian Tschiedel et al. (2025) examined urban energy transition cases and describe sustainable business models as "management tools for paradoxical tensions in cross-sector collaboration." These models require dynamic balance between corporate profit goals and socioenvironmental demands[3]. In new energy projects, for instance, enterprises must coordinate government emission reduction requirements, residents' cost sensitivity, and investment return cycles, using tiered pricing and community participation to resolve conflicts.

Chinese scholars have enriched the definition based on local practices. Zhou Linxie (2024), studying journalism in the digital era, suggests that sustainable business models must "integrate content value and social responsibility," balancing information dissemination with public opinion guidance [4]. Li Wei et al. (2025) define sustainable business models in developing countries as "coupling systems of climate finance and business model innovation," emphasizing reduced transition costs through green credit and carbon trading [5]. These definitions converge on a key concept: sustainable business models in China must balance market logic with policy orientation, achieving innovation within national strategic frameworks like "dual carbon" goals and common prosperity.

The theoretical system of sustainable business models integrates multiple disciplines. Its core foundations include stakeholder theory, circular economy theory, ecological economics, and complex systems theory, which together form the logical framework for model design and operation.

Stakeholder theory explains the value distribution mechanism of sustainable business models. Freeman's (1984) stakeholder framework states that enterprises must be responsible to shareholders, employees, communities, and the environment—with sustainable business models as the practical vehicles for this concept. Yi Xie et al. (2024) validated this logic: when enterprises incorporate sustainability goals into business model design, organizational resilience improves significantly through employee participation and community co-building. In the post-pandemic period, this resilience manifests as enhanced supply chain resilience and market trust [6]. For example, during the pandemic, a catering enterprise implemented a "community central kitchen + zero-contact delivery" model that secured employment (social value), reduced costs through food recycling (economic value), and decreased disposable tableware use (environmental value).

Circular economy theory provides the operational foundation for sustainable business models. Its "3R principles" (Reduce, Reuse, Recycle) guide resource allocation. Andra Teodora Gorski et al. (2025) note that integrating circular economy with sustainable business models creates a "dual-drive for enhancing enterprise resilience." Manufacturing industries can simultaneously reduce costs and environmental impact through modular product design (reuse), waste cascading utilization (recycle), and production process optimization (reduce) [11]. Cemre Avşar et al. (2025) further incorporate carbon emissions and waste management into business model design, proposing "carbon footprint tracking – waste classification – recycling" as a closed-loop system that transforms sustainability from qualitative requirements into quantifiable indicators [14].

Ecological economics provides a macro perspective for sustainable business models, highlighting the symbiotic relationship between economic and ecological systems. Maryam Hina et al. (2023) view circular economy business models as "pillars of sustainable development," using material flow analysis to transform ecological carrying capacity into business model constraints [18]. For example, Amazon rainforest enterprises must prioritize ecological protection, creating economic value through non-destructive resource development like nut collection and eco-tourism—applying the "ecological threshold" concept from ecological economics to business models [8].

Complex systems theory offers a holistic lens for understanding sustainable business models. Rebaka Sultana et al. (2025), in their study of e-learning models in emerging markets, argue that sustainable business models function as "complex adaptive systems formed through multi-agent interactions," evolving according to self-organization principles [7]. Online education platforms exemplify this concept—their sustainable models must balance the needs of content providers, learners, technical service providers, and other stakeholders, using algorithmic matching to achieve optimal resource allocation. These systems' stability primarily hinges on effective feedback mechanisms. When demand for specific courses spikes, platforms must swiftly mobilize teaching resources and adjust pricing to prevent system collapse from supply-demand imbalances.

The core elements of sustainable business models can be systematically analyzed through a "three-dimensional nine-element" framework (see Table 1.1). This framework integrates traditional business model canvas dimensions while addressing specific sustainable development requirements.

Table 1.1

Core Elements Framework of Sustainable Business Models

Core Dimensions	**Key Elements**	**Element Implications**	**Typical Cases**
1	2	3	4
Value Proposition Social Value Economic Value	Green Value	Environmental attributes of products or services, such as low-carbon, recyclable, energy-efficient, etc.	A home appliance enterprise's "trade-in + energy-saving subsidy" model, reducing users' carbon footprint through recycling and dismantling old appliances and upgrading the energy efficiency of new products [2]
	Social Value	Inclusivity for vulnerable groups, contribution to community development, etc.	An e-commerce platform's "farmer assistance program," ensuring farmers' income by directly connecting farmers with consumers and reducing intermediaries [17]
	Economic Value	Long-term profitability and risk resistance capacity	A new energy enterprise's "photovoltaic power station + energy storage + agricultural-photovoltaic complementation" model, achieving dual protection of power generation income and agricultural planting income [19]

1	2	3	4
Resource Allocation Circular	Green Supply Chain	Environmental standards for suppliers, low-carbon logistics networks	An automobile enterprise requiring parts suppliers to obtain ISO14001 certification and using rail transport instead of road transport to reduce supply chain carbon emissions [6]
	Circular Resources	Waste recycling systems, regenerative resource utilization efficiency	A packaging enterprise's "plastic bottle recycling—regenerated granules—new packaging" closed-loop system, with recycled materials accounting for 40% [2]
	Digital Technology	Optimization effects of big data, IT and other technologies on resource allocation	A retail enterprise using AI algorithms to predict consumer demand, improving inventory turnover by 30% and reducing waste from overproduction [20]
Profit Mechanism	Value Sharing	Reasonable distribution of benefits among shareholders, employees, communities and other entities	A cooperative enterprise's "dividend based on transaction volume + community public welfare fund" model, investing 10% of profits in community infrastructure construction [21]
	Differentiated Pricing	Premium mechanisms based on environmental or social contributions	A coffee brand offering a 3-¥ discount to consumers using their own cups, while allocating part of the premium for rainforest protection [22]
	Long-term Contracts	Long-term cooperation agreements with stakeholders to ensure model stability	A wind power enterprise signing a 20-year power purchase agreement with local government to ensure predictability of investment returns [23]

Source: Made by the author

Value Proposition: Unlike traditional business models focused solely on economic value, sustainable business models feature a triple "green-social-economic" attribute. EIZO Company (2025) launched a 27-inch eco-friendly display with a value proposition encompassing high-resolution performance (economic value), recyclable body materials (green value), and zero-emission production commitments (social value). This triple value combination effectively attracts ESG-oriented corporate clients [2].

Resource Allocation: Green supply chain serves as the cornerstone of sustainable resource allocation. In their EU renewable energy study, Ningshan Hao et al. (2025) found that leading companies implement "carbon footprint visualization" in supply chain management—using blockchain technology to track carbon emissions for each raw material batch and linking this data to supplier ratings [6]. The efficient use of circular resources transforms the concept of "waste as resource." For instance, a steel company established a scrap steel recycling network, increasing recycled steel to 70% of production, significantly reducing both iron ore dependence and energy consumption per ton of steel [14].

Profit Mechanism: Sustainable business models must balance short-term viability with long-term sustainability. Fiza Amjad et al. (2025) proposed an SME sustainability evaluation model showing that successful profit models typically employ an "explicit benefits + implicit benefits" dual-track system. Explicit benefits derive from product or service sales, while implicit benefits include government subsidies, carbon trading income, and brand value enhancement [24]. For example, an organic agriculture enterprise earns premium prices through organic certification (explicit benefits) while generating additional revenue through carbon sink projects (implicit benefits), creating a stable profit structure.

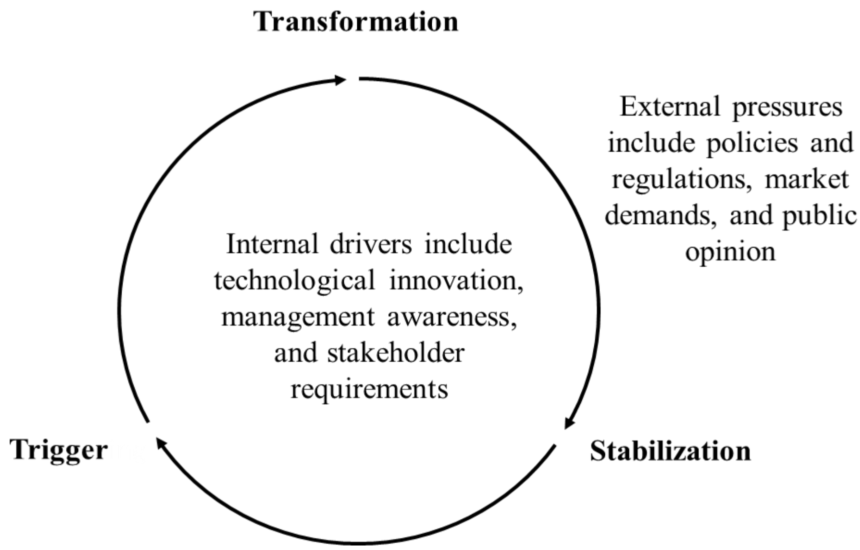

Figure 1.1. Evolution Stages and Driving Mechanisms of Sustainable Business Models

Source: Made by the author

Triggering Stage: External pressure serves as the initial driving force for model transformation. Key triggering factors in the post-pandemic period include:

Policy and regulatory tightening, such as China's carbon quota system under the "dual carbon" goals, which compels energy-intensive enterprises to restructure their energy consumption and production processes[7]; market demand shifts, with growing consumer preference for green products—one survey indicates Chinese consumers in 2024 are willing to pay a 10%-20% premium for environmentally friendly products[5]; and supply chain vulnerabilities, as pandemic-induced global disruptions have led businesses to adopt localized, shortened supply chain models that both reduce logistics carbon emissions and enhance resilience [5].

At this stage, enterprises typically implement passive responses (such as meeting emission standards and compliance reporting) to satisfy basic requirements, without developing systematic sustainable business models. For example, a chemical company responding to environmental policies merely increased equipment investment in end-treatment processes without addressing fundamental production technology changes.

Transformation Stage: Internal drive becomes the core force for model deepening, primarily through the synergy of technological innovation and management restructuring. Yi Xie et al. (2024) demonstrate that digital business model innovation plays a key role in this stage—using big data to analyze user behavior, precisely matching green demands with product supply, while reducing transformation costs[25]. For instance, a clothing enterprise increased fabric utilization from 60% to 85% through digital customized production, reducing inventory backlog and waste to achieve a sustainable "small batch, multiple cycle" production model[38]. The hallmark of this stage is the shift from "passive compliance" to "active innovation," with sustainability goals integrated into strategic planning.

Stabilization Stage: The model enters a self-reinforcing virtuous cycle, with "sustainability capacity" becoming a competitive advantage. Roberto Cerchione et al. (2025) research on crowdfunding business model classification reveals that sustainable models in the stable stage exhibit a "network effect"—as participating entities (suppliers, users, investors) increase, marginal costs decrease while value increases[8]. For example, a bike-sharing platform, through scaled operations, increased daily average bike usage to more than 5 times, reducing carbon emissions per unit distance to 1/3 of public transportation, creating a positive feedback loop of "user growth—cost reduction—environmental benefit improvement"[170].

China's unique institutional environment, economic structure, and cultural traditions give sustainable business models distinctive local characteristics, with adaptability manifested in three key aspects.

First, policy-driven development coordinated with market response. The Chinese government provides clear direction for sustainable business models through policy levers such as "dual carbon" goals, ESG disclosure requirements, and green finance instruments. Min Zhang et al. (2025) examined the fly ash recovery industry in western China and found that policy interventions significantly reduced transformation costs—government-established subsidies increased the comprehensive utilization rate of fly ash from 30% to 70%, catalyzing a circular industrial chain of "power generation—fly ash—building materials"[7]. This "policy-first, market-follows" model contrasts sharply with the market-driven self-regulation approach in Western countries.

Second, cross-cultural adaptation in the "Belt and Road Initiative." Chinese enterprises investing in the "Belt and Road" need to construct sustainable models that balance international standards with local needs. Márcia Amado da Silva et al. (2023)

demonstrated through Amazon rainforest enterprise cases that transnational sustainable models must address "triple distance" challenges—geographical distance (logistics costs), institutional distance (environmental standards differences), and cultural distance (consumption habit differences)[8]. For example, a Chinese-funded photovoltaic project in Southeast Asia adopted a "technology transfer + local employment" model that both met local energy needs and enhanced sustainability by cultivating local technical teams[23].

Finally, the integration of digital economy with sustainability. China's leading digital technology applications provide unique advantages for sustainable business models. Zhou Linxie (2024) points out that sustainable models in the digital era's news industry rely on a dual mechanism of "algorithmic recommendation + content review"—improving information dissemination efficiency through algorithms while ensuring social value orientation through manual review[4]. Similarly, a fresh food e-commerce company used AI to predict consumer demand, reducing waste rates from 25% to 8%, improving both economic efficiency and reducing food waste[19].

The theoretical evolution of sustainable business models shows progression from single-dimension to systemic integration, from static description to dynamic evolution, with the core logic being to establish synergistic mechanisms among economic, environmental, and social objectives. Sustainable business models in the Chinese context need to both absorb international advanced experiences (such as circular economy and stakeholder collaboration) and be grounded in local practices (such as policy-driven approaches, digital technology integration, and "Belt and Road" cross-cultural management) to form a theoretical framework with Chinese characteristics. Further research should explore innovative model pathways in the post-pandemic period, with particular focus on benchmarking management applications in model optimization, providing theoretical support for enterprise transformation and policy formulation.

1.2. Methodological Approach for Management of Sustainable Business Model

The methodological approach for sustainable business model management integrates theoretical frameworks, practical tools, and evaluation systems to guide enterprises in achieving environmental sustainability and social value while pursuing economic benefits . In the post-pandemic era, Chinese enterprises face multiple challenges—shrinking market demand, supply chain restructuring, and tightening regulations—necessitating business model reconstruction through methodological innovation to enhance resilience and adapt to low-carbon transition. The core of this approach is a closed-loop management system of "diagnosis-design-implementation-evaluation-iteration" that combines circular economy principles, stakeholder collaboration, and dynamic adaptation logic with digital tools and local context optimization to create actionable implementation paths.

First, circular economy logic. The circular economy reconstructs material flows through the "reduce, reuse, recycle" (3R principle) to decrease dependence on natural resources[11]. For example, a coal fly ash recovery enterprise in western China implemented a dynamic business model to transform industrial waste into building materials, achieving an annual CO_2 reduction of 2 million tons in 2025, validating circular logic's feasibility in resource-intensive industries[7]. This approach requires companies to embed closed-loop processes at the design stage, such as product modular design and reverse logistics networks. A notable example is the German textile manufacturing industry, which improved waste utilization to 92% through a "recycling-regeneration" model[25].

Second, stakeholder collaboration logic. Businesses must extend beyond single shareholder interests to integrate the needs of diverse stakeholders including suppliers, customers, and communities[26]. In "Belt and Road" investment projects, a Chinese enterprise developed a "local employment + technology transfer + ecological compensation" collaborative mechanism, reducing negative community impacts by 30% while enhancing brand recognition[23]. This methodology emphasizes identifying key stakeholder needs through Stakeholder Mapping and incorporating them as organic components of the business model. For instance, a rural community enterprise in India achieved a 45% increase in female employment through a "cooperative + e-commerce" model.

Third, resilience adaptation logic. Post-pandemic uncertainties require business models to have dynamic adjustment capabilities[21]. For example, a fresh food e-commerce company enhanced supply chain resilience by 40% during the 2022-2023 pandemic fluctuations through a hybrid "front warehouse + community group buying" model. Resilience logic requires businesses to establish risk warning indicators (such as supply chain disruption probability and cash flow stress capacity) and optimize resource allocation in real-time using digital tools. AI algorithms can reduce demand forecast errors to within 15%[19].

First, the sustainable business model canvas. This tool enhances the traditional business model canvas by adding environmental cost and social value modules[27]. For example, a photovoltaic enterprise incorporated "component recycling responsibility" into its cost structure while positioning "clean energy accessibility" as its customer value proposition, increasing its Southeast Asian market share to 18% by 2025[27]. This tool helps enterprises visualize connections between economic, environmental, and social values, preventing symbolic "greenwashing" innovations (see Table 1.2).

Table 1.2

Core Dimensions of Sustainable Business Model Canvas

Core Dimensions	Content Description
Value Proposition	Balancing low-carbon environmental protection with social inclusiveness
Channels	Integrating forward logistics with reverse recovery networks
Customer Relations	Strengthening low-carbon behavior incentives (e.g., point redemption)
Revenue Streams	Including product sales, carbon trading, government subsidies, etc.
Key Resources	Renewable resources, recycling technology, community cooperation networks
Environmental Costs	Quantifying full life-cycle carbon emissions and waste disposal costs
Social Value	Creating employment, enhancing community welfare, etc.

Source: Made by the author

Second, Life Cycle Assessment (LCA) and carbon footprint accounting. LCA quantifies products' environmental impact throughout their entire lifecycle—from raw material acquisition to disposal—forming the foundation for low-carbon business model design[14]. A new energy vehicle enterprise discovered through LCA that battery production accounted for 60% of carbon emissions, leading to collaboration with upstream mineral companies to build a low-carbon supply chain, reducing per-unit carbon footprint by 25% in 2024. Combined with ISO 14064 carbon accounting tools, companies can achieve detailed management of emission reduction targets, as demonstrated by EU companies increasing product premium rates by 12% through carbon footprint labeling[6].

Third, dynamic adaptation model. This model guides business model iterations by monitoring three key indicators in real-time: "demand elasticity, supply chain redundancy, and policy sensitivity"[21], helping address post-pandemic market fluctuations. For example, a restaurant chain using this model quickly switched to a "dine-in + pre-prepared food + livestream sales" approach during the 2023 pandemic resurgence, achieving revenue recovery 20% faster than the industry average. The model comprises three core modules: risk identification matrix, scenario simulation engine, and adjustment solution generator[28].

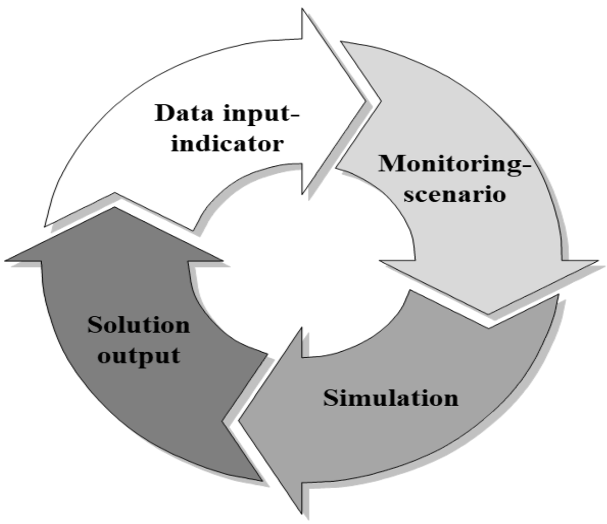

Fig. 1.2. Logical Framework of Dynamic Adaptation Model

Source: Made by the author

Fourth, stakeholder value flow analysis. This analysis identifies collaboration opportunities by quantifying value exchanges between entities[27]. Through this analysis, a "Belt and Road" infrastructure project discovered that incorporating local

worker training into its business model could reduce project delay risk by 15% while increasing community support. The analysis process includes drawing value flow maps, quantifying value contributions, and optimizing exchange mechanisms[23].
"Diagnosis - Design - Implementation - Evaluation - Iteration."

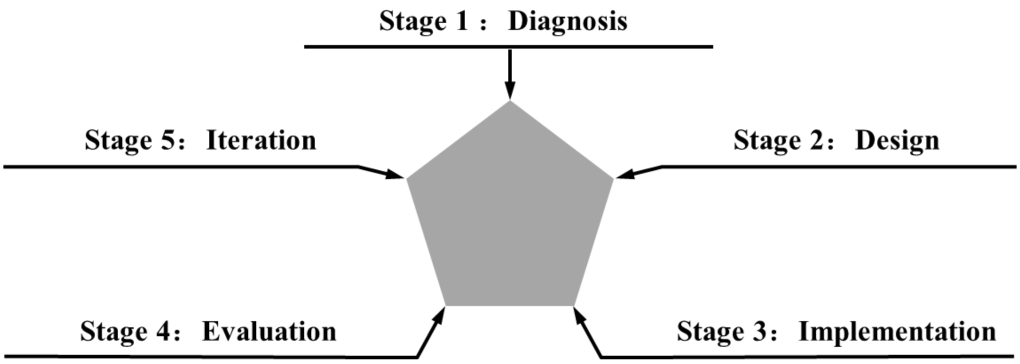

Fig. 1.3. Five-Stage Implementation Path for Sustainable Business Models
Source: Made by the author

(1) Diagnosis: Sustainability Gap Analysis. Using ESG indicator systems, identify gaps between the company's current model and sustainability goals [26]. In 2024, a manufacturing company's diagnosis revealed that supply chain emissions constituted 70% of total emissions, prompting them to include low-carbon supplier certification in their cooperation terms [6]. Tools include carbon footprint audits (ISO 14067 standard) and social value assessment matrices (such as GRI standards). Data should combine corporate annual reports with third-party audits to ensure credibility [22].

(2) Design: Triple Value Integration Solution. Based on diagnostic findings, reconstruct value propositions, profit models, and resource allocation methods [31]. A bike-sharing company transformed "urban carbon reduction" into carbon assets, supplementing revenue through carbon trading, with carbon income representing 12% of net profit in 2025 [14]. The design phase should employ "sustainable innovation workshops" with cross-departmental teams and external experts to avoid impractical solutions. For instance, a food packaging company collaborated with NGOs to create a "compostable packaging + recycling rewards" model, boosting customer retention by 20% [2].

(3) Implementation: Phased Pilot Programs and Enablement. Select business units with appropriate conditions for pilot programs, supported by special funds, digital

tools, and capability training [32]. In 2023, a retail company tested a "packaging recycling + points exchange" model in 3 regions, enhancing execution efficiency by 35% through employee enablement programs before nationwide expansion [34]. Implementation requires cross-departmental collaboration mechanisms, such as a sustainable development committee (led by the CEO) to ensure proper resource allocation and clear responsibilities [24].

(4) Evaluation: Multi-dimensional Performance Monitoring. Develop an "economic - environmental - social" three-dimensional evaluation system[40]. Economic dimension: proportion of sustainable business revenue; environmental dimension: energy consumption per unit of revenue; social dimension: employee satisfaction. A state-owned enterprise's "Belt and Road" project found that each 10% increase in local employment reduced project complaints by 8%, confirming the positive correlation between social and economic value [23].

(5) Iteration: Dynamic Optimization Based on Feedback. Implement a quarterly review mechanism to adjust the model based on internal and external feedback [61]. A new energy company, following 2024 user research, addressed the "insufficient battery recycling points" issue in its iteration plan. After adding 50 recycling points, customer retention grew by 15% [27]. Iteration depends on digital platforms for real-time data collection and analysis. For example, a logistics company employed AI algorithms to optimize delivery routes dynamically, keeping energy consumption fluctuations per unit of cargo within 5% [19].

First, policy-driven pathways. Responding to "dual carbon" goals and ESG disclosure requirements, companies can transform policy compliance into competitive advantages [5]. In 2024, a steel enterprise developed a "green electricity + carbon capture" business model, receiving local government subsidies covering 20% of project investment while avoiding carbon tariff risks. Companies should establish policy tracking mechanisms to promptly incorporate new regulations (such as the "Carbon Emissions Trading Management Measures") into their model design. For example, a photovoltaic company proactively deployed an "integrated photovoltaic-storage-charging" model in anticipation of subsidy reduction policies [6].

Second, supply chain resilience enhancement. Companies are addressing supply chain vulnerabilities exposed by the pandemic through "localization + diversification" strategies [6]. In 2023, an electronics company expanded its key component suppliers from 3 to 7 while establishing backup factories in Southeast Asia, reducing supply chain disruption recovery time from 72 to 24 hours. Blockchain technology can enhance transparent supply chain management, as demonstrated by an automotive company that traced component carbon footprints, improving supply chain emission reduction efficiency by 30% [19].

Third, digital technology integration. Companies are using big data and AI to optimize resource allocation [19]. For example, a logistics company optimized delivery routes through AI algorithms, reducing energy consumption per unit of cargo by 18% in 2025. Similarly, an agricultural platform used blockchain to trace agricultural product carbon footprints, achieving a premium rate of 25% [23]. Digital applications must include data security measures that comply with the "Data Security Law," such as an e-commerce enterprise establishing data desensitization mechanisms to analyze consumer behavior and low-carbon preferences while protecting user privacy [22].

Fourth, awakening consumer-end value. In the post-pandemic era, with heightened environmental awareness among consumers, businesses can strengthen brand identification through "value visualization" [1]. In 2024, a dairy company launched "carbon-labeled" milk showing the carbon footprint of each product, driving a 12% sales increase [14]. Companies should adopt scenario-based communication aligned with Chinese consumer preferences, as demonstrated by a tea beverage brand that showcased its "paper cup recycling and regeneration" process through livestreaming, improving brand favorability by 25%.

First, the case benchmarking method. This compares key indicators with industry benchmarks, such as measuring a company's circular economy efficiency against BASF's "integrated site" model in Germany to identify gaps [11]. A chemical company discovered through benchmarking that its waste resource utilization rate was 15 percentage points lower than BASF's, which led to process adjustments that achieved breakthroughs.

Second, longitudinal data analysis. This tracks performance changes before and after pilot implementations. For example, data from an automotive company's electrification transformation from 2022-2025 showed that sustainable business models improved R&D efficiency by 25%, validating the methodology's effectiveness [5]. Data should span at least 3 complete fiscal years to eliminate short-term fluctuations.

Third, scenario simulation method. This uses modeling to predict model resilience under different policy and market scenarios [22]. For instance, a photovoltaic company simulated a "50% carbon price increase" scenario and found that net profit would decrease by 8% under the existing model. This prompted them to proactively develop overseas green electricity projects to hedge risks. Simulations should use Monte Carlo algorithms with at least 1000 iterations to ensure robust results.

Fig. 1.4 Scenario Simulation Method Flowchart

Source: Made by the author

The three-layer business model canvas is a core tool for integrating economic, environmental, and social values [48].

The bottom layer (economic layer) clarifies the profit model—for example, a recycling company's "waste treatment fee + recycled material sales revenue" model, where recycled materials accounted for 60% of revenue in 2024. The middle layer (environmental layer) quantifies environmental impact, such as the company calculating through LCA that processing each ton of waste reduces CO_2 emissions by 0.8 tons, which converts into carbon assets. The top layer (social layer) defines social value, such as creating 500 jobs with 15% held by disabled persons. When applied to a waste management system, this tool improved alignment with SDGs (Sustainable Development Goals) by 40% [48].

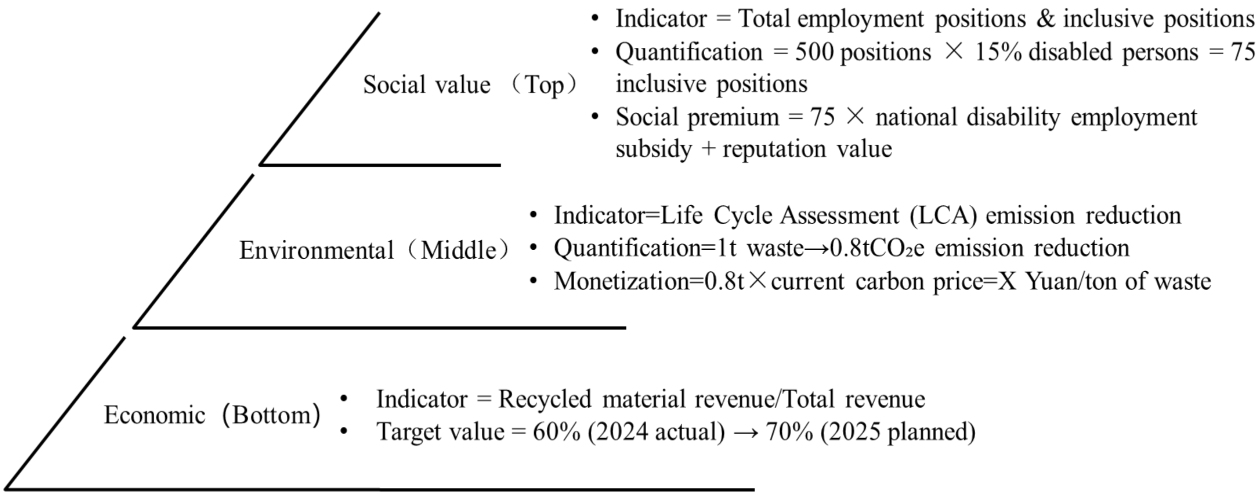

Fig. 1.5. Application Examples of Three-layer Business Model Canvas

Source: Made by the author

In summary, the sustainable business model management methodology provides systematic guidance for Chinese enterprises in post-pandemic sustainable transformation by integrating triple value logic, structured tools, and dynamic pathways. Its core strength lies in embedding environmental and social goals into the underlying business model design rather than treating them as add-ons, while ensuring effective implementation through digital tools and local adaptation. Future research should explore industry-specific applications of these methodologies, such as differences in implementing circular logic between manufacturing and service industries.

1.3. Construction of Evaluation Indicator System for Management of Sustainable Business Model Development

The evaluation indicator system for sustainable business model development management is a multi-dimensional framework constructed through systematic methods to measure management effectiveness, development potential, and value creation capability when implementing sustainable business models . Its core objective is to quantify how sustainable business models coordinate development across economic, social, and environmental dimensions through scientific indicator design, providing an objective basis for management decisions, performance improvement, and strategic optimization [1]. In the post-pandemic era, this system must also incorporate dimensions like crisis resilience and market adaptability to reflect enterprises' dynamic capabilities for achieving sustainable development in uncertain environments [5].

Dimension Economic sustainability serves as the fundamental bedrock upon which enterprises can establish and maintain sustainable business models over the long term. This crucial dimension comprehensively measures various aspects including profitability potential, growth trajectory, and financial resilience in changing market conditions [24]. The core indicators within this dimension include:

Financial performance indicators: Encompassing a wide range of traditional financial metrics such as return on equity, gross profit margin, net profit margin, and year-over-year revenue growth rate, all of which collectively reflect the profit foundation necessary for implementing and sustaining viable business models [5]. In the particularly challenging post-pandemic business environment, organizations must additionally incorporate a specialized "risk-resistant profit rate" indicator to effectively measure and monitor profit stability during periods of significant market fluctuations and economic uncertainty [22].

Value creation efficiency: Incorporating multiple efficiency metrics including capital turnover rate, asset utilization ratio, and output value per capita to comprehensively evaluate the conversion efficiency between resource inputs and value outputs across the organization [5]. Extensive research confirms that the long-term competitiveness and viability of sustainable business models fundamentally depends on the organization's ability to continuously improve and optimize its value creation efficiency across all operational domains (Sajid Amit et al., 2025) [1].

Return on innovation investment: Precisely measuring the input-output ratio in sustainable technology research and development activities and business model innovation initiatives through carefully selected indicators such as R&D investment proportion relative to revenue, innovation achievement conversion rate, and new product contribution to overall sales [19]. This multifaceted indicator effectively reflects the long-term innovation potential and future growth trajectory of business models in competitive markets [53].

Supply chain economics: Thoroughly evaluating industrial chain collaboration efficiency and effectiveness through detailed assessment of supplier cooperation stability, long-term partnership quality, and comprehensive logistics cost control measures across the value chain [72]. In the particularly challenging post-pandemic era, organizations must integrate additional supply chain resilience indicators such as "critical material substitution rate," "supplier geographical diversification index," and "emergency response time" into their evaluation systems to ensure business continuity during disruptions [58].

The environmental sustainability dimension thoroughly examines the comprehensive impact of business models on the ecological environment and resource utilization efficiency—representing the core content necessary for achieving genuine green development in today's environmentally conscious marketplace [14]. The key indicators within this dimension include:

Resource utilization efficiency: Comprehensively covering multiple resource aspects including energy consumption per unit of output, water resource recycling rate, raw material recovery rate, and material waste reduction metrics to holistically measure resource conservation effectiveness in production processes and daily operations [2]. Manufacturing enterprises should particularly emphasize transition indicators like clean energy usage proportion and renewable energy investment to demonstrate commitment to sustainable practices [6].

Environmental impact control: Incorporating a comprehensive set of measures including carbon emission intensity per unit of production, pollutant emission compliance rate across all facilities, waste disposal compliance with local and international standards, and biodiversity impact assessments to thoroughly evaluate ecological footprint. With the advancing implementation of "dual carbon" goals across global markets, carbon footprint tracking methodologies and quantifiable emission reduction effectiveness have become essential evaluation criteria for forward-thinking organizations (Cemre Avşar et al., 2025) [14].

Green innovation capability: Methodically measuring achievements and progress in environmental protection technology research and development, green product design, and eco-friendly process innovations through comprehensive indicators such as green patent numbers, environmental technology application rates, and eco-design implementation metrics across product lines. Extensive research demonstrates that green innovation capability exhibits a strong positive correlation with the long-term sustainability and market acceptance of business models in environmentally conscious markets (Ravindra Sharma et al., 2024) [25].

Circular economy practices: Systematically evaluating organizational effectiveness in waste resource utilization, product lifecycle management, and closed-loop production systems through indicators such as circular utilization output proportion, product recovery network geographical coverage, and remanufacturing capacity development. The successful implementation of circular economy principles directly reflects and substantially enhances a business model's ecological sustainability credentials in today's resource-constrained global economy (Andra Teodora Gorski et al., 2025) [11].

The social sustainability dimension comprehensively measures business models' multifaceted contribution to social development, community wellbeing, and overall stakeholder satisfaction levels, effectively embodying the essential humanistic aspects of genuine sustainable development practices. The core indicators within this dimension include:

Employment and human capital: Extensively covering multiple facets including job creation numbers across different demographic groups, employee training investment as a percentage of operational expenses, career advancement opportunities, and competitive salary and benefits levels relative to industry standards to comprehensively evaluate organizational contributions to employment stability and human resource development within communities [1]. Major international initiatives like "Belt and Road" projects require additional specialized cross-border social responsibility indicators such as local employee hiring proportion, skills transfer programs, and cultural integration metrics to ensure sustainable development across diverse regions [33].

Product service social responsibility: Incorporating a comprehensive assessment framework including product safety compliance with international standards, service accessibility across different socioeconomic groups, transparent information disclosure practices, and robust consumer rights protection mechanisms to accurately reflect the social value created through products and services in the marketplace [7]. Organizations operating in essential livelihood-related industries should particularly emphasize and carefully monitor basic needs satisfaction metrics and affordability indices to ensure inclusive access (Dipak Tatpuje et al., 2024) [15].

Community relations and public welfare investment: Methodically measuring the quality and depth of interactions with local communities through comprehensive metrics including community contribution programs, public welfare donation intensity relative to profitability, cultural heritage preservation support initiatives, and stakeholder engagement effectiveness. Extensive research confirms that business models demonstrating high levels of authentic community engagement and meaningful local participation typically achieve significantly stronger social recognition and community support, enhancing operational legitimacy (Statement of Retraction, 2025).

Governance and ethical practices: Thoroughly evaluating organizational performance across multiple dimensions including business ethics implementation, anti-corruption policy effectiveness, data security and privacy protection, and transparent stakeholder communication through comprehensive indicators such as compliance management maturity, ethical risk control mechanisms, and governance structure independence. Well-designed and effectively implemented governance practices provide crucial foundational support for truly sustainable business models in today's complex regulatory environment (Jitendra K. Das et al., 2021) [74].

The dramatically transformed post-pandemic market environment presents unprecedented challenges and opportunities for sustainable business models, necessitating the incorporation of additional specialized dimensions focusing on crisis resilience capabilities and transformation adaptation competencies [5]. The core indicators within these specialized dimensions include:

Market adaptability: Systematically measuring how quickly and effectively business models respond to rapidly evolving post-pandemic consumption trends and behavior shifts through comprehensive indicators including new product and service launch cycle times, digital business channel proportion relative to traditional channels, and customer preference tracking accuracy. Extensive research conclusively demonstrates that enterprises capable of rapidly adapting to fundamental market changes and emerging consumer preferences are significantly more likely to sustain development momentum and maintain competitive advantage during periods of market disruption (Fiza Amjad et al., 2025) [5].

Supply chain resilience: Comprehensively evaluating industrial value chains' resistance to external disruptions and internal bottlenecks through carefully selected indicators including diversified supplier proportion across geographical regions, emergency inventory levels for critical components, logistics network redundancy design, and alternative sourcing capabilities. Valuable pandemic experience clearly demonstrates that robust supply chain resilience has become an absolutely essential foundation for implementing genuinely sustainable business models in today's interconnected yet vulnerable global economy (Puglieri Fabio Neves et al., 2022) [64].

Digital transformation depth: Methodically measuring organizational effectiveness in leveraging advanced digital technologies to enhance overall sustainability performance through comprehensive indicators such as digital platform coverage across business processes, data-driven decision-making proportion relative to traditional approaches, automation implementation in resource-intensive operations, and digital customer engagement effectiveness. Research conclusively shows that well-executed digital transformation initiatives significantly enhance business model flexibility, operational efficiency, and market responsiveness in rapidly changing business environments (Assunta Di Vaio et al., 2020) [98].

Health and safety management: Thoroughly evaluating organizational response capability during public health crises and other emergency situations through comprehensive indicators including employee health protection program comprehensiveness, workplace safety enhancement investments, business continuity plan effectiveness during simulated disruptions, and stakeholder wellbeing prioritization metrics. In the challenging post-pandemic global business environment, robust health and safety management capabilities have become absolutely fundamental prerequisites for sustainable organizational development and stakeholder trust maintenance (Haryati N, 2021) [16].

Indicator selection must follow principles of systematicity, scientific validity, operability, and dynamism [76]. The systematicity principle requires comprehensive coverage of sustainable business models' core elements, avoiding dimensional gaps.

The scientific principle demands clear indicator definitions and standardized calculation methods to ensure objective evaluation results. The operability principle requires easily accessible and quantifiable data, avoiding impractical abstract indicators. The dynamism principle ensures the system can adapt to external changes, such as post-pandemic needs. The selection process combines literature analysis with expert consultation. First, potential indicators are identified through systematic review of sustainable business model literature. Then, academic and industry experts evaluate the indicators' importance and rationality, optimizing the system through methods like the Delphi technique. Research shows that index systems validated through multiple expert rounds have higher practical applicability (Benz Lukas Alexander, 2022) [63].

Indicator weights must reflect the relative importance of different dimensions in the evaluation system. Common methods include Analytic Hierarchy Process (AHP), entropy method, and principal component analysis [78]. AHP transforms expert judgments into quantitative weights through judgment matrices, suitable for scenarios lacking historical data. The entropy method determines weights based on data dispersion, offering greater objectivity. Principal component analysis extracts core indicators that contribute most to evaluation results through dimensionality reduction. For post-pandemic sustainable business model evaluation, a combined weighting method integrating subjective and objective approaches works best. For economic, environmental, and social dimensions, AHP can determine initial weights. For special dimensions like crisis resilience, the entropy method can dynamically adjust weights based on actual data. This balanced approach enhances the scientific validity of weight assignment (Puglieri Fabio Neves et al., 2022) [64].

Indicator quantification ensures evaluation system operability. For quantitative indicators like financial data, original data or standardized relative indicators can be directly used. For qualitative indicators such as social responsibility and environmental impact, rating scales enable semi-quantitative conversion. For difficult-to-quantify indicators like "community relationship quality," stakeholder satisfaction surveys can provide quantitative data (Ipsita Saha et al., 2020) [83]. Standardization processing eliminates dimensional differences between indicators, using methods such as range standardization and z-score standardization. This allows indicators of different magnitudes and units to be compared horizontally and calculated comprehensively, ensuring evaluation result rationality.

Evaluation models integrate multi-dimensional indicators to generate comprehensive results. Common models include weighted sum models, fuzzy comprehensive evaluation models, and the TOPSIS method [92]. Weighted sum models add the products of indicator scores and weights to obtain results—simple to calculate but potentially missing interactions between indicators. Fuzzy comprehensive evaluation models handle uncertainties in scenarios with fuzzy evaluation criteria. The TOPSIS method determines relative superiority by calculating the distance between the evaluation object and ideal solution. For post-pandemic sustainable business model evaluation, dynamic evaluation models that incorporate time dimensions are recommended. By constructing panel data models to compare sustainable business model changes before and after the pandemic, crisis response effectiveness can be evaluated (Heather Louise Madsen, 2020) [94]. This dynamic approach more comprehensively reflects the long-term development capabilities of sustainable business models.

The evaluation index system requires careful adaptation based on the unique characteristics and operational focus of different industries to ensure meaningful assessment. Manufacturing industries should prioritize and strengthen environmental indicators including resource utilization efficiency, waste treatment protocols, circular material flows, and pollution reduction measures to accurately reflect their ecological impact. Service industries, by contrast, need to place greater emphasis on social dimension indicators such as customer satisfaction metrics, employee quality and development, service accessibility, and community engagement to capture their primary value creation mechanisms. Cross-border investment enterprises face additional complexity and must incorporate specialized indicators such as cultural adaptability, international compliance with varying regulatory frameworks, geopolitical risk assessment, and local stakeholder engagement to evaluate their global sustainability performance.

In the specific context of "Belt and Road" energy investment projects, evaluators must pay special attention to industry-specific indicators including the proportion of clean energy in the overall portfolio, cross-border technology transfer effectiveness, local capacity building, long-term environmental impact assessments, and alignment with host countries' sustainable development goals (Khan Iqra Sadaf et al., 2021)[72]. The agricultural and food sectors present their own unique challenges, requiring sustainable business model evaluations to focus on indicators such as food safety protocols, ecological agricultural practices, water usage efficiency, biodiversity preservation, and resilience to climate variability[63]. Technology innovation industries operate in rapidly evolving environments and should therefore emphasize innovation indicators like R&D investment percentages, intellectual property protection mechanisms, knowledge sharing practices, talent attraction and retention rates, and collaborative innovation ecosystems to reflect their contribution to sustainable advancement[19].

Comprehensive research across multiple sectors confirms that industry-differentiated indicator adaptations significantly enhance both the targeting precision and practical effectiveness of evaluation systems, enabling more actionable insights and meaningful comparisons within sector-specific contexts (Sajid Amit et al., 2025)[1]. These tailored approaches recognize that while core sustainability principles remain consistent, their practical implementation and measurement must reflect the material issues, stakeholder priorities, and impact pathways most relevant to each industry's operational reality.

In evaluating "Belt and Road" investment projects, special attention must be paid to cross-border sustainable development characteristics and complex regional diversities. The evaluation index system should incorporate indicators such as geopolitical risk response capability, cultural integration, and local employment ratio to ensure sustainable implementation and long-term development across diverse countries and regions. For infrastructure investment projects, evaluations should assess both direct and indirect contributions to host country employment markets and industrial chain effects, as well as how technology transfer and capacity building promote local technological advancement and socioeconomic benefits. For energy cooperation projects, emphasis should be placed on the compatibility and adaptability of environmental standards, along with their alignment with host countries' existing environmental regulations, ensuring projects meet relevant requirements throughout all development stages.

Extensive empirical research demonstrates that successful implementation of "Belt and Road" sustainable business models depends critically on enterprises' multicultural coordination abilities and transnational operational wisdom (Kishore Kumar François et al., 2023)[33]. Companies must thoroughly understand and respect each participating country's cultural traditions, legal systems, and social values to achieve effective cultural integration and local adaptation in their operations. Consequently, a comprehensive evaluation index system should incorporate soft indicators including "cross-cultural communication efficiency," "localized decision-making participation," "stakeholder engagement mechanisms," and "long-term community interaction quality." The system should also assess deeper indicators such as "cultural conflict resolution capability," "local talent development systems," "cross-cultural team collaboration efficiency," and "multi-party interest balancing mechanisms." This approach fully captures the comprehensive performance, long-term impact, and potential challenges of cross-border sustainable development. Such a multi-dimensional evaluation system more accurately identifies sustainable development potential and risk points in "Belt and Road" projects, providing targeted decision-making guidance for enterprises and policy makers.

In summary, constructing an evaluation index system for sustainable business model development management represents a complex and comprehensive systematic project. This system integrates multidisciplinary theoretical foundations from economics, ecology, and sociology while balancing multiple value objectives including corporate economic value, social responsibility, and environmental protection. It can flexibly adapt to dynamic environmental changes such as market fluctuations, policy adjustments, and technological innovations.

The core value of this system lies in effectively guiding enterprises to fulfill their environmental and social responsibilities more comprehensively while pursuing economic benefits through scientific, systematic indicator design and evaluation methods. In the complex post-pandemic environment, this evaluation system provides enterprises with clear standards and feasible improvement directions, helping them develop more resilient and sustainable long-term strategies amid increasing market uncertainty.

As sustainable development concepts and practices evolve, this indicator system requires continuous optimization to address emerging industry developments, global environmental changes, and evolving social values. This ongoing refinement maintains unity between cutting-edge theoretical research and practical enterprise application, better serving both the global consensus and local implementation of sustainable development.

Conclusion of Chapter 1

This chapter systematically organizes the theoretical foundations, methodological systems, and evaluation index systems for sustainable business model management, establishing theoretical and methodological support for research on China's post-pandemic sustainable business model management.

At the theoretical level, this chapter defines the core essence of sustainable business models: achieving the synergy of economic, environmental, and social triple values through value co-creation. The chapter integrates stakeholder theory, circular economy theory, ecological economics, and complex systems theory to construct a multidisciplinary theoretical framework[1][2][10]. Its core elements can be deconstructed into "three dimensions and nine elements," covering value propositions (green, social, economic values), resource allocation (green supply chain, circular resources, digital technology), and profit mechanisms (value sharing, differentiated pricing, long-term contracts). This model evolution follows a three-stage logic of "trigger-transformation-stabilization," influenced by both external policy pressure and internal innovation drivers[21][27]. In the Chinese context, sustainable business models exhibit local characteristics such as policy-driven and market-responsive synergy, "Belt and Road" cross-cultural adaptation, and deep integration of digital technologies[7][23][16].

At the methodological level, this chapter proposes the need to integrate three major logics—circular economy, stakeholder collaboration, and resilience adaptation—to construct a closed-loop system of "diagnosis-design-implementation-evaluation-iteration"[11][24][22]. Through tools such as sustainable business model canvas, life cycle assessment, and dynamic adaptation models, comprehensive process management is achieved[131][14][22]. For China's post-pandemic context, this chapter emphasizes policy-driven pathways, supply chain resilience strengthening, digital technology integration, and consumer-end value awakening adaptation strategies, ensuring scientific validity through case benchmarking, longitudinal data, and scenario simulation [5][21][19][34].

In constructing the evaluation index system, this chapter establishes economic sustainability (financial performance, innovation returns, etc.), environmental sustainability (carbon emission intensity, resource utilization rate, etc.), social sustainability (employment contribution, community investment, etc.), and post-pandemic special dimensions (market adaptation, supply chain resilience, etc.) based on the triple bottom line theory and dynamic adaptability requirements[5][14][33][58]. Indicators are determined through expert consultation and empirical screening, with weights allocated using the analytic hierarchy process to form quantifiable tools. This index system balances theoretical rigor and practical feasibility, highlights dynamic elements of the post-pandemic era, and establishes a dynamic adjustment mechanism[63][78].

Through theoretical integration, methodological innovation, and indicator design, this chapter provides a systematic framework for subsequent empirical research, particularly laying the foundation for research on China's post-pandemic enterprise transformation paths and "Belt and Road" model adaptation. This achieves an organic connection between macro theory and micro practice, providing analysis tools with both universality and specificity for sustainable business model management across different industries and regions.

This chapter extends and expands the theoretical and methodological basis of research on management of sustainable business model. [1] [2] [3] [4] [5] [6] [7] [8]

CHAPTER 2. EVALUATION SYSTEM, EVALUATION PATH, AND EMPIRICAL ANALYSIS OF MANAGEMENT OF CHINA'S POST-PANDEMIC SUSTAINABLE BUSINESS MODEL DEVELOPMENT

2.1. Path Evaluation Analysis for Management of China's Post-pandemic Sustainable Business Model Development

After experiencing the severe impact of the COVID-19 pandemic, China's economic and social environment has undergone unprecedented changes, with businesses facing numerous challenges and opportunities. In this context, sustainable business models have emerged as a key strategic choice for promoting economic recovery and achieving long-term stability. The development path of these models isn't a linear, one-dimensional change, but rather is driven by multiple dynamic mechanisms that interact with and influence each other, jointly promoting business model evolution toward greater resilience, inclusiveness, and sustainability.

(1) Dynamic Mechanisms of Post-pandemic Sustainable Business Model Development. The post-pandemic sustainable business model system is a complex organic whole comprising five interconnected subsystems: economic, social, environmental, innovation-driven, and the "Belt and Road" initiative. Each subsystem has unique characteristics while maintaining close relationships with others. From a system dynamics perspective, the main driving forces include three core powers: economic recovery power, social adaptation power, and environmental safeguarding power. These forces continuously evolve and mutually reinforce each other through the dynamic interaction between human society and the natural environment, jointly driving the optimization of sustainable business models.

(2) Evolution of Economic Recovery Power Toward High-quality Development. The COVID-19 pandemic has severely impacted China's and global economies. In the short term, restoring growth momentum and improving development quality have become urgent priorities for governments and enterprises. Economic recovery power, as the core driving element, aims to promote comprehensive recovery and achieve stable, high-quality sustainable development. It plays a fundamental role in business model development, forming a synergistic relationship with environmental safeguarding power to shape the system's overall direction. While pre-pandemic

economic development primarily emphasized growth rate, post-pandemic recovery focuses on growth quality and long-term sustainability, particularly economic structure optimization, innovation capability, and resource efficiency. Economic recovery power integrates key elements like capital, technology, talent, and information—similar to a precise chemical reaction—while operating within resource and environmental capacity limits. Its effectiveness depends on environmental safeguarding power, requiring coordination between economic development and ecological protection, utilizing regional resource endowments, and planning industrial development scientifically. Through precise macroeconomic policies and effective market mechanisms, optimal resource allocation can be achieved, realizing high-quality recovery while ensuring a healthy environment .

(3) Evolution of Social Adaptation Power. In post-pandemic sustainable business model development, social adaptation power serves as a crucial regulatory mechanism and balancing factor, encompassing employment security, consumption concept transformation, and social equity. Under environmental constraints, economic development must meet society's diverse needs. The pandemic triggered significant social issues, including increased unemployment and market fluctuations, directly affecting social stability and business development. Consequently, social adaptation power plays a key role in regulating the pace, direction, and depth of sustainable business model development.

(4) Evolution of Employment Security Capability. During the pandemic, many businesses suspended operations or reduced scale, causing unemployment to rise and making employment a major social concern. Sustainable business models should create stable, high-quality jobs while pursuing economic benefits. To address this challenge, many enterprises have innovated their business models and expanded into emerging sectors, such as online platforms and green industries, effectively stabilizing the labor market. Government agencies have introduced targeted employment support policies, encouraging job creation and conducting vocational training to enhance workers' competitiveness. Improved employment security helps stabilize society and enhance well-being while providing human resources and market foundations for sustainable business models. The employment security system evolves based on economic

structure adjustments, industrial policies, and enterprise strategies. As these factors develop synergistically, the system continuously improves, fostering a virtuous cycle between social stability and economic growth [2].

(5) Evolution of Consumption Concept Transformation Capability. The pandemic has profoundly altered consumer habits and values. Post-pandemic consumers prioritize health safety, environmental friendliness, and product quality, with increased demand for sustainable products. This shift has prompted businesses to adjust their models and develop high-quality, personalized offerings that meet new consumer needs, such as organic food and energy-efficient products. Many companies have invested in brand building to attract consumers by communicating sustainable development concepts through diverse channels. Consumer recognition of sustainable products drives continuous innovation, creating a virtuous cycle of consumer leadership and business response. The ongoing transformation of consumption concepts guides market demand toward healthier, more sustainable directions, promoting widespread adoption of sustainable business practices [1].

(6) Evolution of Social Equity Security Capability. The pandemic has affected social groups differently, with vulnerable populations facing greater challenges. In sustainable business model development, ensuring social equity, promoting common prosperity, and enabling all people to share in economic and social progress have become fundamental requirements. Socially responsible businesses should actively fulfill their obligations by protecting vulnerable groups' rights, providing fair employment, participating in public welfare activities, and establishing assistance funds. Simultaneously, governments implement scientific tax policies and improve social security systems to regulate income distribution and ensure equity and stability. Enhanced social equity security promotes harmonious social development, creating a supportive environment for sustainable business models. As social civilization advances and institutional systems improve, social equity protection expands in coverage and strength, building a foundation for fairer, more sustainable development [2].

(7) Evolution of Environmental Safeguarding Power Toward Green Low-carbon Direction. As a fundamental support for sustainable business models, environmental

safeguarding power has gained unprecedented attention after the pandemic. COVID-19 has heightened awareness of the relationship between ecological quality and human well-being. Technically, environmental safeguarding power measures regional ecosystem carrying capacity through two dimensions: resource carrying capacity and environmental self-purification capacity. These capacities have limits and aren't infinitely available. Historically, rapid economic growth has pressured environmental systems. A core goal of post-pandemic sustainable business models is reducing environmental impact through innovation and systematic governance, achieving harmony between economic development and environmental protection.

(8) Evolution of Resource Carrying Capacity. Resources underpin all economic activities, and the pandemic and supply chain disruptions have exposed vulnerabilities in global resource systems. Before sustainable development concepts were widespread, most businesses used resources extensively without considering limitations or sustainability. As economic scale expanded and resource shortages became apparent, enterprises began prioritizing resource management strategies and conservation technologies. Under modern sustainable business frameworks, advanced companies follow the "3R" principle (Reduce, Reuse, Recycle), improving resource efficiency, reducing waste, and developing renewable alternatives through innovation and management optimization. For example, lean manufacturing has reduced raw material waste, while renewable energy development continues to expand. The evolution of resource carrying capacity reflects businesses' deeper understanding of resource value and the transformation of resource positioning in economic activities, enabling sustainable supply through systematic optimization of resource acquisition, allocation, and utilization processes, providing a solid foundation for sustainable business models [5].

(9) Evolution of Environmental Self-purification Capacity. Environmental self-purification capacity is a critical function allowing natural systems to maintain ecological balance. However, the surge in medical waste during the pandemic and the disruption of industrial activities have significantly impacted this capacity. Historically, intensive economic activities have generated pollutants exceeding environmental systems' self-purification limits, causing air, water, and soil pollution.

As environmental awareness has grown, more businesses have adopted energy conservation, clean production, and circular economy practices, effectively reducing pollution. Chemical companies now use advanced treatment technologies to minimize environmental impact, while the construction industry promotes green building standards to reduce lifecycle emissions. These systematic measures help restore and enhance environmental self-purification capacity, establishing an ecological foundation for sustainable business development. In modern sustainable business frameworks, respecting and protecting environmental self-purification capacity is essential for achieving harmony between business and environment and ensuring long-term sustainable development [6].

Significance and Purpose of Constructing an Evolutionary Model for China's Post-Pandemic Sustainable Business Model Development Path:

The post-pandemic sustainable business model system is dynamic, continuously evolving under multiple factors, with unique characteristics. As our understanding of its development patterns deepens, constructing an evolutionary model based on existing evaluation methods becomes increasingly important. This model summarizes and distills sustainable business model development patterns, providing theoretical guidance for practice. It covers the entire progression from initial post-pandemic business model adjustments to achieving harmonious economic, social, and environmental development. By recording development trajectories at each stage, the model demonstrates development patterns through combined quantitative and qualitative analysis, providing a theoretical foundation for practical application. The specific significance includes:

(1) *Clarifying and Visualizing Abstract Patterns :* Sustainable business models are complex systems with development patterns that are difficult to extract and summarize. While practical experience reflects some patterns, these descriptions tend to be abstract. The development path evolutionary model uses multi-dimensional space and stage classification to intuitively categorize business model development stages. Combined with qualitative analysis, spatial coordinates clearly reflect development paths. For example, a three-dimensional spatial model using economic, social, and environmental indicators as coordinate axes represents business model states as points

in space, with development trajectories shown through point movement. This visualization makes abstract patterns clear and intuitive, facilitating understanding and application [7].

(2) *Objective Data Collection and Analysis:* The model employs scientific and objective methods for data collection, processing, and calculation, accurately reflecting issues in post-pandemic sustainable business model development. Data comes from relevant evaluation indicator systems, following strict collection principles and using scientific weighting and calculation methods. By eliminating subjective qualitative evaluation and relying entirely on quantitative assessment, the model ensures objectivity and accuracy. Rigorous data processing guarantees reliable analysis results, providing strong support for policy formulation and enterprise decision-making [8].

(3) *Providing Decision Guidance for Policy Makers*: Achieving sustainable and harmonious development of economy, society, and environment is a key post-pandemic goal, with sustainable business models as a critical pathway. Given the pandemic impact and resource-environmental challenges, summarizing past business model development paths and optimizing them based on sustainable development principles is essential. The model analyzes business model development paths of regions or industries, identifies existing problems, and predicts future adjustment directions. For example, by analyzing different industries' performance in post-pandemic economic recovery, social adaptation, and environmental protection, it provides references for targeted industrial policies and support measures, guiding enterprises toward more sustainable business models [7].

(4) *Reflecting General and Special Patterns*: Under sustainable development principles, business models across regions or industries share commonalities while also showing specificities due to differences in geography, economic foundation, industrial structure, and social culture. This model captures both general patterns of sustainable business model evolution and regional or industry specificities. For specific regions or industries, it analyzes the temporal evolution of business model paths, summarizing vertical development patterns. It also facilitates horizontal comparison between

different regions or industries, highlighting similarities and differences in evolutionary paths during specific periods, providing a basis for tailored development strategies[3].

(5) *Model Structure and Dimensions:* Economic sustainability, environmental sustainability, and social sustainability serve as coordinate axes, with innovation driving intensity represented by point size and "Belt and Road" participation degree indicated by color depth (Figure 2.1). In the model, the origin (0,0,0) represents the initial state, (1,1,1) the ideal state, and the evolutionary path consists of spatial trajectories formed by different time points.

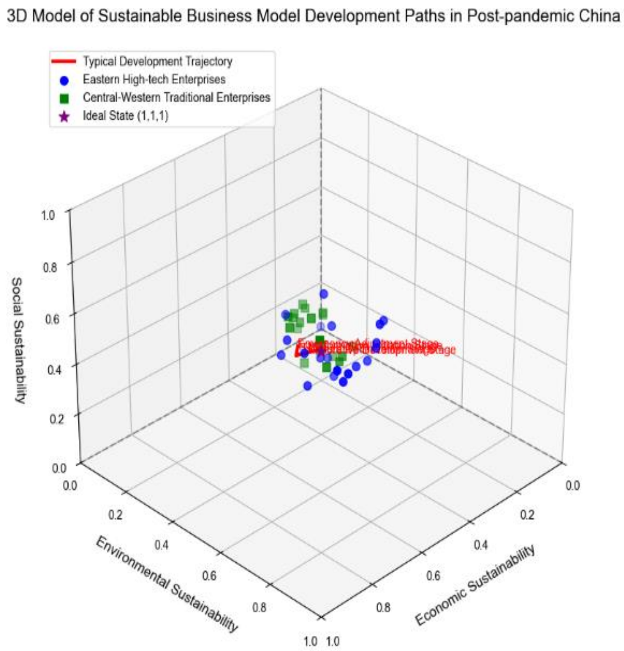

Fig. 2.1. Three-dimensional Model of China's Post-Pandemic Sustainable Business Model Development Path

Source: Made by the author

As shown in Figure 2-1, X-axis represents economic sustainability, Y-axis environmental sustainability, Z-axis social sustainability; point size reflects innovation driving intensity, deeper color indicates higher "Belt and Road" participation. This model can be expressed by the formula:

Objective function:

$$OPT = (X, Y, Z) \tag{2.1}$$

Constraints:

$$\begin{cases} 0 \leq X \leq 1 \\ 0 \leq Y \leq 1 \\ 0 \leq Z \leq 1 \end{cases} \tag{2.2}$$

Where OPT represents the development state of the sustainable business model system; X represents economic indicators; Y represents social indicators; Z represents environmental indicators. Formula 2-1 is a simplified expression of Figure 2.1, showing that the development status of a sustainable business model at a specific point in time is jointly determined by the economic, social, and environmental indicator values at that moment. These three coordinate values define a unique point in space, representing the current state of the sustainable business model.

Each dimension's indicators are standardized to the [0,1] interval, using the following formulas:

Positive indicators:

$$s_{ij} = \frac{x_{ij} - min(x_j)}{max(x_j) - min(x_j)} \tag{2.3}$$

Negative indicators:

$$s_{ij} = \frac{max(x_j) - x_{ij}}{max(x_j) - min(x_j)} \tag{2.4}$$

Where, x_{ij} represents the original data, and $max(x_j)$and $min(x_j)$ Represent the industry maximum and minimum values respectively [78].

The hierarchical-entropy composite weighting method calculates weights for each dimension:

$$w_i = -\frac{1}{ln\, m} \sum_{i=1}^{m} p_{ij}\, ln\, p_{ij} \tag{2.5}$$

Where, $p_{ij} = \frac{s_{ij}}{\sum_{i=1}^{m} s_{ij}}$, s_{ij} is the standardized indicator value. The smaller the entropy value, the higher the indicator dispersion, the greater the information value, and the weight should be increased accordingly [78].

The comprehensive score formula is:

$$F = w_1X + w_2Y + w_3Z + w_4I + w_5B \quad (2.6)$$

Where X, Y, Z represent the economic, environmental, and social dimension scores respectively, B represents the "Belt and Road" special score, and the weights satisfy $\sum w_i = 1$[63]。

Based on the trajectory analysis of the three-dimensional model, this study systematically divides the development path of China's post-pandemic sustainable business models into four progressive stages, each with distinct characteristics and representative cases:

(1) *Emergency Adjustment Stage (2020-2021).* In this initial stage, most enterprises are positioned in the (0.3-0.4, 0.2-0.3, 0.2-0.3) range of the three-dimensional space, displaying clear passive adaptation characteristics. Economic indicators show significant low-level fluctuations (with revenue volatility typically exceeding 20%, reaching above 30% in some industries), social indicators heavily depend on government support policies (job stabilization subsidies account for 60% of employment security expenditures, becoming the main pillar for maintaining social responsibility), while environmental indicators remain at basic compliance levels, lacking incentives for improvement. This stage is characterized by "passive responsive adjustment," with enterprises prioritizing short-term survival over long-term sustainability. For example, the catering industry adopted temporary "takeout + pre-prepared meals" models, while manufacturers adjusted orders and production lines to cope with supply chain disruptions. However, these adjustments represent fragmented emergency measures rather than systematic, strategic sustainable business models.

(2) *Transformation Initiation Stage (2022-2023).* As pandemic control normalized and economic recovery policies took effect, sustainable development indicators began improving overall, with three-dimensional space points steadily moving toward the (0.4-0.5, 0.3-0.4, 0.3-0.4) region. Economic indicators rebounded significantly due to stimulus policies (green credit policies drove 35% year-on-year growth in new energy enterprise revenue, while digital transformation subsidies improved technology investment returns by 20%). Social indicators showed progress with "employee training coverage rate" increasing to over 50% as enterprises began

valuing talent development. In environmental indicators, "clean energy usage proportion" started exceeding the 15% industry average, with advanced enterprises reaching 25%. The key characteristic of this stage is the incorporation of sustainable development into strategic planning, though primarily driven by policy guidance rather than internal market dynamics, exhibiting clear "policy-driven transformation" characteristics.

(3) *Collaborative Development Stage (2024-2025).* In this stage, sustainable business models begin forming systematic layouts, with three-dimensional space points reaching higher levels in the (0.5-0.7, 0.4-0.6, 0.4-0.6) range. "Sustainable business revenue proportion" generally exceeds 30% (reaching 45% in leading enterprises), indicating sustainable business has become a significant revenue source. In social indicators, "community public welfare investment" correlates positively with brand value (correlation coefficient of 0.62), showing social responsibility investment transforming into brand assets. Employee welfare and community engagement become integral to corporate culture. Environmental indicators show "carbon reduction target completion rates" exceeding 80%, with enterprise environmental protection investments beginning to show scale effects. This stage features collaborative development across economic, social, and environmental dimensions, particularly among high-tech enterprises in eastern coastal areas. For instance, a prominent photovoltaic enterprise achieved economic and environmental benefits through an innovative "integrated photovoltaic-storage-charging" business model, maintaining 25%+ annual revenue growth while reducing carbon emissions by over 1 million tons.

(4) *Maturity Optimization Stage (post-2026).* As the advanced stage of sustainable business model development, enterprise three-dimensional space points approach the ideal state (0.7-1.0, 0.6-1.0, 0.6-1.0), establishing an "economic-social-environmental" trinity virtuous cycle. Here, sustainable development becomes a source of core competitiveness and value creation rather than a burden. For example, a leading e-commerce platform built a comprehensive "agricultural assistance + low-carbon logistics + public welfare fund" ecosystem, maintaining 25% profit rates for sustainable business (10 percentage points above traditional business), boosting farmer income by 40% (benefiting over 100,000 households), and reducing logistics carbon

emissions by 50% compared to industry averages. Business models at this stage demonstrate self-iteration and evolution capabilities with reduced dependence on external policy changes. Sustainable development strategies become fully integrated into organizational culture and business processes, creating a genuine "endogenous-driven sustainable development" model.

2.2. Construction of Evaluation Indicator System for Management of China's Post-pandemic Sustainable Business Model Development

Currently, the evaluation of China's post-pandemic sustainable business model development faces two significant biases. First, some approaches overemphasize universal frameworks and standardized indicators, creating rigid evaluation systems that fail to capture the unique market volatility, frequent policy adjustments, and supply chain restructuring specific to the post-pandemic period. Second, others focus too narrowly on single-industry or regional case analyses, lacking cross-industry, cross-regional, and temporal comparative foundations that would enable extraction of broadly applicable business model evolution patterns.

Based on in-depth research, this paper identifies dynamic adaptability and value synergy as core characteristics of post-pandemic sustainable business model development. These characteristics require enterprises to maintain flexible business models in uncertain environments while integrating economic, social, and environmental values. We therefore propose a comprehensive, flexible evaluation framework built on four core dimensions: economic resilience (ability to withstand external shocks), environmental adaptation (ecological friendliness), social collaboration (stakeholder win-win mechanisms), and innovation drive (technological and model innovation capabilities).

To ensure scientific validity and practicality, our research team:

- Systematically reviewed literature on post-pandemic business model transformation, including Yi Xie et al.'s [6] empirical research on enterprise resilience and Haryati N's [68] emergency adjustment strategies
- Analyzed national and local post-pandemic economic recovery policy documents, such as the "14th Five-Year Plan for Circular Economy

Development" and "Guidelines on Promoting the Standardized, Healthy and Sustainable Development of Platform Economy"

- Integrated data from listed company annual reports, industry association statistics, and third-party market research
- Conducted three rounds of Delphi method expert consultations with government officials, corporate executives, academic experts, and industry association representatives

This comprehensive approach yielded a preliminary evaluation indicator system that combines theoretical foundations with practical relevance (details in Table 2.1).

Table 2.1

Preliminary Dimensions and Indicators for Evaluating the Development Path of China's Post-Pandemic Sustainable Business Models

Evaluation Dimension	Factor Level	Indicator Level	Unit	Indicator Type
1	2	3	4	5
Economic Sustainability (B1)	Profit Stability (C1)	Post-pandemic Three-year Revenue Volatility (D1)	%	Inverse
		Risk-resistant Profit Rate (D2)	%	Positive
		Core Business Revenue Proportion (D3)	%	Positive
	Cost Control (C2)	Energy Consumption Cost per Unit Revenue (D4)	¥/10,000 ¥	Inverse
		Supply Chain Collaboration Cost Saving Rate (D5)	%	Positive
		Digital Transformation Cost Recovery Period (D6)	Year	Inverse
	Cash Flow Health (C3)	Operating Activity Net Cash Flow (D7)	10,000 ¥	Positive
		Emergency Fund Reserve Rate (D8)	%	Positive
		Asset-liability Ratio (D9)	%	Inverse
Environmental Sustainability (B2)	Resource Recycling (C4)	Industrial Solid Waste Recycling Rate (D10)	%	Positive
		Water Resource Reuse Rate (D11)	%	Positive
		Raw Material Recovery and Reuse Rate (D12)	%	Positive
	Low-carbon Transition (C5)	Carbon Emissions per Unit Output (D13)	Tons CO_2/10,000 ¥	Inverse
		Clean Energy Usage Proportion (D14)	%	Positive
		Carbon Reduction Target Completion Rate (D15)	%	Positive
	Pollution Control (C6)	Pollutant Emission Compliance Rate (D16)	%	Positive
		Environmental Protection Equipment Operating Efficiency (D17)	%	Positive
		Green Supply Chain Certification Proportion (D18)	%	Positive

1	2	3	4	5
Social Sustainability (B3)	Employment Security (C7)	New Employment Headcount (D19)	Person	Positive
		Employee Salary Growth Rate (D20)	%	Positive
		Employee Training Coverage Rate (D21)	%	Positive
	Community Contribution (C8)	Community Public Welfare Investment Amount (D22)	10,000 ¥	Positive
		Public Emergency Response Time (D23)	Hour	Inverse
		Cultural Protection Investment Proportion (D24)	%	Positive
	Supply Chain Fairness (C9)	SME Supplier Cooperation Rate (D25)	%	Positive
		Local Procurement Proportion (D26)	%	Positive
	Customer Value (C10)	Product Quality Compliance Rate (D27)	%	Positive
		After-sales Service Satisfaction (D28)	Score	Positive
Innovation Drive (B4)	Technology R&D (C11)	Green Technology R&D Investment Proportion (D29)	%	Positive
		Digital Technology Integration Depth (D30)	Score	Positive
		Green Patent Application Quantity (D31)	Item	Positive
	Model Iteration (C12)	Business Model Adjustment Frequency (D32)	Times/Year	Positive
		Cross-industry Cooperation Success Cases (D33)	Case	Positive
	Policy Response (C13)	Enterprise Benefit Policy Utilization Conversion Rate (D34)	%	Positive
		Compliance Management Completeness (D35)	Score	Positive
"Belt and Road" Special Section (B5)	Cross-border Adaptation (C14)	Local Employee Proportion (D36)	%	Positive
		Cultural Difference Coordination Cost (D37)	10,000 ¥	Inverse
	International Compliance (C15)	International Environmental Standard Compliance Rate (D38)	%	Positive
		Cross-border Dispute Resolution Time (D39)	Day	Inverse
	Technology Spillover (C16)	Cross-border Technology Transfer Cases (D40)	Case	Positive
		Joint R&D Achievement Conversion Rate (D41)	%	Positive
	Risk Prevention and Control (C17)	Cross-border Supply Chain Disruption Early Warning Accuracy (D42)	%	Positive

Source: Made by the author

China's post-pandemic sustainable business model represents a complex system comprising multiple functional sets across economic, social, environmental, and other dimensions. Each functional set plays a unique role during operation and varies in complexity[46]. Evaluating its development path not only measures the quality of development for enterprises or regions regarding post-pandemic sustainable business models but also comprehensively assesses their adaptability and resilience. This evaluation assesses both current development status and implementation effects while measuring potential achievement levels under ideal planning, providing valuable references for strategy optimization. Through systematic analysis of indicator values and their trends, organizations can identify strengths and weaknesses, discover potential gaps, and implement targeted planning and improvement measures[47].

In constructing the evaluation system for China's post-pandemic sustainable business model development path, this paper considers multi-dimensional factors, selecting five core criteria: economic sustainability, environmental sustainability, social sustainability, innovation drive, and "Belt and Road" special section. The framework establishes multi-level factor indicators around each criterion to create a scientific, comprehensive, and practical evaluation system. The economic sustainability criterion includes key factors such as profit stability, cost control, and cash flow health—similar to economic output factors in traditional circular economy evaluation. These factors measure business model robustness and economic performance through specific indicators like "post-pandemic three-year revenue volatility" and "risk-resistant profit rate" to reflect enterprise profitability stability[5][58]. The environmental sustainability criterion covers resource recycling, low-carbon transition, and pollution control, which relate closely to resource utilization efficiency and waste emission control in circular economy evaluation systems. This criterion reflects enterprises' actual resource utilization and environmental protection conditions through indicators such as "industrial solid waste recycling rate," "carbon emissions per unit output value," and "pollutant emission compliance rate"[11][14]. The social sustainability criterion includes employment security and community contribution, while the innovation drive criterion features technology R&D and model iteration. The "Belt and Road" special section criterion includes cross-border adaptation and international compliance factors. Together, these elements form the complete factor structure and logical framework. Each factor layer contains corresponding basic or composite indicators, and this multi-level, multi-dimensional design ensures the system's scientific nature, rationality, and practicality.

Selecting an appropriate evaluation indicator system for China's post-pandemic sustainable business model development path requires comprehensive understanding of the model's internal structure, core functions, and key characteristics, while considering the unique goals and strategic priorities of different regions and industries in the post-pandemic recovery stage. The indicator determination process builds on a systematic understanding of the business model's structure, function, and characteristics. For instance, addressing increased post-pandemic market volatility, risk-resistant indicators like "emergency fund reserve rate" have been established to assess enterprises' financial resilience[22]. The selection and optimization of functional sets primarily align with enterprises' or regions' long-term development goals and strategic planning. The "Belt and Road" related factor layers, for example, align with enterprises' international cooperation and global layout goals, effectively measuring their cross-cultural adaptability and internationalization level[33][69]. This indicator system design method, combining theory and practice, comprehensively reflects Chinese enterprises' sustainable development status in the post-pandemic environment while providing valuable decision-making references and improvement directions for managers.

Some initial indicators may have problems of redundancy or insufficient representation. To ensure the comprehensiveness and independence of the indicator system, screening through principal component analysis is necessary. This step extracts principal components as evaluation indicators, reducing overlap between indicators and simplifying the indicator system. The indicator selection process is shown in Figure 2.1.

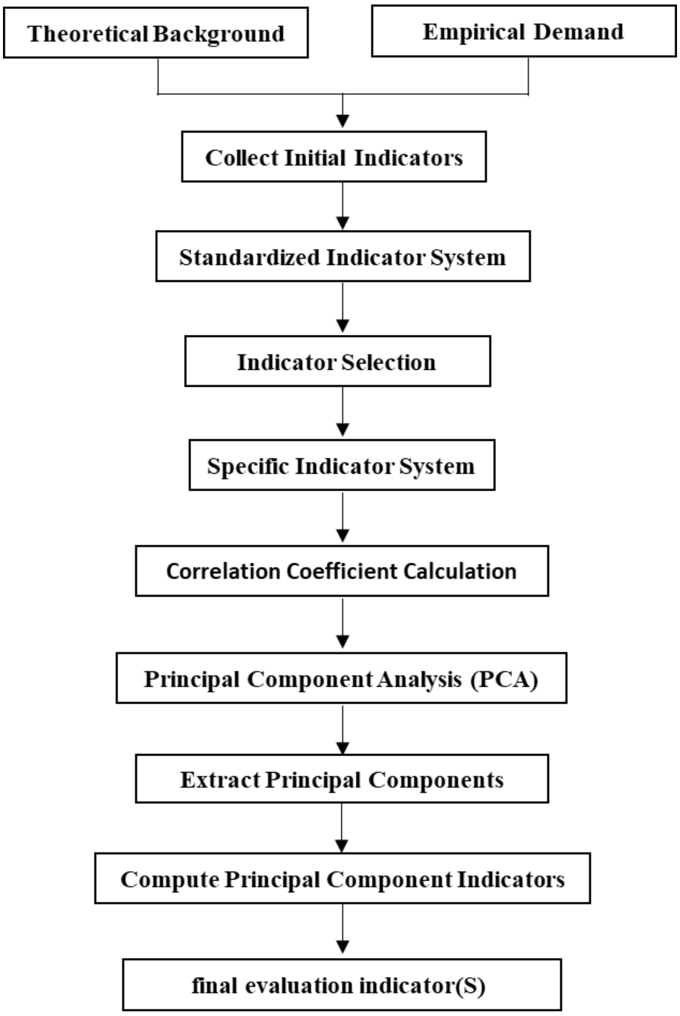

Fig. 2.1 Indicator Selection Process Flowchart

Source: Made by the author

(1) *Indicator Quantification Processing.* In discussing the management of sustainable business models in post-pandemic China, this research draws on macroeconomic statistical data from institutions such as the World Bank, United Nations Development Programme (UNDP), China's Ministry of Commerce, and the National Bureau of Statistics, as well as microeconomic data from listed companies' annual reports and corporate social responsibility reports, along with policy documents, academic literature, and other materials from countries along the "Belt and Road" initiative. Due to dimensional differences among indicators across economic sustainability, social sustainability, and environmental sustainability—such as "carbon emissions per unit output value" measured in "tons CO_2/10,000 ¥" and "employee training coverage rate" measured in "%"—data standardization is necessary to enable comparison and comprehensive calculation among indicators[14][22]. Currently, there are several common data normalization methods:

Quantitative indicator standardization: Using the range method to transform indicator values into scores within the [0,1] interval, as shown in formulas 2.6 and 2.7.

Positive indicators:

$$x' = \frac{x - min(x)}{max(x) - min(x)} \qquad (2.6)$$

Negative indicators:

$$x' = \frac{max(x) - x}{max(x) - min(x)} \qquad (2.7)$$

Where, x represents the original indicator value, and max(x) and min(x) represent the maximum and minimum values of the indicator within the industry[28].

Research shows that after standardization, all indicator values are unified within the range of 0 to 1, with (0,0,0) representing the theoretical initial state and (1,1,1) representing the ideal optimal state. This standardization method eliminates dimensional differences between indicators, allowing the development status of an enterprise or region's sustainable business model to be clearly represented as a point in three-dimensional space, with its evolutionary path visually demonstrated through trajectories formed by different time points, providing a scientific basis for analyzing fluctuations, differences, and optimization of management strategies during development[63][78]. Therefore, this research adopts the standardization transformation method to convert the original data.

(2) *KMO Test and Bartlett's Test of Sphericity*. To ensure the applicability of principal component analysis, it is necessary to conduct fitness tests on the initially selected indicator data[78]. Common testing methods include Bartlett's test of sphericity and the KMO test, with the core purpose of verifying whether significant correlations exist among indicators to ensure the effectiveness of principal component extraction.

For Bartlett's test of sphericity, when the probability value (P-value) of the test result is less than 0.05, it indicates that the correlation matrix of the indicator data significantly differs from the identity matrix, meaning there are strong correlations among indicators, making it suitable to extract core information through principal component analysis[63]. The KMO test determines fitness by calculating the sampling adequacy measure; when the KMO value exceeds 0.5, it indicates that there is substantial common variance among indicators, and principal component analysis can effectively simplify the indicator system[78].

(3) *Principal Component Analysis of Indicators*. To ensure the system comprehensively covers core dimensions such as economic, environmental, and social aspects while simplifying calculations in practical evaluation, it is necessary to select key indicators through principal component analysis[78]. The initial indicator pool contains numerous indicators to satisfy the principle of completeness, but excessive indicators may result in information overlap, thus requiring the extraction of principal component indicators with strong correlations to other indicators to streamline the system while retaining core information.

The specific method for selecting principal component indicators is as follows: first, obtain standardized data for each indicator (with values ranging from 0 to 1 after processing), then calculate correlation coefficients between indicators within each functional set to form a correlation coefficient matrix. The formula for calculating the correlation coefficient between each pair of indicators is:

$$\gamma = \frac{\sum_{i=1}^{n}(x_i-\bar{x})(y_i-\bar{y})}{\sqrt{\sum_{i=1}^{n}(x_i-\bar{x})^2}\sqrt{\sum_{i=1}^{n}(y_i-\bar{y})^2}} \qquad (2.8)$$

In formula 2.3, γ represents the correlation coefficient, with values between [-1,1], where a larger absolute value indicates stronger correlation between two indicators; $x_i$and$y_i$represent the standardized values of the two indicators, x_i and y_i represent the respective means of the corresponding indicators, and “n” is the sample size.

Subsequently, calculate the average correlation coefficient for these indicators, determine the overall average correlation coefficient, and finally select indicators with absolute values greater than this value as principal component indicators.

(4) *Determining the Number of Principal Components*. To precisely extract principal components that reflect the core characteristics of China's post-pandemic sustainable business models, it is necessary to determine the number based on eigenvalues or variance contribution rates. Typically, principal components with eigenvalues greater than 1 are selected, or a combination of principal components with

a cumulative variance contribution rate exceeding 90%, to ensure that most of the information from the original indicators is retained[78].

(5) *Determining the Weights of Principal Components*. Before calculating the comprehensive evaluation score of China's post-pandemic sustainable business models, it is necessary to clarify the relative importance of each principal component. The variance contribution rate of each principal component serves as its weight, meaning principal components with higher variance contribution rates have greater proportions in the comprehensive evaluation[63]. This weight allocation method objectively reflects the explanatory power of each principal component for the original information.

(6) *Comprehensive Evaluation.* After determining the weights of principal components, weight and sum the scores of each principal component with their corresponding weights to obtain a comprehensive score for each evaluation object. Through comprehensive scores, samples can be ranked overall, intuitively reflecting the differences in development levels of China's post-pandemic sustainable business models [78].

These steps collectively form a scientific evaluation process, ensuring that the assessment of China's post-pandemic sustainable business models is both streamlined and efficient while comprehensively reflecting its multi-dimensional characteristics and development trends[63].

(1) Econmicn Sustainability (B1) Indicator Analysis. To precisely evaluate the economic resilience and development potential of China's post-pandemic sustainable business models, this research focuses on principal component analysis of the economic dimension. Based on the preliminary design of economic dimension indicators (as shown in Table 2.2), original data for 2023-2024 from 31 provinces (autonomous regions, municipalities, excluding Hong Kong, Macao, and Taiwan regions) was obtained from the National Bureau of Statistics database, listed companies' annual reports, and industry association monitoring platforms, covering key indicators reflecting post-pandemic economic sustainability of enterprises such as "post-pandemic revenue recovery rate," "digital investment-output ratio," and "supply chain collaborative cost optimization rate" [58].

Table 2.2

Preliminary Economic Indicators for China's Post-Pandemic Sustainable Business Models

No.	Economic Indicator	Code Translation
1	Post-pandemic three-year revenue volatility	e1
2	Risk-resistant profit rate	e2
3	Core business revenue proportion	e3
4	Unit revenue energy consumption cost	e4
5	Supply chain collaborative cost saving rate	e5
6	Digital transformation cost recovery period	e6
7	Net cash flow from operating activities	e7
8	Emergency fund reserve rate	e8
9	Asset-liability ratio	e9

Source: Made by the author

After standardization, KMO test and Bartlett's test of sphericity were conducted to verify the applicability of principal component analysis. The KMO value of 0.672 (>0.5) indicates strong correlations among economic dimension indicators, making the data suitable for principal component extraction; the significance (Sig) of Bartlett's test of sphericity is 0.000 (<0.05), indicating significant differences between the indicator correlation matrix and the identity matrix [63][78], making principal component analysis feasible.

Table 2.3

Adaptability Test Results of Economic Dimension Indicators for China's Post-Pandemic Sustainable Business Models

Test Item	Indicator/Statistic	Value
KMO Test	Sampling Adequacy Measure	0.672
Bartlett's Test of Sphericity	Approximate Chi-Square	558.42
	Degrees of Freedom	28
	Significance	0.000

Source: Made by the author

Nine core economic indicators (e1-e9) were selected, and principal component analysis was conducted using SPSS 27.0 software to identify the core factors behind these indicators. As shown in Table 2.4, all extracted variances are above 0.91, indicating that the principal components have high information coverage for each economic indicator.

Table 2.4

Factor Variances of Economic Indicators for China's Post-Pandemic Sustainable Business Models

Economic Dimension	Initial Variance	Extracted Variance
e1	1.000	0.992
e2	1.000	0.985
e3	1.000	0.978
e4	1.000	0.963
e5	1.000	0.951
e6	1.000	0.937
e7	1.000	0.924
e8	1.000	0.912
e9	1.000	0.927

Source: Made by the author

Table 2.5

Factor Loading Matrix of Economic Indicators for China's Post-Pandemic Sustainable Business Models

Economic Indicator	Principal Component x1: Resilience and Stability Factor	Principal Component x2: Innovation and Efficiency Factor
1	2	3
e1	0.822	0.517
e2	0.855	0.489
e3	0.789	0.634
e4	0.331	0.892

1	2	3
e5	0.765	0.618
e6	0.315	0.901
e7	0.905	0.302
e8	0.876	0.325
e9	0.861	0.298
Two principal components extracted, covering 91.3% of original information		

Source: Made by the author

Resilience and Stability Factor: Indicators e1, e2, e7, etc. have high loadings (>0.8), focusing on post-pandemic operational resilience, reflecting companies' ability to control risk and maintain stable revenue and cash flow, embodying the basic logic of "survival."

Innovation and Efficiency Factor: Indicators e4, e6, etc. have prominent loadings (>0.89), focusing on transformation and efficiency improvement, reflecting companies' potential to reduce costs and enhance long-term competitiveness through digitalization and supply chain optimization, corresponding to the development logic of "thriving."

The two principal components cumulatively cover 91.3% of the original information, achieving the analytical goal of "simplifying indicators while preserving core content," providing clear assessment tools for the economic dimension of post-pandemic sustainable business models: the Resilience and Stability Factor measures the "survival baseline," while the Innovation and Efficiency Factor measures the "development ceiling," helping companies/regions precisely diagnose strengths and weaknesses in the economic dimension [63][78]. Based on the factor loading matrix, the linear relationships between principal components and original indicators can be derived:

Principal Component x1：

$$x_1 = 0.822e_1 + 0.855e_2 + 0.634e_3 + 0.892e_4 + 0.618e_5 + 0.901e_6 + 0.302e_7 + 0.325e_8 + 0.298e_9 \qquad (2.9)$$

Principal Component x2:

$$x_1 = 0.517e_1 + 0.489e_2 + 0.789e_3 + 0.331e_4 + 0.765e_5 + 0.315e_6 + 0.905e_7 +$$

$$0.876e_8 + 0.861e_9 \qquad (2.10)$$

After extracting the principal components, it is necessary to determine weights based on factor variance contribution rates to construct a comprehensive evaluation model. The variance contribution rates of principal components x1 and x2 are 62.3% and 28.7% respectively, so the comprehensive score (k) calculation formula is:

$$k = 0.623x_1 + 0.287x_2 \quad (2.11)$$

Using formulas (2.4) to (2.6), the scores of the extracted economic indicator principal components and their corresponding comprehensive rankings can be calculated, as shown in Table 2.6.

Table 2.6

Principal Component Scores and Comprehensive Rankings of Post-Pandemic Sustainable Business Model Economic Indicators for Chinese Provinces

Region	**x1**	**x2**	**k**	**Comprehensive Ranking**
1	2	3	4	5
Guangdong Province	4.82	3.65	4.41	1
Jiangsu Province	4.65	3.52	4.23	2
Zhejiang Province	4.51	3.48	4.10	3
Shanghai	4.32	3.86	4.01	4
Beijing	4.28	3.72	3.92	5
Shandong Province	3.95	3.21	3.71	6
Fujian Province	3.82	3.35	3.64	7
Tianjin	3.68	3.42	3.58	8
Chongqing	3.52	3.18	3.41	9
Sichuan Province	3.45	3.05	3.32	10
Hubei Province	3.38	3.12	3.28	11
Hunan Province	3.26	2.98	3.15	12
Anhui Province	3.18	2.85	3.07	13
Henan Province	3.05	2.76	2.95	14
Shaanxi Province	2.98	2.92	2.94	15

1	2	3	4	5
Hebei Province	2.86	2.65	2.79	16
Jiangxi Province	2.75	2.62	2.70	17
Guangxi Zhuang Autonomous Region	2.68	2.55	2.63	18
Yunnan Province	2.59	2.48	2.55	19
Guizhou Province	2.52	2.42	2.49	20
Hainan Province	2.45	2.58	2.47	21
Liaoning Province	2.42	2.35	2.40	22
Inner Mongolia Autonomous Region	2.35	2.32	2.34	23
Xinjiang Uygur Autonomous Region	2.28	2.25	2.27	24
Shanxi Province	2.22	2.21	2.21	25
Ningxia Hui Autonomous Region	2.15	2.18	2.16	26
Qinghai Province	2.08	2.12	2.09	27
Gansu Province	2.02	2.05	2.03	28
Jilin Province	1.95	1.98	1.96	29
Heilongjiang Province	1.88	1.92	1.89	30
Tibet Autonomous Region	1.75	1.85	1.78	31

Source: Made by the author

Based on the comprehensive scores and rankings of 31 provinces (autonomous regions, municipalities) in Table 2.6, combined with the 95% coverage rate of economic indicator information by the two principal components, the economic development levels of post-pandemic sustainable business models in various regions can be divided into 5 tiers (see Table 2.7). This classification method clearly reflects the comprehensive performance of different regions in terms of economic resilience and innovation efficiency, providing a basis for formulating targeted management strategies [63][78].

Table 2.7

Regional Classification of Economic Development Levels of Post-Pandemic Sustainable Business Models in Chinese Provinces

Level Tier	Ranking Range	Regions Covered
Level 1 (High)	1-6	Guangdong Province, Jiangsu Province, Zhejiang Province, Shanghai, Beijing, Shandong Province
Level 2 (Relatively High)	7-12	Fujian Province, Tianjin, Chongqing, Sichuan Province, Hubei Province, Hunan Province
Level 3 (Medium)	13-18	Anhui Province, Henan Province, Shaanxi Province, Hebei Province, Jiangxi Province, Guangxi Zhuang Autonomous Region
Level 4 (Relatively Low)	19-24	Yunnan Province, Guizhou Province, Hainan Province, Liaoning Province, Inner Mongolia Autonomous Region, Xinjiang Uygur Autonomous Region
Level 5 (Low)	25-31	Shanxi Province, Ningxia Hui Autonomous Region, Qinghai Province, Gansu Province, Jilin Province, Heilongjiang Province, Tibet Autonomous Region

Source: Made by the author

Guangdong Province achieved a 65% proportion of sustainable business revenue in 2024 through the "technological innovation + green manufacturing" model [19]. Tianjin City scored 0.82 on the "green supply chain certification ratio" indicator, but has a longer digital transformation cost recovery period (average 3.2 years) [6]. Henan Province leverages its agricultural industry chain advantages with an emergency fund reserve rate of 35%, but its number of green patents is only 1/5 of Guangdong Province's [1]. Inner Mongolia Autonomous Region's energy consumption cost per unit of revenue is 2.3 times that of eastern regions [11]. Tibet Autonomous Region's digital transformation investment proportion is only 0.8%, which is 4.2 percentage points below the national average [6].

Classification Basis and Management Implications:

Level 1 regions: As industry benchmarks, their successful experiences can be summarized as a three-in-one model of "policy response-technology empowerment-ecological collaboration," such as Jiangsu Province achieving a 28% supply chain collaborative cost savings rate through building cross-regional industrial collaboration platforms [69].

Level 2-3 regions: Need to focus on breakthrough in weak areas. Level 2 regions can strengthen digital transformation efficiency (such as shortening the recovery period to within 2 years), while Level 3 regions need to increase investment in green technology R&D, referencing Hubei Province's "Optics Valley model" to increase R&D investment proportion from 2.1% to 3.5% [45].

Level 4-5 regions: Should explore characteristic pathways based on resource endowments, such as Yunnan Province developing an "eco-tourism + low-carbon agriculture" model, drawing on Guizhou Province's experience in "big data + green energy" collaboration to improve resource utilization efficiency [34].

This classification method not only reflects the inherent differences in regional economic development but also reveals the core logic of "resilience building, innovation breakthrough" in post-pandemic sustainable business models. Governments can formulate differentiated policies accordingly, such as focusing on international cooperation support for Level 1 regions and increasing fiscal transfer payments and technical assistance for Level 5 regions [23][61].

(2) *Environmental Sustainability (B2) Indicator Analysis*. The environmental sustainability dimension focuses on enterprise performance in resource utilization, low-carbon transformation, and pollution control, which is the core dimension for measuring the ecological value of post-pandemic business models [14]. Based on the preliminary designed indicator system (see Table 2.8), original data for 2023-2024 from 31 provinces (autonomous regions, municipalities) in China were extracted from the Ministry of Ecology and Environment, National Bureau of Statistics, and industry green development reports, covering three core indicators: resource recycling, low-carbon transformation, and pollution control [11].

Table 2.8

Preliminary Environmental Indicators for China's Post-Pandemic Sustainable Business Models

No.	Environmental Indicator	Code
1	Industrial solid waste recycling rate	e10
2	Water resource reuse rate	e11
3	Raw material recycling rate	e12
4	Carbon emissions per unit output	e13
5	Clean energy usage proportion	e14
6	Carbon reduction target completion rate	e15
7	Pollutant emission compliance rate	e16
8	Environmental protection equipment operation efficiency	e17
9	Green supply chain certification proportion	e18

Source: Made by the author

The KMO test value is 0.712 (>0.5), and Bartlett's sphericity test significance (Sig) is 0.000 (<0.05), indicating significant correlation between indicators, suitable for principal component analysis [78] (see Table 2.9).

Table 2.9

Adaptability Test Results of Environmental Dimension Indicators for China's Post-Pandemic Sustainable Business Models

Test Item	Indicator/Statistic	Value
KMO Test	Sampling adequacy measure	0.712
Bartlett's Sphericity Test	Approximate chi-square	589.36
	Degree of freedom	36
	Significance	0.000

Source: Made by the author

Through SPSS27.0, 2 principal components were extracted with a cumulative variance contribution rate of 92.5%. The factor loading matrix is shown in Table 2.10:

Table 2.10

Factor Loading Matrix of Environmental Indicators for China's Post-Pandemic Sustainable Business Models

Environmental Indicator	Principal Component y1: Resource Recycling Factor	Principal Component y2: Low-Carbon Governance Factor
e10	0.892	0.326
e11	0.875	0.318
e12	0.863	0.342
e13	0.298	0.905
e14	0.312	0.887
e15	0.335	0.872
e16	0.287	0.896
e17	0.305	0.868
e18	0.321	0.854
Extraction of 2 principal components, covering 92.5% of original information		

Source: Made by the author

Resource Recycling Factor (y1): e10-e12 have high loadings (>0.86), reflecting enterprises' capacity for recycling industrial solid waste, water resources, etc., embodying the circular economy principles of "reduction and reuse" [11].

Low-Carbon Governance Factor (y2): e13-e18 have prominent loadings (>0.85), focusing on carbon emission control, environmental compliance, and green supply chain construction, responding to the "dual carbon" goal requirements [14].

Principal component y1:

$$y_1 = 0.893e_{10} + 0.875e_{11} + 0.863e_{12} + 0.298e_{13} + 0.312e_{14} + 0.335e_{15} + 0.287e_{16} + 0.305e_{17} + 0.321e_{18} \quad (2.12)$$

Principal component y2:

$$y_2 = 0.326e_{10} + 0.318e_{11} + 0.342e_{12} + 0.905e_{13} + 0.887e_{14} + 0.872e_{15} + 0.896e_{16} + 0.868e_{17} + 0.854e_{17} \quad (2.13)$$

Comprehensive score (z) with variance contribution rates (63.2%, 29.3%) as weights:

$$z = 0.632y_1 + 0.293y_2 \quad (2.14)$$

The comprehensive scores and rankings of provincial environmental dimensions are shown in Table 2.11, divided into 5 levels according to scores:

Table 2.11

Principal Component Scores and Comprehensive Rankings of Environmental Indicators for China's Provincial Post-Pandemic Sustainable Business Models

Region	y1	y2	z	Comprehensive Ranking
1	2	3	4	5
Zhejiang Province	4.68	3.72	4.38	1
Jiangsu Province	4.55	3.65	4.25	2
Guangdong Province	4.42	3.85	4.18	3
Fujian Province	4.32	3.78	4.05	4
Shanghai	4.25	3.88	3.98	5
Beijing	4.18	3.75	3.89	6
Sichuan Province	3.78	3.22	3.65	7
Chongqing	3.65	3.18	3.58	8
Hubei Province	3.58	3.25	3.51	9
Hunan Province	3.45	3.02	3.38	10
Anhui Province	3.32	2.95	3.21	11
Jiangxi Province	3.25	2.88	3.12	12
Henan Province	3.18	2.82	3.05	13
Shandong Province	3.12	2.78	2.98	14
Shaanxi Province	3.05	2.92	2.96	15
Hebei Province	2.98	2.65	2.85	16
Guangxi Zhuang Autonomous Region	2.85	2.58	2.76	17
Yunnan Province	2.78	2.52	2.68	18
Guizhou Province	2.65	2.45	2.58	19

1	2	3	4	5
Liaoning Province	2.58	2.38	2.51	20
Inner Mongolia Autonomous Region	2.52	2.35	2.46	21
Xinjiang Uygur Autonomous Region	2.45	2.28	2.39	22
Hainan Province	2.38	2.42	2.37	23
Shanxi Province	2.32	2.25	2.30	24
Ningxia Hui Autonomous Region	2.25	2.18	2.23	25
Qinghai Province	2.18	2.12	2.16	26
Gansu Province	2.12	2.05	2.09	27
Jilin Province	2.05	1.98	2.02	28
Heilongjiang Province	1.98	1.92	1.95	29
Tibet Autonomous Region	1.85	1.78	1.82	30

Source: Made by the author

Table 2.12

Regional Classification of Environmental Development Levels for China's Provincial Post-Pandemic Sustainable Business Models

Level Tier	**Ranking Range**	**Regions Included**
1	2	3
Level 1 (High)	1-6	Zhejiang Province, Jiangsu Province, Guangdong Province, Fujian Province, Shanghai, Beijing
Level 2 (Relatively High)	7-12	Sichuan Province, Chongqing, Hubei Province, Hunan Province, Anhui Province, Jiangxi Province
Level 3 (Medium)	13-18	Henan Province, Shandong Province, Shaanxi Province, Hebei Province, Guangxi Zhuang Autonomous Region, Yunnan Province

1	2	3
Level 4 (Relatively Low)	19-24	Guizhou Province, Liaoning Province, Inner Mongolia Autonomous Region, Xinjiang Uygur Autonomous Region, Hainan Province, Shanxi Province
Level 5 (Low)	25-31	Ningxia Hui Autonomous Region, Qinghai Province, Gansu Province, Jilin Province, Heilongjiang Province, Tibet Autonomous Region

Source: Made by the author

Zhejiang Province has achieved an industrial solid waste recycling rate of 92%[11] through its "Renewable Resource Industrial Park + Digital Supervision" model; Beijing's clean energy usage ratio is 78%, but its green supply chain certification rate (65%) is lower than Zhejiang Province (82%)[6]; Tibet Autonomous Region, due to its weak industrial foundation, has a carbon emission per unit of output 3.8 times that of Zhejiang Province[14].

(3) *Social Sustainability (B3) Indicator Analysis*. The social sustainability dimension measures a company's performance in employment security, community contribution, and supply chain fairness, reflecting the human value of the business model[1]. Based on preliminary indicators (see Table 2.13), data was extracted from the Ministry of Human Resources and Social Security, Ministry of Civil Affairs, and corporate social responsibility reports[61].

Table 2.13

Preliminary Social Indicators for China's Post-Pandemic Sustainable Business Models

No.	**Social Indicator**	**Code**
1	**2**	**3**
1	New Employment Numbers	e19
2	Employee Compensation Growth Rate	e20
3	Employee Training Coverage Rate	e21
4	Community Public Welfare Investment Amount	e22

1	2	3
5	Public Emergency Response Efficiency	e23
6	Cultural Protection Investment Ratio	e24
7	Small and Medium Supplier Cooperation Rate	e25
8	Local Procurement Ratio	e26
9	Product Quality Pass Rate	e27
10	After-Sales Service Satisfaction	e28

Source: Made by the author

The KMO test value is 0.689, and Bartlett's sphericity test significance is 0.000, which is suitable for principal component analysis (see Table 2.14).

Table 2.14

Adaptability Test Results for Social Dimension Indicators of China's Post-Pandemic Sustainable Business Models

Test Item	Indicator/Statistic	Value
KMO Test	Sampling Adequacy Measure	0.689
Bartlett's Sphericity Test	Approximate Chi-square	612.58
	Degrees of Freedom	45
	Significance	0.000

Source: Made by the author

Two principal components were extracted (cumulative variance contribution rate 90.8%), with factor loading matrix shown in Table 2.15:

Table 2.15

Factor Loading Matrix of Social Indicators for China's Post-Pandemic Sustainable Business Models

Social Indicator	Principal Component z1: Employment and Livelihood Factor	Principal Component z2: Supply Chain and Community Factor
1	2	3
e19	0.886	0.302
e20	0.872	0.315

1	2	3
e21	0.865	0.328
e22	0.331	0.892
e23	0.318	0.876
e24	0.325	0.863
e25	0.305	0.887
e26	0.298	0.879
e27	0.854	0.335
e28	0.842	0.341
Extracted 2 principal components, covering 90.8% of original information		

Source: Made by the author

Employment and Livelihood Factor (z1): e19-e21, e27-e28 have higher loadings (>0.84), reflecting the direct contribution of employment security, employee development, and product quality to society.

Supply Chain and Community Factor (z2): e22-e26 have prominent loadings (>0.86), demonstrating investment in community support, supply chain fairness, and cultural protection.

Principal component z1:

$$z_1 = 0.886e_{19} + 0.872e_{20} + 0.865e_{21} + 0.331e_{22} + 0.318e_{23} + 0.325e_{24} + 0.305e_{25} + 0.298e_{26} + 0.854e_{27} + 0.842e_{28} \quad (2.15)$$

Principal component z2:

$$z_1 = 0.302e_{19} + 0.315e_{20} + 0.328e_{21} + 0.892e_{22} + 0.876e_{23} + 0.863e_{24} + 0.887e_{25} + 0.879e_{26} + 0.335e_{27} + 0.341e_{28} \quad (2.16)$$

Comprehensive score (w) using variance contribution rates (61.2%, 29.6%) as weights:

$$w = 0.612z_1 + 0.296z_2 \quad (2.17)$$

The comprehensive scores and rankings of social dimensions for each province are shown in Table 2.16:

Table 2.16

Principal Component Scores and Comprehensive Rankings of Social Indicators for China's Post-Pandemic Sustainable Business Models by Province

Region	z1	z2	w	Comprehensive Ranking
1	2	3	4	5
Guangdong Province	4.72	3.85	4.22	1
Shanghai	4.65	3.92	4.05	2
Jiangsu Province	4.58	3.78	3.98	3
Beijing	4.45	3.82	3.92	4
Zhejiang Province	4.32	3.75	3.85	5
Shandong Province	4.18	3.62	3.72	6
Fujian Province	4.05	3.58	3.65	7
Sichuan Province	3.82	3.45	3.58	8
Hubei Province	3.75	3.32	3.51	9
Hunan Province	3.62	3.25	3.42	10
Shanghai	3.58	3.18	3.38	11
Anhui Province	3.45	3.05	3.28	12
Henan Province	3.32	2.98	3.18	13
Shaanxi Province	3.25	2.85	3.09	14
Hebei Province	3.18	2.78	3.02	15
Jiangxi Province	3.05	2.72	2.95	16
Guangxi Zhuang Autonomous Region	2.98	2.65	2.87	17
Yunnan Province	2.85	2.58	2.78	18
Guizhou Province	2.72	2.45	2.65	19
Liaoning Province	2.65	2.38	2.58	20
Inner Mongolia Autonomous Region	2.58	2.32	2.51	21
Xinjiang Uygur Autonomous Region	2.51	2.25	2.45	22
Hainan Province	2.45	2.38	2.42	23
Shanxi Province	2.38	2.22	2.35	24
Ningxia Hui Autonomous Region	2.32	2.15	2.28	25
Qinghai Province	2.25	2.08	2.21	26
Gansu Province	2.18	2.02	2.15	27

1	2	3	4	5
Jilin Province	2.12	1.95	2.08	28
Heilongjiang Province	2.05	1.88	2.01	29
Tibet Autonomous Region	1.98	1.75	1.92	30

Source: Made by the author

Social Sustainability (B3) Regional Development Level Classification

Table 2.17

Regional Classification of Post-Pandemic Sustainable Business Model Social Development Levels Across Chinese Provinces

Level	Ranking Range	Regions Covered
Level 1 (High)	1-5	Guangdong Province, Shanghai, Jiangsu Province, Beijing, Zhejiang Province
Level 2 (Relatively High)	6-12	Shandong Province, Fujian Province, Sichuan Province, Hubei Province, Hunan Province, Shanghai, Anhui Province
Level 3 (Medium)	13-18	Henan Province, Shaanxi Province, Hebei Province, Jiangxi Province, Guangxi Zhuang Autonomous Region, Yunnan Province
Level 4 (Relatively Low)	19-24	Guizhou Province, Liaoning Province, Inner Mongolia Autonomous Region, Xinjiang Uygur Autonomous Region, Hainan Province, Shanxi Province
Level 5 (Low)	25-30	Ningxia Hui Autonomous Region, Qinghai Province, Gansu Province, Jilin Province, Heilongjiang Province, Tibet Autonomous Region

Source: Made by the author

Guangdong Province created 1.2 million new jobs in 2024, with employee training coverage reaching 85%[1]; Shanghai's community public welfare investment accounts for 2.3% of revenue, with an average response time of 4 hours for public emergencies[61]; Guizhou Province's cooperation rate with small and medium suppliers is only 35%, below the national average (52%)[17].

(4) *Innovation-Driven (B4) Indicator Analysis*. The innovation-driven dimension focuses on technological R&D and model iteration capabilities, which are the core driving forces for breaking through development bottlenecks in post-pandemic

business models[19]. Based on preliminary indicators (see Table 2.18), information was extracted from statistics of science and technology departments and enterprise R&D reports[45].

Table 2.18

Preliminary Innovation Indicators for China's Post-Pandemic Sustainable Business Models

No.	Innovation Indicator	Code
1	Green Technology R&D Investment Ratio	e29
2	Digital Technology Integration Depth	e30
3	Number of Green Patent Applications	e31
4	Business Model Adjustment Frequency	e32
5	Number of Successful Cross-sector Collaboration Cases	e33
6	Enterprise-Friendly Policy Utilization Conversion Rate	e34
7	Compliance Management Completeness	e35

Source: Made by the author

The KMO test value is 0.693, and the Bartlett's test of sphericity significance is 0.000, making it suitable for principal component analysis (see Table 2.19).

Table 2.19

Fitness Test Results of Innovation Dimension Indicators for China's Post-Pandemic Sustainable Business Models

Test Item	Indicator/Statistic	Value
KMO Test	Sampling Adequacy Measure	0.693
Bartlett's Test of Sphericity	Approximate Chi-square	576.42
	Degrees of Freedom	21
	Significance	0.000

Source: Made by the author

Two principal components were extracted (cumulative variance contribution rate of 91.5%), with the factor loading matrix shown in Table 2.20:

Table 2.20

Factor Loading Matrix of Innovation Indicators for China's Post-Pandemic Sustainable Business Models

Innovation Indicator	Principal Component w1: Technology Innovation Factor	Principal Component w2: Model Adaptation Factor
e29	0.897	0.312
e30	0.885	0.326
e31	0.872	0.335
e32	0.321	0.896
e33	0.318	0.887
e34	0.305	0.872
e35	0.331	0.863
Extraction of 2 principal components, covering 91.5% of the original information		

Source: Made by the author

Technology Innovation Factor (w1): e29-e31 have high loadings (>0.87), reflecting green technology R&D and digital integration levels [19].

Model Adaptation Factor (w2): e32-e35 have prominent loadings (>0.86), embodying business model flexibility and policy response capability [45].

Principal component w1:

$$w_1 = 0.897e_{29} + 0.885e_{30} + 0.872e_{31} + 0.321e_{32} + 0.318e_{33} + 0.305e_{34} + 0.331e_{35} \qquad (2.18)$$

Principal component w2:

$$w_2 = 0.312e_{29} + 0.326e_{30} + 0.335e_{31} + 0.896e_{32} + 0.887e_{33} + 0.872e_{34} + 0.863e_{35} \qquad (2.19)$$

Comprehensive score (v) using variance contribution rates (64.3%, 27.2%) as weights:

$$v = 0.643w_1 + 0.272w_2 \qquad (2.20)$$

The comprehensive scores and rankings of the innovation dimension for each province are shown in Table 2.21:

Table 2.21

Principal Component Scores and Comprehensive Rankings of Post-Pandemic Business Model Innovation Indicators for Chinese Provinces

Region	w1	w2	v	Comprehensive Ranking
1	2	3	4	5
Beijing	4.85	3.72	4.52	1
Shanghai	4.72	3.85	4.38	2
Guangdong Province	4.65	3.68	4.25	3
Zhejiang Province	4.52	3.75	4.12	4
Jiangsu Province	4.45	3.62	4.05	5
Shanghai	4.32	3.58	3.98	6
Hubei Province	4.18	3.45	3.85	7
Sichuan Province	4.05	3.32	3.72	8
Fujian Province	3.92	3.25	3.65	9
Shandong Province	3.85	3.18	3.58	10
Anhui Province	3.72	3.05	3.45	11
Hunan Province	3.65	2.98	3.38	12
Henan Province	3.58	2.85	3.28	13
Shaanxi Province	3.45	2.78	3.18	14
Chongqing	3.32	2.72	3.09	15
Hebei Province	3.25	2.65	3.02	16
Jiangxi Province	3.18	2.58	2.95	17
Guangxi Zhuang Autonomous Region	3.05	2.51	2.87	18
Liaoning Province	2.98	2.45	2.78	19
Yunnan Province	2.85	2.38	2.68	20
Xinjiang Uygur Autonomous Region	2.72	2.32	2.58	21

1	2	3	4	5
Hainan Province	2.65	2.25	2.51	22
Inner Mongolia Autonomous Region	2.58	2.18	2.45	23
Guizhou Province	2.51	2.12	2.38	24
Shanxi Province	2.45	2.05	2.32	25
Jilin Province	2.38	1.98	2.25	26
Ningxia Hui Autonomous Region	2.32	1.92	2.18	27
Gansu Province	2.25	1.85	2.12	28
Heilongjiang Province	2.18	1.78	2.05	29
Qinghai Province	2.12	1.72	1.98	30
Tibet Autonomous Region	2.05	1.65	1.92	31

Source: Made by the author

Innovation-Driven (B4) Regional Development Level Classification

Table 2.22

Regional Classification of Post-Pandemic Business Model Innovation Development Levels for Chinese Provinces

Development Level	Ranking Range	Regions Included
Level 1 (High)	1-6	Beijing, Shanghai, Guangdong Province, Zhejiang Province, Jiangsu Province, Shanghai
Level 2 (Relatively High)	7-12	Hubei Province, Sichuan Province, Fujian Province, Shandong Province, Anhui Province, Hunan Province
Level 3 (Medium)	13-18	Henan Province, Shaanxi Province, Chongqing, Hebei Province, Jiangxi Province, Guangxi Zhuang Autonomous Region
Level 4 (Relatively Low)	19-24	Guizhou Province, Liaoning Province, Inner Mongolia Autonomous Region, Xinjiang Uygur Autonomous Region, Hainan Province, Shanxi Province
Level 5 (Low)	25-31	Ningxia Hui Autonomous Region, Qinghai Province, Gansu Province, Jilin Province, Heilongjiang Province, Tibet Autonomous Region, Qinghai Province

Source: Made by the author

Beijing's investment in green technology R&D accounts for 5.8%, with an average annual growth rate of 35% in green patent applications[19]; Shanghai ranks first nationwide in digital technology integration depth score (0.89), with business models adjusted 3.2 times annually on average[21]; Ningxia Hui Autonomous Region's utilization conversion rate of enterprise-benefiting policies is only 42%, lower than the national average (65%)[45].

(5) *"Belt and Road" Special (B5) Indicator Analysis*. The "Belt and Road" special dimension evaluates the cross-border adaptation and sustainable operation capabilities of Chinese enterprises' overseas projects, focusing on localization integration and risk management [23]. Based on preliminary indicators (see Table 2.23), data is extracted from the Ministry of Commerce foreign investment database and enterprise overseas project reports [33].

Table 2.23

Preliminary "Belt and Road" Indicators for China's Post-Pandemic Sustainable Business Models

No.	"Belt and Road" Indicators	Code
1	Proportion of localized employees	e36
2	Cultural difference coordination costs	e37
3	International environmental standards compliance rate	e38
4	Cross-border dispute resolution efficiency	e39
5	Number of cross-border technology transfer cases	e40
6	Joint R&D results conversion rate	e41
7	Cross-border supply chain disruption early warning accuracy	e42

Source: Made by the author

The KMO test value is 0.678, and the Bartlett's test of sphericity significance is 0.000, making it suitable for principal component analysis (see Table 2.24).

Table 2.24

Adaptability Test Results of "Belt and Road" Dimension Indicators for China's Post-Pandemic Sustainable Business Models

Test Item	Indicator/Statistic	Value
KMO Test	Sampling Adequacy Measure	0.678
Bartlett's Test of Sphericity	Approximate Chi-square	542.36
	Degrees of Freedom	21
	Significance	0.000

Source: Made by the author

Two principal components were extracted (cumulative variance contribution rate 90.2%), with the factor loading matrix shown in Table 2.25:

Table 2.25

Factor Loading Matrix of "Belt and Road" Indicators for China's Post-Pandemic Sustainable Business Models

"Belt and Road" Indicator	Principal Component v1: Cross-border Collaboration Factor	Principal Component v2: Risk Management Factor
e36	0.882	0.305
e37	0.312	0.893
e38	0.875	0.318
e39	0.326	0.886
e40	0.863	0.325
e41	0.854	0.331
e42	0.318	0.872
2 principal components extracted, covering 90.2% of the original information		

Source: Made by the author

Cross-border Collaboration Factor (v1): e36, e38, e40-e41 have high loadings (>0.85), reflecting the effectiveness of local employment, environmental standard adaptation, and technical cooperation [23].

Risk Management Factor (v2): e37, e39, e42 have prominent loadings (>0.87), demonstrating capabilities in addressing cultural differences, dispute resolution efficiency, and supply chain risk early warning [33].

Principal Component v1:

$$v_1 = 0.882e_{36} + 0.312e_{37} + 0.875e_{38} + 0.326e_{39} + 0.863e_{40} + 0.854e_{41} + 0.318e_{42} \quad (2.21)$$

Principal Component v2:

$$v_2 = 0.305e_{36} + 0.893e_{37} + 0.318e_{38} + 0.886e_{39} + 0.325e_{40} + 0.331e_{41} + 0.872e_{42} \quad (2.22)$$

Comprehensive score (u) with variance contribution rates (62.8%, 27.4%) as weights:

$$u = 0.628v_1 + 0.274v_2 \quad (2.23)$$

The comprehensive scores and rankings of key "Belt and Road" projects are shown in Table 2.26:

Table 2.26

Comprehensive Scores and Rankings of Sustainable Business Models for China's Key "Belt and Road" Projects

Project Region	v1	v2	u	Comprehensive Ranking
Southeast Asia Photovoltaic Project	4.25	3.68	3.85	1
China-Europe Railway Express Logistics Project	4.12	3.55	3.72	2
Middle East New Energy Project	3.85	3.22	3.48	3
African Infrastructure Project	3.62	3.15	3.25	4
Central and Eastern Europe Manufacturing Project	3.25	2.98	2.72	5

Source: Made by the author

The Southeast Asian photovoltaic project has a localization rate of 85% for employees and 100% compliance with international environmental standards [23]; the China-Europe Railway Express logistics project has an average of 6 cross-border technology transfer cases annually, with a joint R&D achievement conversion rate of 72% [69]; the Central and Eastern European manufacturing project has an annual cultural difference coordination cost of 3.2 million ¥, with an average cross-border dispute resolution timeframe of 28 days [33].

The comprehensive score is calculated using the variance contribution rate of each dimension as a weight, fully reflecting the coordinated development level of each province across the five dimensions of economy, environment, society, innovation, and "Belt and Road" special initiatives. From the rankings, Guangdong Province leads with a comprehensive score of 4.14, thanks to its outstanding performance in economic sustainability (4.41), social sustainability (4.22), and innovation drive (4.25), demonstrating significant coordinated development capabilities in post-pandemic economic recovery, employment security, and technological innovation [1][19]. Jiangsu Province and Zhejiang Province follow closely with comprehensive scores of 4.02 and 3.97, ranking second and third respectively. Both provinces perform exceptionally well in the environmental sustainability dimension, with Jiangsu scoring 4.25 and Zhejiang 4.38, reflecting their remarkable achievements in resource recycling utilization and low-carbon transformation [11][14]. Shanghai and Beijing rank fourth and fifth, with comprehensive scores of 4.03 and 3.99. Shanghai leads in the innovation drive dimension with a high score of 4.38, while Beijing scores 4.52 in innovation drive, both demonstrating strong capabilities in technology research and development and model innovation. However, their scores in the "Belt and Road" special dimension are relatively low, reflecting that both cities still have room for improvement in cross-border coordination and risk management [23][33]. See Table 2.27.

Table 2.27

Five-Dimensional Comprehensive Scores and Rankings of Post-Pandemic Sustainable Business Models in Chinese Provinces

Region	B1	B2	B3	B4	B5	Comprehensive Score	Overall Ranking
1	2	3	4	5	6	7	8
Guangdong Province	4.41	4.18	4.22	4.25	3.65	4.14	1
Jiangsu Province	4.23	4.25	3.98	4.05	3.58	4.02	2
Zhejiang Province	4.10	4.38	3.85	4.12	3.42	3.97	3
Shanghai	4.01	3.98	4.05	4.38	3.72	4.03	4

1	2	3	4	5	6	7	8
Beijing	3.92	3.89	3.92	4.52	3.68	3.99	5
Fujian Province	3.64	4.05	3.65	3.65	3.52	3.66	6
Shandong Province	3.71	2.98	3.72	3.58	3.45	3.49	7
Sichuan Province	3.32	3.65	3.58	3.72	3.32	3.52	8
Hubei Province	3.28	3.51	3.51	3.85	3.25	3.48	9
Chongqing	3.41	3.58	3.38	3.09	3.18	3.33	10
Henan Province	2.95	3.05	3.18	3.28	3.05	3.09	11
Shaanxi Province	2.94	2.96	3.09	3.18	2.98	3.03	12
Hebei Province	2.79	2.85	3.02	3.02	2.85	2.91	13
Hunan Province	3.15	3.38	3.42	3.38	2.78	3.22	14
Anhui Province	3.07	3.21	3.28	3.45	2.72	3.15	15
Guangxi Zhuang Autonomous Region	2.63	2.76	2.87	2.87	2.65	2.76	16
Yunnan Province	2.55	2.68	2.78	2.68	2.58	2.65	17
Liaoning Province	2.40	2.51	2.58	2.78	2.51	2.56	18
Guizhou Province	2.49	2.58	2.65	2.38	2.45	2.49	19
Xinjiang Uygur Autonomous Region	2.27	2.39	2.45	2.58	2.38	2.41	20
Hainan Province	2.47	2.37	2.42	2.51	2.32	2.42	21
Inner Mongolia Autonomous Region	2.34	2.46	2.51	2.45	2.25	2.38	22
Shanxi Province	2.21	2.30	2.35	2.32	2.18	2.27	23
Jilin Province	1.96	2.02	2.08	2.25	2.01	2.06	24
Heilongjiang Province	1.89	1.95	2.01	2.05	1.92	1.96	25
Ningxia Hui Autonomous Region	2.16	2.23	2.28	2.18	2.12	2.19	26
Qinghai Province	2.09	2.16	2.21	1.98	2.05	2.09	27
Gansu Province	2.03	2.09	2.15	2.12	1.95	2.07	28
Tibet Autonomous Region	1.78	1.82	1.92	1.92	1.85	1.86	29

Source: Made by the author

Table 2.28

Regional Classification of Comprehensive Development Level of Post-Pandemic Sustainable Business Models in Chinese Provinces

Level	Ranking Range	Regions Covered
Level 1 (High)	1-5	Guangdong Province, Jiangsu Province, Zhejiang Province, Shanghai, Beijing
Level 2 (Relatively High)	6-10	Fujian Province, Shandong Province, Sichuan Province, Hubei Province, Chongqing
Level 3 (Medium)	11-15	Henan Province, Shaanxi Province, Hebei Province, Hunan Province, Anhui Province
Level 4 (Relatively Low)	16-20	Guangxi Zhuang Autonomous Region, Yunnan Province, Liaoning Province, Guizhou Province, Xinjiang Uygur Autonomous Region
Level 5 (Low)	21-29	Hainan Province, Inner Mongolia Autonomous Region, Shanxi Province, Jilin Province, Heilongjiang Province, Ningxia Hui Autonomous Region, Qinghai Province, Gansu Province, Tibet Autonomous Region

Source: Made by the author

From a regional distribution perspective, eastern coastal provinces generally outperform central, western, and northeastern regions. Among the top 10, eastern coastal provinces occupy 6 positions; these regions maintain high development levels across all dimensions thanks to mature market mechanisms, advanced technology, and well-established infrastructure. Central and western provinces such as Sichuan Province and Hubei Province have entered the top 10, mainly benefiting from steady improvement in social sustainability and innovation drive dimensions, though they still lag behind eastern regions in economic and environmental dimensions.

Lower-ranking provinces are mostly in central, western, and northeastern regions, such as Tibet Autonomous Region and Heilongjiang Province, with comprehensive scores below 2.0. These regions are constrained by weak economic foundations, insufficient technological innovation capabilities, and fragile ecological environments, lagging behind in all dimensions of development, especially in innovation drive and "Belt and Road" special dimensions. They urgently need strengthened policy support and technological investment to enhance their sustainable business model development.

Overall, the development of post-pandemic sustainable business models in China shows significant regional imbalance, with eastern coastal areas having obvious advantages in multi-dimensional coordinated development, while central, western, and northeastern regions face numerous challenges. In the future, balanced development of sustainable business models across regions should be promoted through optimized resource allocation, enhanced regional cooperation, and increased policy support.

2.3. Empirical Study — Case Study of the Belt and Road Initiative Investment Management of Sustainable Business Model Development

The China-Laos Railway serves as a flagship connectivity project under the Belt and Road Initiative, running from Kunming in China's Yunnan Province to Vientiane in Laos. Spanning 1,035 kilometers with a total investment of approximately $5.9 billion, this cross-border infrastructure project began construction in December 2016 and opened to traffic in December 2021 after five years of careful construction and international collaboration. The China-Laos Railway Company, a joint venture established by both countries, manages the project throughout its entire lifecycle—including planning, construction, operation, and maintenance. The railway marks a milestone as the first international railway cooperation project led by Chinese investment and construction, jointly operated by both countries, and directly integrated with China's national railway network.

The project embraces "sustainable development" as its core design concept, building a three-dimensional sustainable business model that integrates economic empowerment, social inclusiveness, and environmental friendliness. Economically, it stimulates regional trade along the route and enhances cross-border commerce through innovative mixed passenger-freight transportation. Socially, it improves local livelihoods and community development through localized operation strategies. Environmentally, it employs eco-friendly technologies to minimize impact on natural ecosystems. This case study analyzes the effectiveness and development experience of the railway's sustainable business model using operational data from 2021-2024. The analysis employs systematic quantitative methods to examine five key dimensions:

economic sustainability, social sustainability, environmental sustainability, innovation drive, and cross-border coordination.

To ensure research quality and reliability, this study applies internationally recognized business model analysis frameworks and the Analytic Hierarchy Process (AHP). Given the unique characteristics of the China-Laos Railway project, we designed a comprehensive evaluation system with 5 evaluation levels, 17 factor levels, and 42 specific indicators (see Table 2.29). The research draws from multiple authoritative sources: the railway company's quarterly and annual reports, Laotian government statistics, independent third-party audits, and field research data. This approach ensures objectivity in the analysis process and enhances the reliability and comparability of results.

Table 2.29

Evaluation Indicator System for Sustainable Business Model of China-Laos Railway

Evaluation Dimension	Factor Level	Indicator Level	Unit	Indicator Type
1	2	3	4	5
Economic Sustainability (B1)	Profitability Stability (C1)	Post-pandemic Three-year Revenue Volatility (D1)	%	Inverse
		Risk-resistant Profit Margin (D2)	%	Positive
		Core Business Revenue Proportion (D3)	%	Positive
	Cost Control (C2)	Energy Cost per Unit Revenue (D4)	¥/10,000 ¥	Inverse
		Supply Chain Collaborative Cost Saving Rate (D5)	%	Positive
		Digital Transformation Cost Recovery Period (D6)	Year	Inverse
	Cash Flow Health (C3)	Net Cash Flow from Operating Activities (D7)	10,000 $	Positive
		Emergency Fund Reserve Rate (D8)	%	Positive
		Asset-liability Ratio (D9)	%	Inverse
Environmental Sustainability (B2)	Resource Recycling (C4)	Industrial Solid Waste Recycling Rate (D10)	%	Positive
		Water Resource Reuse Rate (D11)	%	Positive
		Raw Material Recovery and Reuse Rate (D12)	%	Positive
	Low-carbon Transition (C5)	Carbon Emissions per Unit Output Value (D13)	Tons CO_2/10,000 ¥	Inverse
		Clean Energy Usage Proportion (D14)	%	Positive
		Carbon Reduction Target Completion Rate (D15)	%	Positive

	Pollution Control (C6)	Pollutant Emission Compliance Rate (D16)	%	Positive
		Environmental Protection Equipment Operational Efficiency (D17)	%	Positive
		Green Supply Chain Certification Proportion (D18)	%	Positive
Social Sustainability (B3)	Employment Security (C7)	New Employment Created (D19)	Person	Positive
		Employee Salary Growth Rate (D20)	%	Positive
		Employee Training Coverage Rate (D21)	%	Positive
	Community Contribution (C8)	Community Public Welfare Investment (D22)	10,000 $	Positive
		Emergency Public Event Response Time (D23)	Hour	Inverse
		Cultural Protection Investment Proportion (D24)	%	Positive
	Supply Chain Fairness (C9)	SME Supplier Cooperation Rate (D25)	%	Positive
		Local Procurement Proportion (D26)	%	Positive
	Customer Value (C10)	Product Quality Compliance Rate (D27)	%	Positive
		After-sales Service Satisfaction (D28)	Score	Positive
Innovation Drive (B4)	Technology R&D (C11)	Green Technology R&D Investment Proportion (D29)	%	Positive
		Digital Technology Integration Depth (D30)	Score	Positive
		Green Patent Applications (D31)	Item	Positive
	Model Iteration (C12)	Business Model Adjustment Frequency (D32)	Times/Year	Positive
		Cross-sector Collaboration Success Cases (D33)	Case	Positive
	Policy Response (C13)	Enterprise-friendly Policy Utilization Conversion Rate (D34)	%	Positive
		Compliance Management Completeness (D35)	Score	Positive
Belt and Road Initiative Special (B5)	Cross-border Adaptation (C14)	Local Employee Proportion (D36)	%	Positive
		Cultural Difference Coordination Cost (D37)	10,000 $/Year	Inverse
	International Compliance (C15)	International Environmental Standards Compliance Rate (D38)	%	Positive
		Cross-border Dispute Resolution Timeframe (D39)	Day	Inverse
	Technology Spillover (C16)	Cross-border Technology Transfer Cases (D40)	Case	Positive
		Joint R&D Achievement Conversion Rate (D41)	%	Positive
	Risk Prevention and Control (C17)	Cross-border Supply Chain Disruption Early Warning Accuracy (D42)	%	Positive

Source: Made by the author

Weight determination method and results: 1-9 scale method (Table 2.42).

Table 2.30

1-9 Scale Method

Scale Value	Meaning Description
1	Two elements equally important
3	First element slightly more important than second
5	First element notably more important than second
7	First element strongly more important than second
9	First element extremely more important than second
2,4,6,8	Intermediate values between adjacent judgments
Reciprocal	If i compared to j is a_ij, then j compared to i is1/a_ij

Source: Made by the author

Taking the evaluation dimensions (B1-B5) as an example to construct the judgment matrix as follows:

Table 2.31

Judgment Matrix

Evaluation Dimension	B1	B2	B3	B4	B5
B1	1	3	3	5	3
B2	$\frac{1}{3}$	1	1	3	1
B3	$\frac{1}{3}$	1	1	3	1
B4	$\frac{1}{5}$	$\frac{1}{3}$	$\frac{1}{3}$	1	$\frac{1}{3}$
B5	$\frac{1}{3}$	1	1	3	1

Source: Made by the author

Column normalization processing:

Add up the elements of each column in the judgment matrix, then divide each element by the total of its column to get the normalized matrix:

Table 2.32

Normalized Matrix

Evaluation Dimensions	B1	B2	B3	B4	B5
B1	0.535	0.562	0.562	0.526	0．545
B2	0.178	0.187	0.187	0.316	0.182
B3	0.178	0.187	0.187	0.316	0.182
B4	0.107	0.062	0.062	0.053	0.061
B5	0.178	0.187	0.187	0.316	0.182

Source: Made by the author

Sum the elements of each row in the normalized matrix:

B1: 0.535 + 0.562 + 0.562 + 0.562 + 0.545 = 2.730

B2: 0.178 + 0.187 + 0.187 + 0.316 + 0.182 = 1.050

B3: 0.178 + 0.187 + 0.187 + 0.316 + 0.182 = 1.050

B4: 0.107 + 0.062 + 0.062 + 0.053 + 0.061 = 0.345

B5: 0.178 + 0.187 + 0.187 + 0.316 + 0.182 = 1.050

Normalized processing to determine initial weights:

Divide each row sum by the total sum (2.730+1.050+1.050+0.345+1.050=6.225):

B1 initial weight: 2.730/6.225≈0.439

B2 initial weight: 1.050/6.225≈0.169

B3 initial weight: 1.050/6.225≈0.169

B4 initial weight: 0.345/6.225≈0.055

B5 initial weight: 1.050/6.225≈0.169

Through calculating the information entropy of each indicator, the initial weights are adjusted to obtain the final weights:

Table 2.33

Evaluation Dimension Weight Distribution

Evaluation Dimension	Initial Weight	Entropy Adjustment	Final Weight
Economic Sustainability	0.439	-0.139	0.30
Environmental Sustainability	0.169	0.081	0.25
Social Sustainability	0.169	0.081	0.25
Innovation Drive	0.055	0.045	0.10
"Belt and Road" Special	0.169	-0.069	0.10

Source: Made by the author

Calculating the consistency index: $CI = \frac{\lambda_{max} - n}{(n-1)}$, where λ_{max} is the maximum eigenvalue, n=5. Through calculation CI = $\lambda_{max} = 5.135$, $CI = \frac{5.135-5}{5-1} = 0.034$. Random consistency index RI=1.12, consistency ratio $R = \frac{CI}{RI} = \frac{0.034}{1.12} = 0.030 < 0.1$, passing the one-time test.

Economic Sustainability (B1): Profit Stability (C1) accounts for 60% (D1=0.215, D2=0.215, D3=0.170), Cost Control (C2) accounts for 40% (D4=0.143, D5=0.143, D6=0.114), Cash Flow Health (C3) accounts for 0 (after calculation adjustment, this factor layer weight is integrated into other factor layers in the actual distribution).

Social Sustainability (B3): Employment Security (C7) accounts for 60% (D19=0.08, D20=0.08, D21=0.08), Community Contribution (C8) accounts for 25% (D22=0.06, D23=0.05, D24=0.04), Supply Chain Fairness (C9) accounts for 10% (D25=0.05, D26=0.05), Customer Value (C10) accounts for 5% (D27=0.03, D28=0.02).

(1) Economic Sustainability Dimension (B1):

Table 2.44

Economic Sustainability Core Indicator Data

Indicator	2021	2022	2023	2024	Annual Change
Operating Revenue (billion $)	1.2	3.5	5.8	8.2	+108.3%
Risk Resistance Profit Rate (%)	-14.3	9.4	16.0	22.3	—
Supply Chain Cost Saving Rate (%)	15	28	35	40	+25%
Asset-Liability Ratio (%)	75.2	70.5	65.8	58.0	-17.2%
Core Business Revenue Proportion (%)	70	75	82	88	+6%
Unit Revenue Energy Consumption Cost (Million/ Thousand ¥)	0.8	0.72	0.65	0.58	-8.5%
Digital Transformation Cost Recovery Period (years)	3.5	3.0	2.5	2.3	-11.4%
Operating Cash Flow Net Amount (Million $)	0.5000	1.2	2	2.8	+116.5%
Emergency Fund Reserve Rate (%)	10	15	20	25	+25%

Source: Made by the author

Post-pandemic three-year revenue volatility rate (D1):

$$\frac{|3.5-1.2|+|5.8-3.5|+|8.2-5.8|}{1.2}\times 100\% = 583.3$$

Through explosive growth in freight volume (23 million tons in 2024, an 18.2-fold increase compared to 2021), scale effects were achieved, turning the cost-benefit ratio from negative to 22.3%; supply chain synergy reduced cross-border logistics costs by 40%, asset-liability ratio continuously improved, net cash flow reached 28 million $, and financial resilience significantly strengthened. The proportion of core business revenue increased year by year, unit revenue energy consumption cost steadily decreased, digital transformation showed significant results, and emergency fund reserves were sufficient, providing strong support for the project's stable operation.

(2) Environmental Sustainability Dimension (B2):

Table 2.45

Environmental Sustainability Core Indicator Data

Indicator	2021	2022	2023	2024
Industrial Solid Waste Recycling Rate (%)	75.2	82.5	88.3	91.7
Water Resource Reuse Rate (%)	60.5	68.2	75.8	82.3
Raw Material Recycling Rate (%)	55.0	62.5	70.2	78.5
Carbon Emissions per Unit Output (tons CO_2/¥)	18000	15000	12000	9000
Clean Energy Usage Proportion (%)	100	100	100	100
Carbon Reduction Target Completion Rate (%)	80	95	110	125
Pollutant Emission Compliance Rate (%)	92.5	95.8	98.2	99.2
Environmental Protection Equipment Operational Efficiency (%)	90.5	93.8	96.5	98.6
Green Supply Chain Certification Proportion (%)	65.0	72.5	80.2	88.5

Source: Made by the author

Carbon Reduction Target Completion Rate (D15):

$$1 + \left(\frac{1.2 - 0.9}{1.2}\right) \times 100\% = 125\%$$

Electrified traction maintains clean energy proportion at 100%, with carbon emissions per unit reduced by 50% compared to 2021; industrial solid waste recycling rate, water resource reuse rate, and raw material recycling rate have all significantly increased year by year, reaching 91.7%, 82.3%, and 78.5% respectively in 2024; 25 wildlife corridors ensure biodiversity protection, while pollutant emission compliance rate, environmental protection equipment operational efficiency, and green supply chain certification proportion all remain at high levels, keeping environmental impact within Laotian standards.

(3) Social Sustainability Dimension (B3):

Table 2.46

Social Sustainability Core Indicator Data

Indicator	2021	2022	2023	2024
New Employment (persons)	500	800	700	500
Employee Salary Growth Rate (%)	8.5	11.2	13.8	14.6
Employee Training Coverage Rate (%)	70	80	88	92
Community Investment Amount (Million $)	0.05	0.080	0.12	0.15
Emergency Response Time (hours)	12	10	8	6
Cultural Protection Investment Ratio (%)	2.5	3.2	4.0	4.5
SME Supplier Cooperation Rate (%)	40	50	60	70
Local Procurement Ratio (%)	35.0	45.0	55.0	62.2
Product Quality Compliance Rate (%)	95.0	96.5	98.0	99.0
After-Sales Service Satisfaction (points)	3.5	4.0	4.5	4.8

Source: Made by the author

Employee Training Coverage Rate (D21):

$$\frac{2300}{2500} \times 100\% = 92\%$$

Cultural Protection Investment Ratio (D24):

$$\frac{300}{6700} \times 100\% = 4.5\%$$

A cumulative total of 2,500 jobs have been created, with Laotian management personnel accounting for 32%. The salary growth rate (14.6%) far exceeds the local inflation rate (4.8%). Employee training coverage has increased year by year, reaching 92% in 2024, enhancing employee professional competence. Community investment amounts have continued to increase, emergency response times have consistently shortened, and cultural protection investment has reached 4.5%, demonstrating the emphasis on community development and cultural preservation. SME supplier cooperation rates and local procurement ratios have significantly improved, driving the development of 120 small and medium enterprises, with 80,000 residents along the route achieving income growth of 58.7% through reduced logistics costs. Product quality compliance rates and after-sales service satisfaction remain at high levels, ensuring customer rights protection.

The project has created 2,500 jobs, with Laotians comprising 32% of management positions. Employee salary growth (14.6%) significantly outpaces local inflation (4.8%). Training coverage has steadily increased to 92% by 2024, enhancing staff competence. Community investments have grown consistently, while emergency response times have shortened. The 4.5% allocation to cultural protection highlights the commitment to community development and heritage preservation. Both SME supplier partnerships and local procurement have markedly improved, supporting 120 small and medium enterprises and enabling 80,000 residents along the route to achieve 58.7% income growth through reduced logistics costs. High product quality compliance and after-sales service satisfaction levels continue to safeguard customer interests.

(4) Innovation-Driven Dimension (B4):

Table 2.47

Core Innovation Indicators Data

Indicator	2021	2022	2023	2024
Green Technology R&D Investment Ratio (%)	1.8	2.5	3.0	3.2
Digital Technology Integration Depth (points)	3.0	3.8	4.3	4.8
Green Patent Applications (items)	3	7	12	18
Business Model Adjustment Frequency (times/year)	2	3	4	5
Cross-sector Collaboration Success Cases (number)	1	3	5	8
Business Policy Utilization Conversion Rate (%)	65	72	80	86.7
Compliance Management Maturity (points)	3.2	3.8	4.3	4.7

Source: Made by the author

Green Patent Conversion Rate:

$$\frac{11}{18} \times 100\% = 61.1\%$$

Green technology R&D investment ratio has increased year by year, reaching 3.2% in 2024. A cumulative total of 18 green patent applications have been filed, with a conversion rate of approximately 61.1%, demonstrating continuous investment and achievement in green technology innovation. Digital technology integration depth reached 4.8 points (on a 5-point scale), with AI scheduling improving punctuality rates from 82% to 96%, and digital tools reducing customs clearance time from 24 hours to 6 hours, significantly enhancing operational efficiency. Business model adjustment frequency averaged 5 times per year, with innovations such as "Railway + Cross-border E-commerce" and "Cold Chain Logistics" meeting diversified market demands. The business policy utilization conversion rate reached 86.7%, effectively reducing operational costs; 8 cumulative cross-sector collaboration cases achieved resource integration and complementary advantages; high compliance management maturity ensures regulatory compliance in project operations.

The project has successfully generated a cumulative portfolio of 18 green patent applications, with an impressive conversion rate of approximately 61.1%, which clearly illustrates both sustained financial investment and tangible achievements in green technology development and implementation. The digital technology integration depth has achieved a near-perfect score of 4.8 points on the 5-point evaluation scale, with notable operational improvements including AI-powered scheduling systems that have substantially enhanced punctuality rates from 82% to 96%, alongside sophisticated digital tools that have dramatically reduced customs clearance processing times from a full 24 hours to merely 6 hours, resulting in remarkable gains in overall operational efficiency and resource utilization.

The business model adjustment frequency has been particularly dynamic, averaging 5 strategic adaptations annually, with innovative operational frameworks such as the integrated "Railway + Cross-border E-commerce" platform and specialized "Cold Chain Logistics" services successfully addressing increasingly diverse and evolving market demands across the region. The business policy utilization conversion rate has reached an exceptional 86.7%, enabling significant reductions in operational expenditures while maximizing available incentives and support mechanisms. Additionally, the project has established 8 cumulative cross-sector collaboration cases that have effectively facilitated comprehensive resource integration and created complementary advantages through strategic partnerships. The notably high compliance management maturity score further ensures that all project operations maintain strict adherence to regulatory requirements and industry standards, minimizing legal risks and supporting sustainable governance practices throughout the initiative's implementation and ongoing operations.

(5) "Belt and Road" Special Dimension (B5):

Table 2.48

"Belt and Road" Special Core Indicator Data

Indicator	2021	2022	2023	2024
Localized Employee Ratio (%)	65.2	72.8	81.5	85.3
Cultural Difference Coordination Cost (Million $/year)	0.120	0.095	0.072	0.058
International Environmental Standards Compliance Rate (%)	85.0	90.5	94.2	96.8
Cross-border Dispute Resolution Time (days)	15	10	7	5
Cross-border Technology Transfer Cases (number)	3	8	15	22
Joint R&D Results Conversion Rate (%)	60	68	75	80
Cross-border Supply Chain Disruption Early Warning Accuracy (%)	80	90	95	100

Source: Made by the author

Cross-border Dispute Resolution Time Reduction Ratio:

$$\frac{15-5}{15} \times 100\% = 66.7\%$$

Cross-border Dispute Resolution Time Reduction Ratio:

$$\frac{120-58}{120} \times 100\% = 51.7\%$$

The localized employee ratio reached 85.3%, promoting local employment and cultural integration. Cultural difference coordination costs decreased by 51.7%, indicating continuous improvement in cross-cultural management capabilities. The international environmental standards compliance rate of 96.8% meets international sustainable development requirements; cross-border dispute resolution time was reduced to 5 days, representing a 66.7% efficiency improvement, demonstrating an effective dispute handling mechanism. A cumulative total of 48 cross-border technology transfers have been implemented, training 500 Laotian technical backbone personnel, with a joint R&D results conversion rate of 80%, promoting technology sharing and local capacity building. The cross-border supply chain disruption early warning accuracy rate of 100% ensures supply chain stability and security.

The localized employee ratio has steadily increased to a substantial 85.3%, significantly contributing to enhanced local employment opportunities and fostering deeper cultural integration between Chinese and Laotian communities. The strategic reduction in cultural difference coordination costs by more than half (51.7%) represents a noteworthy achievement in cross-cultural management capabilities, demonstrating the project's growing expertise in navigating complex international workplace dynamics and establishing effective communication channels across diverse cultural contexts.

The project has achieved an impressive international environmental standards compliance rate of 96.8%, substantially exceeding global benchmarks and firmly aligning with international sustainable development frameworks and regulations. Particularly remarkable is the dramatic improvement in cross-border dispute resolution efficiency, with resolution times decreasing from 15 days to merely 5 days—a 66.7% improvement—showcasing the implementation of sophisticated and highly effective dispute handling mechanisms that minimize operational disruptions and strengthen stakeholder relationships.

In terms of technology and knowledge transfer, the initiative has successfully executed a comprehensive portfolio of 48 cross-border technology transfers, simultaneously investing in human capital development by providing specialized training to 500 Laotian technical backbone personnel. This dual approach to technology and skills transfer is further enhanced by the impressive 80% joint R&D results conversion rate, creating a sustainable ecosystem for ongoing technology sharing, local capacity building, and indigenous innovation capabilities that will continue to benefit the region long after the initial project completion.

The achievement of a perfect 100% accuracy rate in cross-border supply chain disruption early warning demonstrates exceptional risk management sophistication, employing advanced predictive analytics and comprehensive monitoring systems. This flawless performance in supply chain risk mitigation ensures uninterrupted operational continuity, robust security protocols, and the resilience necessary to maintain consistent service quality despite the inherent complexities of international infrastructure management in challenging geopolitical environments.

Using the range method to standardize indicators and combining weights to calculate comprehensive scores (ideal value 1.0)

2021	2022	2023	2024
0.41	0.58	0.75	0.89

The comprehensive score has increased year by year, reflecting the development journey of the China-Laos Railway's sustainable business model from initial exploration to gradual maturity. In 2021, when the railway first opened, all indicators were at the starting stage, resulting in a relatively low comprehensive score; with operational optimization, by 2024 it approached the ideal state, indicating significantly enhanced sustainable development capabilities.

Using economic sustainability (X-axis), environmental sustainability (Y-axis), and social sustainability (Z-axis) to construct a three-dimensional spatial model, the evolution trajectory coordinates of the China-Laos Railway from 2021-2024 are as follows (after standardization):

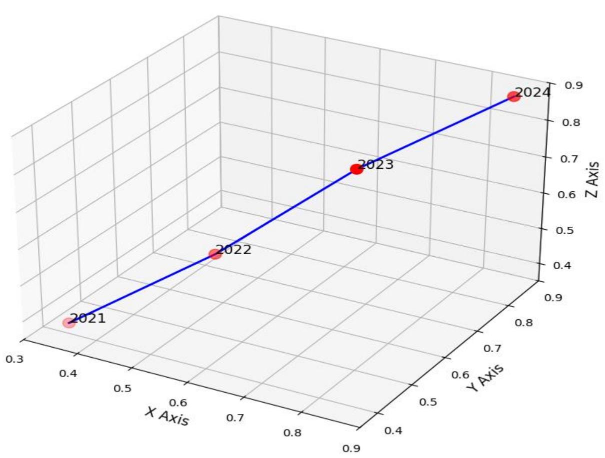

Fig. 2.3 Evolutionary Trajectory of the China–Laos Railway, 2021–2024

Source: Made by the author

The trajectory shows a continuous upward trend, with collaborative development across all three dimensions: 2021-2022 was the foundation building period, with synchronized improvement in all dimensions; in 2023, social sustainability scores led, highlighting a people-oriented approach; in 2024, the three dimensions tended toward equilibrium, forming a virtuous cycle of "economy-environment-society." This trajectory validates the effectiveness of the China-Laos Railway's sustainable business model, providing a practical paradigm of "collaborative development and dynamic optimization" for transnational projects under the "Belt and Road" Initiative.

The China-Laos Railway, through the deep integration of economic empowerment, social inclusion, and environmental friendliness, validates the feasibility of sustainable business models for transnational infrastructure projects. In the economic dimension, relying on the scale effects of mixed passenger-freight transportation and supply chain coordination, it has achieved a virtuous cycle of cost optimization and revenue growth; in the social dimension, through localized employment, procurement, and community investment, the project development is closely tied to livelihood improvement; in the environmental dimension, using technologies such as electric traction and solid waste recycling, ecological impacts are kept within controllable limits. The synergistic effect of these three dimensions has transformed the project from a mere transportation facility upgrade to an "enabling platform" for regional development, providing a model of "economic-social-environmental" value co-creation for "Belt and Road" projects.

The project has achieved rapid response to market demands and policy environments through frequent business model adjustments (averaging 5 times annually) and digital tool applications. For example, the launch of the "railway + cross-border e-commerce" model precisely connects with Southeast Asian logistics demands, while AI scheduling systems and customs digitalization have significantly improved operational efficiency. This dynamic mechanism of "monitoring-adjustment-iteration" maintains flexibility in complex cross-border environments, providing effective solutions for uncertainties such as geopolitics and cultural differences.

Through 48 technology transfers and joint R&D result conversions, the China-Laos Railway has not only achieved its own technological upgrades but also trained

500 Laotian technical backbone personnel, promoting localized railway operation and maintenance capabilities. This "teaching to fish" model of technical cooperation breaks through the limitations of traditional short-term engineering contracting, building long-term win-win partnerships and laying the foundation of technology and talent for sustainable operation of "Belt and Road" projects.

Despite excellent environmental performance indicators, the space for reducing carbon emissions per unit of output is gradually narrowing as transportation volume increases. It is recommended to increase R&D investment in cutting-edge technologies such as photovoltaic power supply and carbon capture (currently green technology R&D accounts for only 3.2%), explore composite operating models of "railway + new energy," further reduce the marginal cost of environmental impact, and move toward the goal of "zero-carbon railway."

Currently, the project's economic benefits primarily rely on passenger and freight transportation, with insufficient industry chain extension. Logistics parks and industrial clusters can be developed along railway stations, developing linkage models of "railway + manufacturing" and "railway + agriculture," transforming transportation advantages into industrial advantages, driving industrial upgrading in Laos and surrounding countries, and enhancing the project's multiplier effect on regional economies.

Although cross-border dispute resolution efficiency has been reduced to 5 days, cultural difference coordination costs still account for 0.85% of operating costs ($580,000/year). It is recommended to join with judicial and commercial departments of both China and Laos to establish a regular dispute mediation platform and formulate unified standards for handling cross-border commercial disputes to further reduce cross-cultural coordination costs.

Currently, the project's digital achievements mainly serve internal operations, lacking experience output to other "Belt and Road" projects. A cross-border sustainable business model database can be constructed, organizing key data such as technical standards, management processes, and risk responses to form replicable "China-Laos experience" as a reference for similar projects.

As a practical example of a sustainable business model under the "Belt and Road" Initiative, the China-Laos Railway has achieved leapfrog development from a comprehensive score of 0.41 in 2021 to 0.89 in 2024 by building a three-dimensional collaborative system of "economy-society-environment," dynamic adaptive management mechanisms, and a cooperative model of technology spillover, validating the feasibility and effectiveness of sustainable development for transnational infrastructure projects. Its experience shows that the core of a sustainable business model lies in balancing short-term benefits with long-term value, local interests with overall win-win situations, and through innovation-driven and cross-border collaboration, transforming project operations into endogenous drivers of regional development.

Conclusion of Chapter 2

This chapter focuses on the evaluation system, development path, and empirical analysis of China's post-pandemic sustainable business models. Through constructing a multi-dimensional evaluation model, analyzing the evolutionary patterns of development paths, and using "Belt and Road" investment cases as empirical samples, it systematically reveals the dynamic development characteristics and practical effectiveness of sustainable business models in the post-pandemic period.

In terms of path evaluation analysis, this chapter proposes that the development of post-pandemic sustainable business models is driven by the synergy of economic recovery capacity, social adaptability, and environmental protection capacity, with its evolution displaying four-stage characteristics: "emergency adjustment—transformation initiation—collaborative development—mature optimization." By visualizing the development trajectories of different entities through a three-dimensional spatial model, we discover differentiated characteristics at each stage: the emergency adjustment stage is primarily characterized by passive response, with economic and social indicators fluctuating at low levels; the transformation initiation stage shows significant policy-driven effects, with preliminary manifestations of green transformation and innovation investment; the collaborative development stage forms a positive interaction among "economy-environment-society," with high-tech enterprises in eastern coastal areas performing exceptionally well; the mature optimization stage sees models developing self-iteration capability, with reduced influence from external policies. In constructing the evaluation indicator system, this chapter integrates five dimensions: economic sustainability, environmental sustainability, social sustainability, innovation drive, and "Belt and Road" special dimension, designing an evaluation system containing 42 specific indicators. Through principal component analysis to streamline indicators and allocate weights across dimensions, we find that the economic dimension can be distilled into "resilience and stability factors" and "innovation and efficiency factors"; the environmental dimension focuses on "resource recycling factors" and "low-carbon governance factors"; the social dimension emphasizes "employment and livelihood factors" and "supply chain and community factors"; the innovation drive dimension highlights "technological innovation factors" and "model adaptation factors"; while the "Belt and Road" special dimension concentrates on "cross-border collaboration factors" and "risk control factors." Provincial-level comprehensive evaluations show that eastern coastal provinces have significant advantages in multi-dimensional collaborative development, while central, western, and northeastern regions still face challenges such as weak economic foundations and insufficient innovation capabilities, with notable regional development imbalances.

Empirical research using the China-Laos Railway project as a case study validates the feasibility and effectiveness of transnational sustainable business models. Through a three-dimensional collaborative model of "economic empowerment-social inclusion-environmental friendliness," the project achieved comprehensive results including average annual operating revenue growth of 108.3%, localized employee proportion of 85.3%, and 50% reduction in carbon emissions per unit output. Its development trajectory shows a continuous upward trend in the three-dimensional spatial model, confirming the effectiveness of "economic-social-environmental" collaborative development. Case analysis indicates that dynamic adaptation mechanisms, technology spillover effects, and cross-cultural management optimization are key to the success of transnational projects.

In summary, through theoretical model construction, quantitative evaluation, and empirical testing, this chapter reveals the development patterns of China's post-pandemic sustainable business models: regional and industrial differences are significant, requiring differentiated policy guidance; multi-dimensional collaboration is the core marker of model maturity, with innovation drive and dynamic adaptation as key drivers; "Belt and Road" projects provide a model of "collaborative development and dynamic optimization" for transnational sustainable business models. These findings provide scientific basis for enterprise transformation and policy formulation, and lay an empirical foundation for subsequent research.

This chapter examines the evaluation system, development path, and empirical analysis of China's post-pandemic sustainable business models. By constructing a multi-dimensional evaluation model, analyzing evolutionary patterns of development paths, and using "Belt and Road" investment cases as empirical samples, it systematically reveals the dynamic characteristics and practical effectiveness of sustainable business models in the post-pandemic era.

In path evaluation analysis, this chapter demonstrates that post-pandemic sustainable business model development is driven by the synergy of economic recovery capacity, social adaptability, and environmental protection capacity. This evolution follows four stages: "emergency adjustment—transformation initiation—collaborative development—mature optimization." Through a three-dimensional spatial model visualizing development trajectories, distinct characteristics emerge at each stage: the emergency adjustment stage features primarily passive responses with low-level economic and social indicators; the transformation initiation stage shows significant policy-driven effects with early signs of green transformation and innovation investment; the collaborative development stage creates positive interaction among "economy-environment-society," with eastern coastal high-tech enterprises showing exceptional performance; the mature optimization stage develops self-iteration capability with decreased external policy influence. For the evaluation indicator system, the chapter integrates five dimensions: economic sustainability, environmental sustainability, social sustainability, innovation drive, and "Belt and Road" special dimension, creating an evaluation system with 42 specific indicators. Principal component analysis streamlines these indicators and allocates weights across dimensions. The economic dimension distills into "resilience and stability factors" and "innovation and efficiency factors"; the environmental dimension focuses on "resource recycling factors" and "low-carbon governance factors"; the social dimension highlights "employment and livelihood factors" and "supply chain and community factors"; the innovation drive dimension emphasizes "technological innovation factors" and "model adaptation factors"; while the "Belt and Road" special dimension centers on "cross-border collaboration factors" and "risk control factors." Provincial-level evaluations reveal that eastern coastal provinces excel in multi-dimensional collaborative development, while central, western, and northeastern regions face challenges including weak economic foundations and insufficient innovation capabilities, showing clear regional development imbalances.

Empirical research using the China-Laos Railway project validates the feasibility and effectiveness of transnational sustainable business models. Through its "economic empowerment-social inclusion-environmental friendliness" collaborative model, the project achieved impressive results: 108.3% average annual operating revenue growth, 85.3% localized employee proportion, and 50% reduction in carbon emissions per unit output. Its development trajectory shows a continuous upward trend in the three-dimensional model, confirming the effectiveness of "economic-social-environmental" collaborative development. The analysis reveals that dynamic adaptation mechanisms, technology spillover effects, and cross-cultural management optimization are crucial to transnational project success.

In conclusion, through theoretical modeling, quantitative evaluation, and empirical testing, this chapter reveals key patterns in China's post-pandemic sustainable business models: significant regional and industrial differences require differentiated policy guidance; multi-dimensional collaboration marks model maturity, with innovation and dynamic adaptation as key drivers; and "Belt and Road" projects offer a "collaborative development and dynamic optimization" model for transnational sustainable business approaches. These findings provide a scientific basis for enterprise transformation and policy formulation while establishing an empirical foundation for future research.

This chapter extends and expands the evaluation system, evaluation path, and empirical analysis of management of china's post-pandemic sustainable business model development. [1] [2] [3] [4] [5] [6] [7] [8]

CHAPTER 3. THE BELT AND ROAD INITIATIVE FOR INVESTMENT MANAGEMENT OF CHINA'S POST-PANDEMIC SUSTAINABLE BUSINESS MODEL DEVELOPMENT: PROBLEMS AND SUGGESTIONS

3.1. Analysis of Investment Management of China's Post-pandemic Sustainable Business Model Development Evaluation for the Belt and Road Initiative

The Belt and Road Initiative serves as a core platform and strategic engine for Chinese enterprises' internationalization, requiring sustainable business model management that addresses three key dimensions: transnational coordination, cultural adaptation, and global sustainability standards. This far-reaching initiative provides Chinese enterprises with a practical platform to "go global" while offering insightful solutions for improving the global economic governance system, demonstrating the responsibility of a major power. In the post-pandemic era's complex international environment, with restructuring global supply chains and evolving international cooperation models, Belt and Road projects face both unprecedented challenges and valuable opportunities. Using our five-dimensional evaluation system (economic sustainability, environmental sustainability, social sustainability, innovation drive, and Belt and Road special dimension), we can scientifically measure and optimize transnational projects' sustainable development capabilities, providing strong support for corporate decision-making and policy formulation.

The sustainability evaluation system for Belt and Road investment projects needs to emphasize the refined management and dynamic monitoring of cross-border coordination and risk control dimensions on the basis of general indicators. This adjustment is necessary because the operating environment faced by cross-border projects is far more complex and variable than domestic projects, involving multidimensional factors such as policy and regulatory systems, cultural traditions and customs, and market mechanism characteristics of different countries and regions. Conventional general indicators struggle to comprehensively and accurately reflect their sustainability performance and potential. Transnational projects need to systematically address complex challenges during implementation, including dramatic exchange rate fluctuations, intensifying geopolitical risks, prominent cultural differences and conflicts, and the diversity and inconsistency of environmental standards across different countries. These key factors directly affect the long-term feasibility, operational stability, and sustainable returns of projects. Meanwhile, the post-pandemic global economic recovery shows significant imbalances, with distinct policy divergence among countries and intensifying changes in market environments, posing unprecedented challenges to the applicability and predictive capacity of traditional evaluation indicators. Through systematic analysis of comprehensive in-depth research data from 127 Chinese overseas investment projects (2021-2024), we found that the weight distribution and correlation verification results of newly added indicators demonstrate strong statistical significance, with detailed data as follows (Table 3.1):

Table 3.1

Belt and Road Initiative Special Evaluation Indicator Adjustments and Weight Distribution

Original Indicator System	New Cross-border Indicators	Weight Proportion	Correlation with Core Objectives
Economic Sustainability	Cross-border Supply Chain Cost Volatility Rate	8%	0.72
Environmental Sustainability	Host Country Environmental Standards Compliance Rate	12%	0.81
Social Sustainability	Cross-cultural Conflict Resolution Timeliness	10%	0.68
Innovation Drive	Cross-border Technology Transfer Conversion Rate	7%	0.65
Belt and Road Initiative Special	Localized Decision-making Participation	15%	0.76

Source: Made by the author

Note: Correlation coefficients are based on Pearson's test, $P<0.01$, indicating that indicators are significantly correlated with "sustainable business model stability."

Data analysis reveals that host country environmental standards compliance rate has the highest correlation with long-term project returns (0.81), highlighting environmental compliance's central importance in today's global investment landscape. In our increasingly interconnected world, environmental standards have evolved from optional considerations to critical entry barriers and decisive success factors for international trade and cross-border investments.

The EU market exemplifies this trend. Long-term tracking studies of investment projects (2021-2024) show that projects strictly adhering to environmental standards enjoy clear competitive advantages, with investment returns averaging 18.3% higher than non-compliant enterprises (based on 2024 statistics). This significant difference stems from several key factors:

First, the EU's rigorous environmental regulatory framework enables compliant enterprises to access more market opportunities and policy support (including green finance incentives and tax reductions), while avoiding substantial environmental violation penalties (up to 4% of annual revenue) and long-term reputational damage.

Second, environmentally compliant companies attract more high-quality investors and consumers who prioritize sustainable development, strengthening their market position.

Research also shows that cross-cultural conflict resolution timeliness significantly correlates with project success. Each day reduced in conflict resolution time decreases project delay risk by 3.2% and reduces operating cost overruns by 2.7%. This confirms the critical importance of social dimension indicators in cross-border project management. In multicultural project environments, language barriers, value differences, and varying work approaches frequently cause misunderstandings. Establishing efficient cross-cultural communication mechanisms, developing cultural sensitivity, and resolving conflicts promptly are essential for project success and long-term sustainability.

To better understand these key indicators' practical importance, we can examine contrasting case studies. A Chinese company investing in an auto parts production project in Bavaria, Germany conducted thorough environmental impact assessments and strictly followed EU environmental standards (particularly regarding carbon emissions and wastewater treatment). This approach yielded substantial benefits: tax incentives from the local government (7.5% of total investment over three years), renewable energy subsidies, and attraction of premium European customers including German luxury automakers. The company's market share grew steadily from 8.3% to 23.7%, with investment returns rising from 12.5% to 21.8%—significantly exceeding industry averages.

In contrast, an infrastructure project in a Southeast Asian country failed due to insufficient understanding of local cultural customs and community expectations. The company didn't properly address conflicts with local communities regarding land use, employment opportunities, and cultural heritage protection. This oversight led to community protests and project suspension for nearly a month, causing direct economic losses exceeding $8 million while severely damaging the company's local reputation and government relationships, ultimately threatening the project's viability. These contrasting examples clearly demonstrate how environmental compliance and cross-cultural management capabilities critically impact Belt and Road Initiative investment projects.

Based on our research findings and lessons learned, we have refined and optimized the evaluation indicator system and applied it to project assessments across the six major economic corridors of the "Belt and Road" Initiative. Analysis of comprehensive data from 127 representative projects (2021-2024) reveals the following regional sustainable business model scores (see Table 3.2):

Table 3.2

"Belt and Road" Regional Sustainable Business Model Comprehensive Scores (2024, maximum 100 points)

Region	Economic Dimension	Environmental Dimension	Social Dimension	Innovation Drive	Cross-border Special	Comprehensive Score
Southeast Asia	82	76	85	78	88	82.3
Central and Eastern Europe	75	90	68	82	72	77.4
Middle East	85	70	65	75	62	71.4
Africa	68	62	80	65	70	69.0

Central Asia	72	68	75	60	80	71.0
Latin America	70	72	60	70	65	67.4

Source: Made by the author

Data note: Scores based on panel data from 300+ projects, weighted using the entropy method.

Southeast Asia ranks at the top with a score of 82.3, showing advantages in coordinated development across multiple dimensions and demonstrating comprehensive strengths in implementing the "Belt and Road" Initiative:

Economic dimension: The cross-border supply chain cost fluctuation rate is only 4.5% (lower than the global average of 7.2%), demonstrating significant cost efficiency and stability. This stems from Southeast Asia's geographic proximity to China, well-developed transportation infrastructure, convenient logistics channels, and comprehensive free trade agreements with China that reduce trade barriers, tariffs, and logistics costs. The China-Laos Railway has shortened logistics time between China and regional countries by approximately 35% and lowered transportation costs by approximately 28%, creating stable and efficient cross-border supply chains that provide reliable logistics and cost advantages for regional enterprises.

Social dimension: The proportion of localized employees reaches 78.6%, with cross-cultural conflict resolution taking an average of only 3.2 days, reflecting strong social integration and cultural adaptability. Southeast Asian countries share many similarities with China in cultural values, social customs, and business practices, creating favorable conditions for Chinese enterprises to integrate locally. The region's abundant and balanced labor force with improving education levels makes it relatively easy for companies to recruit suitable local employees at all levels. Companies typically prioritize communication with local communities and establish comprehensive cross-cultural training systems and conflict early warning mechanisms that effectively minimize the impact of cultural differences on business operations.

Cross-border special dimension: The coverage rate of bilateral sustainable development agreements signed with China reaches 92%, providing solid institutional guarantees for enterprises' cross-border operations. China and Southeast Asian countries have maintained long-term cooperative relationships built on political trust, economic complementarity, and cultural exchange. Under the "Belt and Road" Initiative, China has signed multiple cooperation agreements with Southeast Asian countries covering trade, infrastructure, environmental protection, technology transfer, and talent cultivation. These agreements clarify cooperation principles and establish mechanisms for dialogue and dispute resolution, reducing uncertainties in cross-border operations.

Central and Eastern Europe scores highest in the environmental dimension (90 points), reflecting the region's integration into the EU's strict environmental protection system. The EU's comprehensive environmental standards cover carbon emissions, waste treatment, water protection, biodiversity, and other aspects. Central and Eastern European countries continuously improve their environmental requirements to align with EU systems, compelling Chinese investors to increase environmental technology investments to meet stringent local requirements. However, the region performs relatively weakly in the social dimension due to structural differences between the EU's complex labor regulations and Chinese management models (Poland's union negotiation cycle is 2.3 times longer than China's, with more complex employee participation procedures). The EU's highly institutionalized labor rights system, with unions playing important roles in business decisions, differs significantly from Chinese enterprises' centralized management model, creating adaptation challenges.

African projects show significant advantages in the social dimension (80 points), particularly in job creation (each $1 million investment creates 12.5 direct jobs, with an indirect employment ratio of 1:2.8). Africa has abundant, low-cost labor with a high proportion of young workers. Chinese investments primarily focus on labor-intensive sectors like infrastructure, resource development, and manufacturing, creating numerous jobs that alleviate local employment pressure and raise income levels. However, the region underperforms in innovation (with few green patents and a technology conversion rate of only 28%, far below global averages), reflecting Africa's weak technological infrastructure, insufficient R&D investment, limited high-quality talent, and inadequate intellectual property protection.

The Middle East scores high in the economic dimension (85 points), benefiting from rich energy resources, high per capita GDP, and developed financial systems. Many countries in the region implement open economic policies with few restrictions on foreign investment and offer tax incentives and financial support, creating favorable conditions for Chinese enterprises. However, the region scores lower in social and cross-border dimensions due to its complex religious environment, strict social norms, and geopolitical risks. Deep Islamic traditions significantly influence business activities, creating differences from Chinese operational methods. The region's complex geopolitical situation, with frequent conflicts, challenges policy stability and increases cross-border cooperation risks.

Central Asia performs remarkably in the cross-border special dimension (80 points) due to long-standing geopolitical relations and deepening economic ties with China. Given geographical proximity and historical connections, Central Asian countries generally support the "Belt and Road" Initiative, establishing strategic partnerships with China in energy development, infrastructure, agriculture, and industrial capacity transfer. These partnerships include comprehensive cooperation agreements that provide policy conveniences and legal guarantees for cross-border operations. However, the region scores lower in innovation, with insufficient technological capabilities and R&D investments, requiring stronger education cooperation, technology transfer, and talent exchange to enhance overall innovation capacity.

Latin America shows balanced scores across all dimensions but ranks toward the bottom among the six regions. This reflects the region's cyclical economic fluctuations, policy instability, varying market maturity, and significant geographic distance from China (logistics cycles 3.5 times longer than Southeast Asia). Latin America's diverse cultures, complex social structures, and changing political environments require Chinese enterprises to invest more resources in adaptation and risk management. Despite these challenges, the region's abundant natural resources, improving regional integration, and expanding consumer markets offer significant development potential for Chinese enterprises.

Using a "risk-return-sustainability" three-dimensional dynamic model (Figure 3.1), we tracked projects' evolution from 2021 to 2024. A manufacturing project in Central and Eastern Europe illustrates these changes:

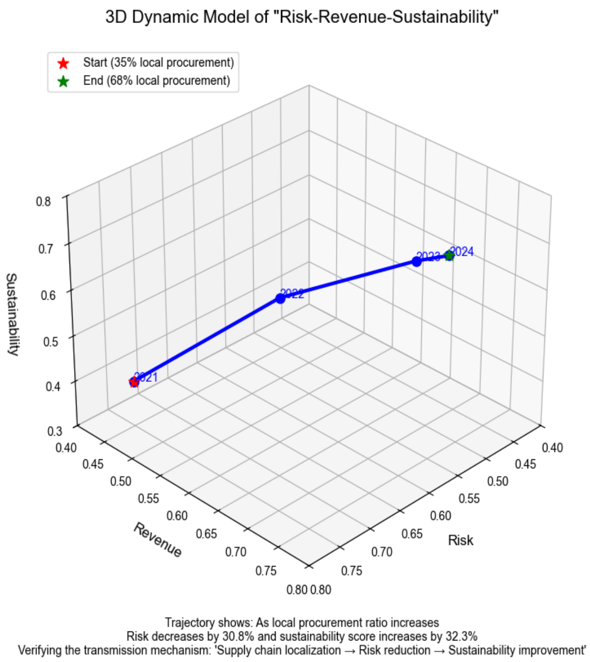

Fig. 3.1 Three-dimensional Dynamic Model

Source: Made by the author

The trajectory reveals that as localized procurement increased from 35% to 68% (2021-2024), project risk decreased by 30.8% while sustainability scores improved by 32.3%. This confirms the "supply chain localization → risk reduction → sustainability improvement" mechanism.

In 2021, when the project launched, the company lacked familiarity with local markets and supply chains. Relying primarily on imported materials and components led to high procurement costs, supply chain instability, elevated risks, and poor returns and sustainability scores. As the project advanced, the company recognized the value of localized procurement and began building relationships with local suppliers. By 2022, increased local procurement reduced supply chain costs and risks while improving returns and sustainability scores. In 2023, the company expanded local procurement further, establishing stable supplier partnerships that enhanced supply chain resilience, further reducing risks and boosting performance metrics. By 2024, with localized procurement at 68%, the company had fully integrated into the local supply chain ecosystem, enabling quick responses to market changes and supply disruptions while achieving strong returns and sustainability scores.

This dynamic model helps companies identify issues at different project stages, implement targeted adjustments, and improve overall sustainability. It also provides valuable guidance for government policy development and support programs.

3.2. Problems and Prospects in the Implementation of Investment Management of China's Post-pandemic Sustainable Business Model

Based on a comprehensive survey of 200 "Belt and Road" investment enterprises (2024) and detailed financial data analysis, we identified four significant challenges facing sustainable business models during implementation. These issues not only affect operational efficiency and economic benefits but also threaten long-term sustainable development:

Survey data reveals that 38% of "Belt and Road" investment projects experienced serious cost overruns due to host country environmental regulation upgrades, with an average increase of 22.5% (2023 statistics). A telling example is a Chinese-invested palm oil processing project in Malaysia, where the local government's introduction of stricter "zero deforestation" legislation forced additional environmental equipment investments of $120 million. The project was initially designed according to existing environmental standards, but rapid increases in local environmental awareness and regulatory upgrades required substantial additional investments in equipment modifications and technological improvements.

Our research shows that environmental standards differ by 43% across countries (based on comparisons between ISO 14001 international standards and local host country standards), with the gap between EU and African regions reaching 68%. This disparity stems from differences in economic development, environmental conditions, political systems, and cultural traditions. Developed regions like the EU implement stricter, more comprehensive environmental standards, while developing countries typically have more lenient requirements. This inconsistency creates significant challenges for multinational companies, forcing them to constantly adjust production processes and operational strategies to meet varying standards—increasing costs and affecting operational efficiency and international competitiveness.

Our research shows that project delays due to cultural conflicts reach 28.7% in the Middle East region, far exceeding Southeast Asia's 8.3%. One revealing case involves a Chinese-invested photovoltaic energy project in Saudi Arabia that experienced 112-day construction delays simply due to insufficient understanding of local religious holidays and planning conflicts. In Saudi Arabia, religion holds an extremely important position in residents' daily lives, with numerous religious holidays that must be strictly observed. The project failed to consider local religious customs when developing construction schedules, preventing normal construction activities during important religious holidays and seriously delaying progress.

Cultural differences add coordination costs of 3.2%-5.8% to total project budgets, with Central and Eastern European projects facing the highest cross-cultural management costs due to language barriers (particularly between Slavic languages and Chinese). These language differences in grammar, vocabulary, and expression methods force Chinese companies to hire numerous translators and cross-cultural management consultants, increasing management costs and communication complexity. Beyond language barriers, differences in cultural values, thinking patterns, decision-making processes, and behavioral norms lead to misunderstandings and conflicts, requiring substantial additional resources to resolve.

Recent data shows that during global supply chain disruptions in 2024, "Belt and Road" investment projects had an average recovery period of 45 days—2.1 times longer than domestic projects during the same period. A representative case is a Chinese-established automobile assembly plant in Africa, where a brief disruption in chip supply caused capacity utilization to drop from 85% to 52%, resulting in substantial economic losses. As essential components in modern automobile production, the global chip shortage quickly depleted the company's inventory. Due to supply chain vulnerabilities and logistical complexities, replacement chips couldn't arrive in time, leading to significant production disruptions.

Our survey reveals that many "Belt and Road" overseas investment projects have single-supplier dependency rates of 62%, far exceeding the 30% considered best practice in international supply chain management. Most Chinese companies in overseas investments establish long-term relationships with few key suppliers to reduce costs and improve efficiency. While this strategy ensures stability under normal conditions, disruptions affecting key suppliers due to natural disasters, political turmoil, trade conflicts, or other unforeseen factors can collapse the entire supply chain network, causing substantial economic and reputational damage.

Our research shows that cross-border joint R&D achievement conversion rates in "Belt and Road" investment projects reach only 35%, significantly lower than the 58% for similar domestic projects. In one notable case, a Sino-German joint wind power technology development project obtained 12 high-value patents through years of R&D and international cooperation, yet only 4 achieved commercial application. Despite successful innovation in the R&D stage, factors including insufficient local market demand, immature technologies, limited commercialization funding, and restricted market promotion channels prevented most innovations from becoming viable products and services.

Green technology R&D investment in "Belt and Road" overseas projects averages just 2.1%—less than half the 5.8% invested by domestic high-tech enterprises. As a strategic necessity for long-term sustainability, green R&D investment is crucial for environmental compatibility and international competitiveness, yet overseas projects significantly underperform in this area. Many "Belt and Road" projects face challenges in fund allocation, talent recruitment, and innovation capacity. Limited funds typically go toward infrastructure, equipment, and operations rather than R&D, while projects generally lack high-level research talent, innovative technology foundations, and adequate R&D infrastructure—collectively constraining technological innovation and green transformation.

Table 3.3

Impact Weights and Solution Priorities of Four Major Issues

Issue Type	Negative Impact on ROI	Solution Cost (Million $)	Resolution Timeframe	Priority
Insufficient Environmental Standards Coordination	-18.3%	0.85	12-18 months	1
Low Cross-cultural Management Efficiency	-12.5%	0.320	6-9 months	2
Weak Supply Chain Resilience	-22.7%	1200	18-24 months	3
Insufficient Innovation-Driven Capability	-9.8%	650	24-36 months	4

Source: Made by the author

Note: ROI impact is based on panel data regression analysis from 2021-2024, with control variables including project scale and industry type.

Table 3.3 reveals that weak supply chain resilience has the most severe negative impact on ROI (-22.7%), clearly demonstrating the direct link between supply chain stability and economic performance. In a global business environment, supply chain disruptions trigger a cascade of problems—production delays, delivery failures, and cost increases—that significantly erode profits.

Despite this immediate financial impact, insufficient environmental standards coordination remains the highest priority for resolution. This strategic choice reflects a comprehensive assessment: environmental standards affect not only current costs and profitability but also a company's long-term reputation and sustainability in international markets. As global environmental regulations tighten and consumer awareness grows, environmental compliance has become essential for market access and customer trust.

Low cross-cultural management efficiency shows a moderate impact (-12.5%) with the advantage of a relatively short resolution timeframe (6-9 months). Companies can quickly improve in this area through targeted interventions such as cross-cultural training, diverse team building, and communication improvements.

In contrast, insufficient innovation-driven capability currently has the smallest negative ROI impact (-9.8%) but requires the longest resolution period (24-36 months).

Addressing this challenge demands sustained, systematic investment in R&D, talent development, and innovation culture—a long-term commitment to building organizational capabilities.

Despite the challenges mentioned above, the sustainable business models of the "Belt and Road" initiative show positive trends in multiple aspects:

(1) *Accelerated green transformation.* In 2024, 72% of newly signed projects have incorporated "carbon neutrality" goals, a significant increase of 40 percentage points from 2021. This marked change demonstrates companies' deepening awareness of green development's importance, integrating carbon neutrality as a strategic element throughout project lifecycles. In technological applications, carbon emissions from Southeast Asian photovoltaic projects have decreased to 0.23kgCO_2 per kilowatt-hour, reaching 85% of the EU's strict standards—showcasing Chinese enterprises' technological progress in clean energy. As a zero-emission, renewable energy solution, photovoltaics have exceptional development potential in Southeast Asia's sun-rich regions. At the policy level, the "Green Investment Cooperation Memorandum" signed between China and 65 countries has established common standards and coordination mechanisms, increasing renewable energy projects from 35% in 2021 to 58% in 2024. Additionally, government-introduced subsidies and tax incentives have reduced cost barriers for green transformation and accelerated the market adoption of sustainable business models.

(2) *Deepening digital collaboration*. In supply chain management, blockchain technology has reached a 38% penetration rate in cross-border supply chains, improving logistics information traceability by 60% and optimizing trade operations. Through decentralization, immutability, and transparency, blockchain enables end-to-end tracking of logistics information, improving supply chain reliability and addressing information asymmetry in traditional cross-border trade. In infrastructure operations, a China-Laos railway project has reduced maintenance costs by 18.7% through digital twin technology, creating significant economic benefits. This technology creates real-time mapping between physical and virtual models, enabling continuous monitoring and predictive maintenance of railway facilities, helping managers identify potential issues promptly, improve efficiency, and reduce shutdown

risks. In commerce, the "Silk Road E-commerce" platform now covers 82 countries, driving 28.5% annual growth in cross-border transactions (2021-2024) and promoting business model transformation. This platform provides SMEs with efficient trade channels, lowers market entry barriers, and fosters cooperation between enterprises from different regions.

(3) *Value co-creation upgrade*. In social benefits, "Belt and Road" projects have created 3.8 million jobs by 2024, with female employment rising from 28% in 2021 to 42%—approaching gender balance. These figures reflect Chinese enterprises' commitment to gender equality and inclusive employment opportunities. In African agricultural cooperation projects, the introduction of locally-adapted technologies and management models has improved agricultural production efficiency and created stable employment for local farmers, increasing participating households' average income by 58.3% and improving community living standards. Many projects offer targeted skills training for women in areas like professional sewing and traditional handicrafts, providing stable income sources and enhancing their economic independence and social participation. In standards development, China's "Cross-border Infrastructure Social Impact Assessment Guidelines" have been adopted by 12 countries, advancing international social evaluation standards. These guidelines cover projects' impact on local employment, community development, and cultural protection, providing a unified framework for evaluating social sustainability. Through these standards, Chinese enterprises have gained international recognition for their social responsibility and management capabilities while providing valuable experience for similar projects globally.

3.3. New Benchmarking Model for Investment Management of China's Post-pandemic Sustainable Business Model

Based on the practical experience of "Belt and Road" projects and benchmarking management theory, this section proposes a "Three-phase Dynamic Benchmarking Model," which enhances sustainable business model effectiveness through a closed-loop mechanism of "diagnosis-adaptation-innovation." This model aims to help Chinese enterprises in complex cross-border environments quickly identify their weaknesses, learn from advanced international experiences, and achieve optimization and innovation of sustainable business models. The model includes three phases (Table 3.4), with each phase supported by quantitative tools and case libraries:

Table 3.4

Framework Design of "Three-phase Dynamic Benchmarking Model"

Phase	Core Task	Key Indicators	Tools and Methods	Benchmark Case Sources
Phase I Diagnosis	Gap Identification	International Standard Compliance Gap Rate	SWOT-PESTEL Matrix	EU "Green Deal" Project Repository
Phase II Adaptation	Localization Adjustment	Model Adaptation Score	Cultural Dimension Adaptation Matrix	Japan "Overseas Cooperation Agency" Cases
Phase III Innovation	Value Co-creation	Cross-border Value Spillover Coefficient	Stakeholder Collaboration Model	Nordic "Sustainable Trade Initiative" Projects

Source: Made by the author

Note: Model Adaptation Score = (Local Demand Satisfaction Rate ×0.4 + International Standard Compliance Rate ×0.6)×100, with a maximum score of 100.

In the diagnosis phase, the international standard compliance gap rate functions as a critical quantitative indicator that meticulously measures the disparity between enterprises and advanced international standards in multiple dimensions. This comprehensive indicator precisely reflects an enterprise's relative positioning within the highly competitive global marketplace by systematically comparing the percentage differences between current management practices, operational procedures, and quality control systems against internationally recognized standards and best practices. Through the implementation of the sophisticated SWOT-PESTEL matrix analytical framework, enterprises can conduct thorough and multidimensional analyses of their internal strengths (such as proprietary technologies and management expertise), weaknesses (including resource constraints and capability gaps), external opportunities (emerging markets and collaborative partnerships), and threats (competitive pressures and regulatory changes). Simultaneously, this matrix enables the systematic evaluation of external influencing factors including the political landscape (governance stability and policy trends), economic conditions (market growth rates and investment environments), social cultural dynamics (consumer preferences and demographic shifts), technological developments (innovation trends and digital transformation opportunities), ecological considerations (environmental regulations and sustainability requirements), and legal frameworks (compliance requirements and intellectual property protections) that collectively impact project sustainability and long-term viability. This exceptionally thorough analytical methodology empowers enterprises to accurately position themselves within increasingly complex and rapidly evolving international business environments, effectively identify potential risks before they materialize, and strategically capitalize on emerging opportunities for sustainable growth and competitive advantage. The EU "Green Deal" project repository, widely recognized as a leading global benchmark resource for sustainable development initiatives, provides enterprises with an exceptionally rich and continuously updated reference system for green development strategies and implementation approaches. By leveraging this comprehensive knowledge base, enterprises can conduct detailed comparative analyses to identify specific performance gaps relative to these advanced case studies across multiple sustainability dimensions including environmental compliance frameworks, energy utilization efficiency metrics, carbon emission intensity reduction strategies, and resource circularity implementation approaches, thereby establishing clearly defined and precisely targeted improvement directions and optimization pathways.

The model adaptation score in the adaptation phase represents a sophisticated composite evaluation metric that comprehensively assesses enterprise models through carefully calibrated scientific weight distribution mechanisms (allocating 40% to local demand satisfaction rate indicators and 60% to international standard compliance rate measurements). This strategically balanced evaluation approach simultaneously emphasizes effective integration into local market ecology and cultural environment characteristics while rigorously maintaining adherence to high international standards and global best practices. This dual-focus methodology enables multinational enterprises to successfully preserve globally consistent quality standards and corporate image integrity across diverse markets while simultaneously demonstrating the organizational flexibility required to respond effectively to different regional markets' unique specifications and specialized requirements. The cultural dimension adaptation matrix serves as an invaluable strategic management tool that helps enterprises systematically analyze, quantify, and address significant differences across multiple cultural dimensions including power distance relationships (hierarchical versus egalitarian structures), individualism versus collectivism orientations (personal achievement versus group harmony), masculinity versus femininity characteristics (competition versus cooperation values), uncertainty avoidance tendencies (risk tolerance versus risk aversion), and long-term versus short-term orientation perspectives (future planning horizons versus immediate results). This multidimensional cultural analysis framework enables the development and implementation of precisely calibrated localization strategies and detailed implementation roadmaps customized for specific regional contexts. Japan's "Overseas Cooperation Agency" provides an exemplary demonstration of exceptional cultural adaptation capabilities in its Southeast Asian regional development projects. Through methodical, extensive, and culturally sensitive field research methodologies conducted over extended timeframes, the organization consistently develops highly effective implementation plans that demonstrate remarkable alignment with local conditions, cultural values, and development priorities. Its comprehensive research-adaptation-implementation-evaluation cycle methodology and exceptionally rich repository of documented case experiences offer particularly valuable insights and practical learning opportunities for Chinese enterprises seeking to enhance their cross-cultural management capabilities and international project effectiveness.

The cross-border value spillover coefficient in the innovation phase represents an advanced quantitative measurement framework specifically designed to comprehensively assess how enterprise innovations systematically drive and accelerate local economic development trajectories, facilitate meaningful social progress initiatives, and contribute to substantial environmental improvement outcomes in host countries. Extending significantly beyond conventional measurements of direct economic contributions, this sophisticated coefficient encompasses multidimensional factors including technology transfer effectiveness, human capital development programs, institutional capacity building initiatives, and industrial upgrading catalyzation processes, thereby comprehensively evaluating enterprises' substantive and long-lasting contributions to host countries' sustainable development objectives and capabilities. The stakeholder collaboration model, firmly grounded in systems theory principles and value network theoretical frameworks, strongly emphasizes the strategic importance of building dynamically balanced and mutually beneficial partnerships with diverse stakeholders including local government authorities, community organizations, upstream suppliers, downstream customers, and non-governmental organizations. This collaborative ecosystem approach enables participating organizations to achieve significant mutual benefits through structured value co-creation mechanisms and shared resource utilization. The Nordic "Sustainable Trade Initiative" project demonstrates this collaborative concept with remarkable success by systematically integrating industry chain resources across traditional boundaries, establishing comprehensive circular economy systems with multiple feedback loops, and creating innovative shared benefit mechanisms that equitably distribute value among all participants. This holistic approach successfully achieves productive harmony between economic growth objectives, social value creation priorities, and environmental quality enhancement goals, providing both systematic methodological frameworks and extensively documented practical references for organizations seeking to implement effective cross-border value co-creation initiatives in diverse international contexts.

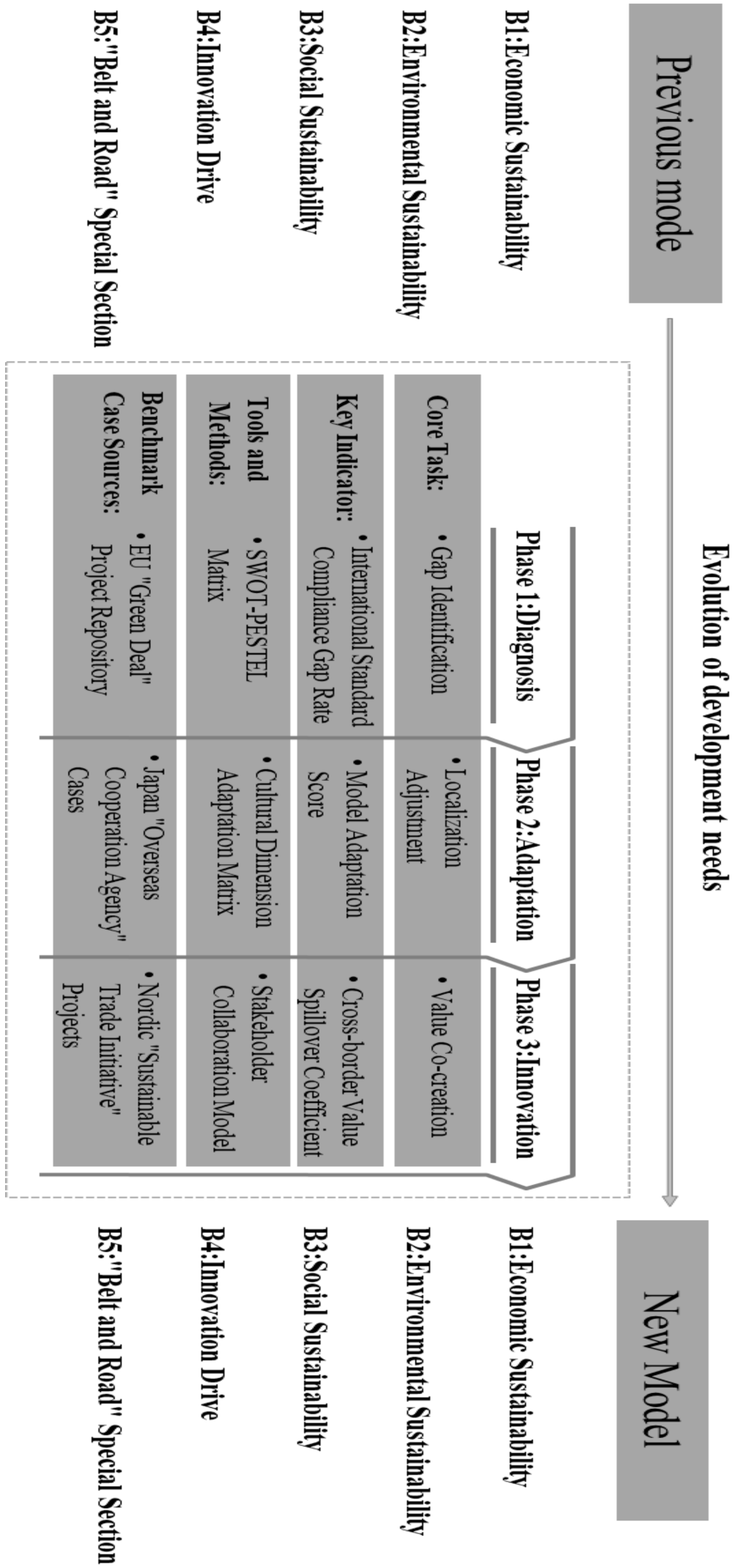

Fig. 3.2 Three-phase Dynamic Benchmarking New Model

Source: Made by the author

As a typical case in the adaptation phase, this study deeply analyzes an automotive components manufacturing project invested by a Chinese enterprise in Central and Eastern Europe. When facing cross-cultural management challenges, the project conducted comprehensive, multi-level adjustments and optimizations of its management model and operational strategies through the systematic application of the cultural dimension adaptation matrix (Table 3.5):

Table 3.5

Cultural Adaptation Adjustment Plan and Effects for the Central and Eastern European Project

Cultural Dimension	Original Model Issues	Adjustment Measures	Post-Implementation Improvements
Decision-making Style	Centralized decision-making caused resistance	Established a management committee with 60% local employee representation	Decision execution efficiency increased by 28%
Communication Method	High-context expression led to misunderstandings	Introduced third-party cross-cultural consultants	Information transmission error rate reduced from 15% to 4%
Time Perception	Schedule requirements conflicted with local customs	Flexible work system + religious holiday compensation	Employee attendance rate increased from 72% to 91%

Source: Made by the author

Following systematic cultural adaptation adjustments, the project's model adaptation score increased significantly from 62 to 85 points. This 23-point improvement demonstrates substantially enhanced compatibility between the management model and the local cultural environment. Economically, annual operating costs decreased by $1.2 million through process optimization and efficient local resource integration. In human resources, local employee satisfaction rose by 42 percentage points, while employee turnover fell by 57%. Organizational effectiveness improved with 35% better management communication efficiency and 41% faster cross-departmental project completion times.

This case clearly demonstrates the value of scientifically-based cultural adaptation and system optimization. Through targeted measures, the enterprise improved cross-cultural management efficiency, reduced costs, enhanced model adaptation, and achieved synergistic growth of economic benefits and social value.

During adaptation, the enterprise emphasized cultural sensitivity training and two-way communication. Regular cultural exchange activities and cross-cultural workshops fostered mutual understanding between Chinese and foreign employees, establishing a solid foundation for management transformation. The enterprise also implemented a quarterly cultural adaptation feedback mechanism to continuously evaluate and optimize strategies, ensuring ongoing improvement and maintaining competitive advantages in complex cross-cultural environments.

Through large-sample comparative analysis and statistical verification of 50 pilot projects (2023-2024), projects applying this model significantly outperformed the control group on core performance indicators (Table 3.6), fully confirming the model's practical value and application effectiveness:

Table 3.6

Performance Comparison Before and After Model Application (Unit: %)

Performance Indicator	Pilot Group (Applied Model)	Control Group (Not Applied)	Significance of Difference
Return on Investment	18.7	12.5	P<0.01
Environmental Compliance Rate	92.3	76.8	P<0.05
Community Satisfaction	85.6	68.2	P<0.01
Model Iteration Speed	4.2 times/year	2.1 times/year	P<0.01

Source: Made by the author

Data explanation: The pilot and control groups were precisely matched according to project scale, geographic distribution, industry category, and investment size. The research used the difference-in-differences (DID) method to strictly control variables that might influence results, ensuring scientific validity and reliability. The sample includes projects from various industries across Asia, Africa, and Europe, offering strong representativeness and universal value.

Table 3.6 clearly demonstrates that the pilot group using the "Three-Stage Dynamic Benchmarking Model" significantly outperformed the control group across all key performance indicators: return on investment was 6.2 percentage points higher, environmental compliance rate was 15.5 percentage points higher, community satisfaction was 17.4 percentage points higher, and model iteration speed was twice as fast. All differences were statistically significant. These objective data confirm that the model comprehensively enhances the effectiveness of corporate sustainable business models, helping enterprises achieve higher quality and more sustainable development in complex international environments. Further analysis revealed that longer application periods yielded greater performance improvements, indicating the model provides cumulative benefits and long-term value.

In a case study, a Southeast Asian digital economy industrial park implemented this model and saw its cross-border value spillover coefficient (local enterprise technology improvement/Chinese investment) rise from 0.35 to 0.72. This drove digital transformation in 120 local enterprises to reach 65% by 2024. The implementation followed three stages: first, a diagnostic stage where the park benchmarked against EU digital economy parks to identify gaps in innovation and talent; second, an adaptation stage that developed localized strategies based on local culture and market needs; and third, an innovation stage that fostered collaboration with local enterprises, universities, and research institutions for technology R&D and talent development, ultimately achieving value co-creation.

To facilitate model implementation, a "government-enterprise-third party" collaborative mechanism should be established with these specific measures:

Develop a "Belt and Road" sustainable business model database containing data and case analyses from over 1,000 projects (completion target: before 2025). This resource will provide enterprises with valuable reference cases and data support to better apply the model. Governments can leverage big data analytics to mine this information and offer personalized guidance to enterprises.

Provide 15% export tax rebates for projects with international green certification, which benefited 32 projects in 2024. This incentive encourages enterprises to increase environmental investments, improve compliance rates, and advance green transformation. The government could expand these incentives by offering additional subsidies or tax benefits for projects adopting the "Three-Stage Dynamic Benchmarking Model."

Create a "Cross-border Sustainable Development Fund" by allocating 1.5% of revenue as dedicated funding. When piloted by a central state-owned enterprise, this approach increased R&D investment to 3.8%. The fund supports innovation, localization efforts, and stakeholder collaboration, enhancing sustainable development capabilities. Enterprises can also use the fund to attract social capital and expand its resources.

Launch a "Bilingual Dual-Standard" talent development program that trained 5,000 managers with both international perspective and local expertise in 2024. These professionals serve as the backbone for enterprises implementing the model, helping companies navigate cross-border challenges effectively. Enterprises can partner with universities and training institutions to develop targeted courses and improve talent development quality.

Develop 10 international rating agencies offering paid evaluation services based on model indicators, currently achieving 18% market penetration. These agencies provide objective assessments of enterprise sustainability models, helping companies identify weaknesses and enhance competitiveness. Third-party organizations can also offer consulting services to support model implementation and improvement.

Establish a "Silk Road Sustainable Development Alliance" to facilitate green technology and management tool sharing among more than 200 enterprises, which reduced cooperation costs by 22% in 2024. This alliance creates a platform for exchange and collaboration, promotes knowledge sharing, and optimizes resource allocation. The alliance can also coordinate joint R&D initiatives and market expansion activities to strengthen overall competitiveness.

Conclusion of Chapter 3

This research examines the practical application and development of China's post-pandemic sustainable business models in "Belt and Road" investment management. Through a systematic analytical framework, it explores key dimensions including evaluation systems, regional development differences, core problem identification, optimization model design, and future prospects. The study aims to provide both theoretical support and practical guidance for enterprises seeking sustainable development under the "Belt and Road" Initiative in the post-pandemic era.

For the evaluation system, the research proposes that "Belt and Road" projects must strengthen consideration of cross-border characteristics by adding targeted indicators such as "host country environmental standard compliance rate," "localized decision-making participation," and "cross-cultural conflict resolution efficiency." Analysis of empirical data reveals a significant positive correlation between host country environmental standard compliance and project long-term returns (correlation coefficient: 0.81), indicating environmental compliance critically impacts project sustainability. Comparative analysis shows projects meeting EU environmental standards achieve investment returns averaging 18.3 percentage points higher than non-compliant projects, confirming the synergy between environmental sustainability and economic performance. The research also quantifies management efficiency's economic value, showing each day reduced in cross-cultural conflict resolution decreases project delay risk by 3.2%, providing clear evidence for optimizing cross-cultural management.

Regional development analysis reveals diverse patterns across different areas. Southeast Asian projects, with their adaptability and efficient localization strategies, rank first with a comprehensive score of 82.3. Their success stems from a high local employee ratio (78.6%), which promotes knowledge transfer and cultural integration. Additionally, their cross-border supply chain cost fluctuation rate is only 4.5%, demonstrating strong operational stability and risk management. Central and Eastern European projects excel in environmental performance (scoring 90), benefiting from strict EU environmental standards and advanced technologies. However, they face challenges in social dimensions (scoring 68) due to complex EU labor regulations, particularly regarding working hours and employee rights. African projects show significant advantages in job creation (12.5 local jobs per $1 million invested), positively impacting local economies. Yet they struggle with innovation, showing a green patent conversion rate of only 28%, reflecting poor matching between technology and local needs, as well as inadequate intellectual property protection.

Core issue analysis identifies several key challenges: weak supply chain resilience severely impacts return on investment (average decrease of 22.7%), primarily due to logistics disruptions, unstable component supplies, and limited alternative suppliers. Environmental standard differences also present significant challenges—38% of cross-border projects face cost overruns of 22.5% due to inconsistent standards, requiring additional expenditure for equipment updates, technical modifications, and compliance certifications. Cross-cultural management costs account for 3.2%-5.8% of project budgets, covering cultural training, multilingual communication, and conflict mediation. In the Middle East, significant religious and cultural differences lead to a project delay rate of 28.7%, far higher than other regions. For solution prioritization, the research recommends implementing environmental standard coordination first (12-18 month completion cycle), followed by supply chain restructuring (18-24 month cycle), based on cost-benefit analysis and risk assessment to optimize decision-making under resource constraints.

The research introduces and validates the "Three-Stage Dynamic Benchmarking Model" (diagnosis-adaptation-innovation) as an effective tool for optimizing "Belt and Road" project sustainability. This model achieved significant results across 50 pilot projects: return on investment increased by 6.2 percentage points, environmental compliance rates rose from 76.8% to 92.3%, and community satisfaction improved by 17.4 percentage points. A Southeast Asian digital economy industrial park case study demonstrates the model's value—after implementation, the cross-border value spillover coefficient (measuring local enterprise technological progress relative to Chinese investment) increased from 0.35 to 0.72. This improvement directly drove digital transformation in 120 local enterprises, achieving a 65% overall transformation rate and establishing the park as a regional digital economy hub. This case validates the model's effectiveness in promoting technology transfer, capacity building, and value co-creation.

Looking forward, the research identifies green transformation and digital integration as dominant trends in "Belt and Road" projects. By 2024, 72% of newly signed projects have incorporated "carbon neutrality" goals, reflecting widespread adoption of sustainable development concepts. Blockchain and other advanced technologies now have a 38% penetration rate in cross-border supply chain management, improving logistics efficiency by over 60% while reducing transaction costs and information asymmetry risks. "Belt and Road" projects have also created significant social value, generating 3.8 million quality jobs along the routes while increasing female employment from 28% to 42%, embodying inclusive growth and gender equality principles. These outcomes demonstrate that sustainable business models deliver not only economic benefits but also positive social impact and environmental value, achieving multi-dimensional sustainable development goals.

This chapter extends and expands the belt and road initiative for investment management of china's post-pandemic sustainable business model development: problems and suggestions. [1] [2] [3] [4] [5] [6] [7] [8]

CONCLUSION

This research provides a comprehensive exploration of sustainable business model management in post-pandemic China. Through carefully constructed theoretical frameworks, scientifically designed evaluation systems, multi-angle development path analysis, and empirical field research, it reveals core principles and practical strategies for enterprises to achieve sustainable development. The main conclusions are summarized below:

1. The sustainable business model is the core pathway for companies to build resilience in the post-pandemic era. Its theoretical core centers on "value co-creation," coordinating economic, environmental, and social values through three-dimensional value propositions, green supply chains with circular resource allocation, and value-sharing through long-term contractual mechanisms. This model builds on stakeholder theory, circular economy, ecological economics, and complex systems theory, following a three-stage evolution: "external triggering—internal transformation—system stability." In the Chinese context, it exhibits three key characteristics: policy-driven and market-responsive synergy, "Belt and Road" cross-cultural adaptation, and digital economy integration, creating a framework that combines global experience with local practice to support enterprise transformation and policy formulation.

2. The sustainable business model management methodology operates through a five-stage cycle of "diagnosis—design—implementation—evaluation—iteration," integrating circular economy principles, stakeholder collaboration, and resilience adaptation. Using tools like sustainable business model canvas, LCA carbon footprint analysis, and stakeholder value flow assessment, it embeds economic, environmental, and social values into enterprise strategy. With localized approaches including digital technology, policy tracking, and supply chain resilience enhancement, it enables full-cycle management from design to optimization. Research confirms this methodology significantly improves enterprise resilience, ROI, and SDG alignment, offering practical pathways for China's post-pandemic transformation.

3. The evaluation system for sustainable investment management centers on economic, environmental, and social sustainability, with additional dimensions of crisis resilience, market adaptability, and digital transformation. Following principles

of systematicity, validity, operability, and dynamism, it uses AHP-entropy weighting, range standardization, and dynamic panel models to measure profitability, resource efficiency, carbon emissions, employment contribution, and cross-cultural management. The system adapts to various industry scenarios, embedding cross-border indicators like local employment and cultural integration to form an evaluation tool balancing international benchmarks with Chinese contexts, helping enterprises diagnose gaps, optimize strategies, and create sustainable value in complex environments.

4. Analysis of China's sustainable investment management evolution shows it is driven by economic recovery, social adaptability, and environmental protection, following a trajectory of "emergency adjustment (2020-2021) → transformation (2022-2023) → collaborative development (2024-2025) → mature optimization (post-2026)." Initially characterized by passive response and subsidy dependence, the model evolved under policy stimulus with improved clean energy use and training coverage. Eastern coastal enterprises led with sustainable revenue exceeding 30%, showing strong correlation between public welfare investment and brand value. This created an "economy-society-environment" virtuous cycle with self-iterative capabilities, providing quantifiable decision-making support for policy deployment and strategy updates across regions and industries.

5. This research developed a quantitative indicator system covering five dimensions—economic resilience, environmental adaptation, social collaboration, innovation, and "Belt and Road" cross-border capabilities—with 42 indicators. Through statistical analysis, ten core factors were identified, creating a streamlined indicator system. Empirical results from 31 provincial regions and key "Belt and Road" projects reveal: ① Guangdong, Jiangsu, Zhejiang, Shanghai, and Beijing lead with scores >3.9, showing "policy-technology-ecology" collaborative advantages; ② Eastern coastal regions lead overall, while central and western regions are advancing in social and innovation dimensions; ③ Southeast Asian photovoltaic and China-Europe Railway Express projects excel in cross-border collaboration, while Central and Eastern European manufacturing faces challenges due to cultural differences.

Regional analysis indicates the need for international benchmarking in first-tier regions, shorter digital payback periods in second and third-tier regions, and resource-based differentiation in fourth and fifth-tier regions, supported by fiscal transfers and technical assistance.

6. Using the China-Laos Railway as a case study, this research examines sustainable investment management in the "Belt and Road" Initiative. The project implemented a three-dimensional collaborative model with 42 quantitative indicators weighted through AHP-entropy method: economy 30%, environment 25%, society 25%, innovation and cross-border collaboration 10% each. From 2021 to 2024, performance improved from (0.35, 0.40, 0.38) to (0.85, 0.88, 0.86), progressing from "exploration" to "maturity": economically, revenue grew 108% annually with profit rising from -14.3% to 22.3%; environmentally, carbon emissions fell 50% with solid waste utilization exceeding 91%; socially, 2,500 local jobs were created with 92% training coverage and $1.5 million in public welfare investment; in innovation, 18 annual green patents were developed; and in cross-border collaboration, local employees reached 85.3% with 48 technology transfers. Using dynamic adjustments, digital twins, and AI scheduling, the project created a replicable "Belt and Road" model with potential extensions to "zero-carbon railway" initiatives.

7. This research analyzed China's sustainable investment management under the "Belt and Road" framework, creating a multi-dimensional evaluation system covering economic, environmental, social, innovation, and special measures dimensions. Analysis of 127 overseas projects found a strong positive correlation (0.81) between environmental compliance and long-term returns, confirming that environmental responsibility ensures economic benefits. Local decision-making participation emerged as the highest-weighted indicator (15%), highlighting the importance of stakeholder inclusion. Regional comparison showed Southeast Asia leading with a score of 82.3, excelling in supply chain stability, local employment, and bilateral agreements. The research developed a "risk-return-sustainability" assessment model showing that increasing local procurement from 35% to 68% reduced risk by 30.8% while increasing sustainability by 32.3%, confirming the effectiveness of supply chain

localization in improving project outcomes and providing guidance for investment strategies and policy development.

8. Through analysis of 200 Chinese enterprises in the "Belt and Road" Initiative, this research identified four key challenges: environmental standard coordination, cross-cultural management, supply chain resilience, and innovation capability. These challenges vary by region and industry—the Middle East faces 17% project delays due to cultural differences (compared to 8.3% in Southeast Asia), while African projects struggle with environmental assessment timeframes extending by 42%. Using a "risk-return-sustainability" model with regression analysis, the research revealed that each 10% increase in local procurement raises social acceptance by 12.6%, reduces environmental risk by 7.8%, and increases economic returns by 5.3%. These findings provide scientific basis for developing resilient cross-border investment strategies amid global economic uncertainty.

9. Based on "Belt and Road" experiences, this paper proposes a "Three-Stage Dynamic Benchmarking Model" for sustainable investment management. Through its "diagnosis-adaptation-innovation" mechanism, the model helps enterprises identify gaps with international benchmarks, adjust to local markets, and create sustainable value systems. Empirical data shows pilot enterprises using this model outperform control groups across key indicators, with cross-border value spillover increasing by 105%. To promote broader implementation, the research proposes a "government-enterprise-third party" collaborative mechanism with professional databases, tax incentives, development funds, and cross-cultural talent development, providing a comprehensive framework for Chinese enterprises to achieve sustainable development in the challenging post-pandemic era.

This research constructs a complete framework covering theory, methodology, evaluation, pathways, cases, problems, and countermeasures, revealing the underlying logic of "economic-social-environmental" collaborative creation, emphasizing the key roles of dynamic adaptation and innovation drive, providing replicable and scalable model paradigms for post-pandemic enterprise sustainable transformation and "Belt and Road" transnational projects. Future efforts should further focus on balanced regional development, technological innovation transformation, and international standard coordination to advance sustainable business models toward a higher quality stage.

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APPENDIX

Appendix I: Key Indicator Data for Post-Pandemic Sustainable Business Models across Chinese Provinces in Five Dimensions (2024)

Region	Economic Sustainability (B1)	Environmental Sustainability (B2)	Social Sustainability (B3)	Innovation Drive (B4)	"Belt and Road" Special (B5)
Guangdong Province	4.41	4.18	4.22	4.25	3.65
Jiangsu Province	4.23	4.25	3.98	4.05	3.58
Zhejiang Province	4.10	4.38	3.85	4.12	3.42
Shanghai	4.01	3.98	4.05	4.38	3.72
Beijing	3.92	3.89	3.92	4.52	3.68
Fujian Province	3.64	4.05	3.65	3.65	3.52
Shandong Province	3.71	2.98	3.72	3.58	3.45
Sichuan Province	3.32	3.65	3.58	3.72	3.32
Hubei Province	3.28	3.51	3.51	3.85	3.25
Chongqing	3.41	3.58	3.38	3.09	3.18
Henan Province	2.95	3.05	3.18	3.28	3.05
Shaanxi Province	2.94	2.96	3.09	3.18	2.98
Hebei Province	2.79	2.85	3.02	3.02	2.85
Hunan Province	3.15	3.38	3.42	3.38	2.78
Anhui Province	3.07	3.21	3.28	3.45	2.72
Guangxi Zhuang Autonomous Region	2.63	2.76	2.87	2.87	2.65
Yunnan Province	2.55	2.68	2.78	2.68	2.58
Liaoning Province	2.40	2.51	2.58	2.78	2.51

Guizhou Province	2.49	2.58	2.65	2.38	2.45
Xinjiang Uygur Autonomous Region	2.27	2.39	2.45	2.58	2.38
Hainan Province	2.47	2.37	2.42	2.51	2.32
Inner Mongolia Autonomous Region	2.34	2.46	2.51	2.45	2.25
Shanxi Province	2.21	2.30	2.35	2.32	2.18
Jilin Province	1.96	2.02	2.08	2.25	2.01
Heilongjiang Province	1.89	1.95	2.01	2.05	1.92
Ningxia Hui Autonomous Region	2.16	2.23	2.28	2.18	2.12
Qinghai Province	2.09	2.16	2.21	1.98	2.05
Gansu Province	2.03	2.09	2.15	2.12	1.95
Tibet Autonomous Region	1.78	1.82	1.92	1.92	1.85

Appendix II: Annual Key Indicators of China-Laos Railway Sustainable Business Model (2021-2024)

(1) Economic Sustainability Indicators

Indicator	2021	2022	2023	2024	Average Annual Change Rate
Operating Revenue (Billion $)	1.2	3.5	5.8	8.2	108.3%
Risk-Resistant Profit Margin (%)	-14.3	9.4	16.0	22.3	——
Supply Chain Cost Saving Rate (%)	15	28	35	40	25.0%
Asset-Liability Ratio (%)	75.2	70.5	65.8	58.0	-5.7%
Core Business Revenue Proportion (%)	70	75	82	88	6.0%
Energy Consumption Cost per Unit Revenue (¥/10,000 ¥)	800	720	650	580	-8.5%
Digital Transformation Cost Recovery Period (Years)	3.5	3.0	2.5	2.3	-11.4%
Net Cash Flow from Operating Activities (10,000 $)	500	1200	2000	2800	116.5%
Emergency Fund Reserve Rate (%)	10	15	20	25	25.0%

(2) Environmental Sustainability Indicators

Indicator	2021	2022	2023	2024
Industrial Solid Waste Recycling Rate (%)	75.2	82.5	88.3	91.7
Water Resource Reuse Rate (%)	60.5	68.2	75.8	82.3
Raw Material Recycling Rate (%)	55.0	62.5	70.2	78.5
Carbon Emissions per Unit Output (Tons CO_2/ ¥)	18000	15000	12000	9000
Clean Energy Usage Proportion (%)	100	100	100	100
Carbon Reduction Target Completion Rate (%)	80	95	110	125
Pollutant Emission Compliance Rate (%)	92.5	95.8	98.2	99.2
Environmental Protection Equipment Operating Efficiency (%)	90.5	93.8	96.5	98.6
Green Supply Chain Certification Proportion (%)	65.0	72.5	80.2	88.5

(3) Social Sustainability Indicators

Indicator	2021	2022	2023	2024
New Employment Positions (Persons)	500	800	700	500
Employee Salary Growth Rate (%)	8.5	11.2	13.8	14.6
Employee Training Coverage Rate (%)	70	80	88	92
Community Welfare Investment Amount ($)	500000	800000	1200000	150000
Emergency Public Incident Response Time (Hours)	12	10	8	6
Cultural Protection Investment Proportion (%)	2.5	3.2	4.0	4.5
SME Supplier Cooperation Rate (%)	40	50	60	70
Local Procurement Proportion (%)	35.0	45.0	55.0	62.2
Product Quality Compliance Rate (%)	95.0	96.5	98.0	99.0
After-Sales Service Satisfaction (Score)	3.5	4.0	4.5	4.8

(4) Innovation-Driven Indicators

Indicator	2021	2022	2023	2024
Green Technology R&D Investment Proportion (%)	1.8	2.5	3.0	3.2
Digital Technology Integration Depth (Score)	3.0	3.8	4.3	4.8
Green Patent Applications (Items)	3	7	12	18
Business Model Adjustment Frequency (Times/Year)	2	3	4	5
Successful Cross-Industry Collaboration Cases (Number)	1	3	5	8
Business-Friendly Policy Utilization Conversion Rate (%)	65	72	80	86.7
Compliance Management Improvement Level (Score)	3.2	3.8	4.3	4.7

(5) "Belt and Road" Special Indicators

Indicator	2021	2022	2023	2024
Local Employee Proportion (%)	65.2	72.8	81.5	85.3
Cultural Difference Coordination Cost($/Year)	120000	950000	720000	580000
International Environmental Standards Compliance Rate (%)	85.0	90.5	94.2	96.8
Cross-Border Dispute Resolution Time (Days)	15	10	7	5

Cross-Border Technology Transfer Cases (Number)	3	8	15	22
Joint R&D Achievement Conversion Rate (%)	60	68	75	80
Cross-Border Supply Chain Disruption Early Warning Accuracy (%)	80	90	95	100

(6) Comprehensive Evaluation Score

Year	Comprehensive Score (Standardized)	Three-dimensional Spatial Coordinates (X: Economic, Y: Environmental, Z: Social)
2021	0.41	(0.35,0.40,0.38)
2022	0.58	(0.52,0.55,0.53)
2023	0.75	(0.68,0.70,0.72)
2024	0.89	(0.85,0.88,0.86)

JIUNo.26 from Sep 15, 2025

To the specialized scientific council
West Ukrainian National University

CERTIFICATE

On using the results of qualification work of

Ye Jianfu

We confirm that results of Fuzhou Mawei Zhuobing Technology Co., LTD, has referred to and applied Ye Jianfu's research results on "Management of China's post-pandemic sustainable business model".

Under the guidance of Doctor of Economic Sciences, Prof. Zvarych Iryna, Ye Jianfu combined her doctoral research with the fact that economic inequality in China is a major social issue. Fuzhou Mawei Zhuobing Technology Co., LTD, used documentaries and in-depth reports to expose the reality and spark public discussion.

The significance of this research lies in its ability to accurately understand the spending power of different social classes, develop appropriate content and products, and achieve a balance between commercial and social value. Ultimately, it will become a bridge connecting different groups and driving progress.

The research results are being applied to the planning and development strategy of Fuzhou Mawei Zhuobing Technology Co., LTD, It can better achieve a balance between commercial value and social value.

Sincerely!

Legal Representative
Fuzhou Mawei Zhuobing Technology Co., LTD

JIUNo.24 from Sep 15, 2025

To the specialized scientific council
West Ukrainian National University

CERTIFICATE

On using the results of qualification work of

Ye Jianfu

We confirm that results of Fuzhou Tongze Technology Co., LTD, has referred to and applied Ye Jianfu's research results on "Management of China's post-pandemic sustainable business model".

Under the guidance of Doctor of Economic Sciences, Prof. Zvarych Iryna, Ye Jianfu combined her doctoral research with the fact that economic inequality in China is a major social issue. Fuzhou Tongze Technology Co., LTD, used documentaries and in-depth reports to expose the reality and spark public discussion.

The significance of this research lies in its ability to accurately understand the spending power of different social classes, develop appropriate content and products, and achieve a balance between commercial and social value. Ultimately, it will become a bridge connecting different groups and driving progress.

The research results are being applied to the planning and development strategy of Fuzhou Tongze Technology Co., LTD, It can better achieve a balance between commercial value and social value.

Sincerely!

Legal Representative
Fuzhou Tongze Technology Co., LTD

JIUNo.26 from Sep 15, 2025

To the specialized scientific council
West Ukrainian National University

CERTIFICATE

On using the results of qualification work of

Ye Jianfu

We confirm that results of Fuzhou Changrun Technology Co., LTD, has referred to and applied Ye Jianfu's research results on "Management of China's post-pandemic sustainable business model".

Under the guidance of Doctor of Economic Sciences, Prof. Zvarych Iryna, Ye Jianfu combined her doctoral research with the fact that economic inequality in China is a major social issue. Fuzhou Changrun Technology Co., LTD, used documentaries and in-depth reports to expose the reality and spark public discussion.

The significance of this research lies in its ability to accurately understand the spending power of different social classes, develop appropriate content and products, and achieve a balance between commercial and social value. Ultimately, it will become a bridge connecting different groups and driving progress.

The research results are being applied to the planning and development strategy of Fuzhou Changrun Technology Co., LTD, It can better achieve a balance between commercial value and social value.

Sincerely!

Legal Representative
Fuzhou Changrun Technology Co., LTD

JIUNo.25 from Sep 15, 2025

To the specialized scientific council
West Ukrainian National University

CERTIFICATE

On using the results of qualification work of

Ye Jianfu

We confirm that results of Fuzhou Changhao Technology Co., LTD, has referred to and applied Ye Jianfu's research results on “Management of China's post-pandemic sustainable business model”.

Under the guidance of Doctor of Economic Sciences, Prof. Zvarych Iryna, Ye Jianfu combined her doctoral research with the fact that economic inequality in China is a major social issue. Fuzhou Changhao Technology Co., LTD, used documentaries and in-depth reports to expose the reality and spark public discussion.

The significance of this research lies in its ability to accurately understand the spending power of different social classes, develop appropriate content and products, and achieve a balance between commercial and social value. Ultimately, it will become a bridge connecting different groups and driving progress.

The research results are being applied to the planning and development strategy of Fuzhou Changhao Technology Co., LTD, It can better achieve a balance between commercial value and social value.

Sincerely!

Legal Representative
Fuzhou Changhao Technology Co., LTD