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Preface

The 8th International Conference on Economic Management and Green Development (ICEMGD 2024) is an annual conference focusing on research areas including finance, economics and business management. It aims to establish a broad and interdisciplinary platform for experts, researchers, and students worldwide to present, exchange, and discuss the latest advance and development in finance, economics and business management.

This volume contains the papers of the 8th International Conference on Economic Management and Green Development (ICEMGD 2024). Each of these papers has gained a comprehensive review by the editorial team and professional reviewers. Each paper has been examined and evaluated for its theme, structure, method, content, language, and format.

Cooperating with prestigious universities, ICEMGD 2024 organized five workshops in Bratislava, Murcia, Edinburgh and Beijing. Dr. Lukáš Vartiak chaired the workshop “Practicing How the EFQM Model Helps Manage the Organization”, which was held at Comenius University in Bratislava. Dr. Javier Cifuentes-Faura chaired the workshop “Policies to Enhance Sustainable Development through the Green Economy”, which was held at University of Murcia. Prof. Gbenga Adamolekun chaired the workshop “Decoupling Corporate Finance Implications of Firm Climate Action”, which was held at Edinburgh Napier University. Prof. Xinzhong Bao chaired the workshop “Innovative Strategies in Microeconomic Business Management”, which was held at Beijing Union University. Dr. Li Chai chaired the workshop “Environmental Economics and Sustainable Business”, which was held at China Agricultural University.

Besides these workshops, ICMRED 2024 also held an online session. Eminent professors from top universities worldwide were invited to deliver keynote speeches in this online session, such as Dr. Lukáš Vartiak from Comenius University in Bratislava and Dr. Javier Cifuentes-Faura from University of Murcia. They have given keynote speeches on related topics of finance, economics and business management.

On behalf of the committee, we would like to give sincere gratitude to all authors and speakers who have made their contributions to ICEMGD 2024, editors and reviewers who have guaranteed the quality of papers with their expertise, and the committee members who have devoted themselves to the success of ICEMGD 2024.

Dr. Lukáš Vartiak
General Chair of Conference Committee

Workshops

Workshop – Bratislava: Practicing How the EFQM Model Helps Manage the Organization



September 26th, 2024 (GMT+2)

Faculty of Social and Economic Sciences, Comenius University in Bratislava

Workshop Chair: Dr. Lukáš Vartiak, Associate Professor in Comenius University in Bratislava

Workshop – Murcia: Policies to Enhance Sustainable Development through the Green Economy



October 30th, 2024 (UTC+1)

Research Group on Economics, University of Murcia

Workshop Chair: Dr. Javier Cifuentes-Faura, Researcher in University of Murcia

Workshop – Edinburgh: Decoupling Corporate Finance Implications of Firm Climate Action



August 28th, 2024 (UTC+1)

The Business School, Edinburgh Napier University

Workshop Chair: Dr. Gbenga Adamolekun, Assistant Professor in Edinburgh Napier University

Workshop – Beijing: Innovative Strategies in Microeconomic Business Management



September 27th, 2024 (GMT+8)

Management College, Beijing Union University

Workshop Chair: Dr. Xinzhong Bao, Professor in Beijing Union University

Workshop – Beijing: Environmental Economics and Sustainable Business



September 21st, 2024 (GMT+8)

International College Beijing, China Agricultural University

Workshop Chair: Dr. Li Chai, Associate Professor in China Agricultural University

The 8th International Conference on Economic Management and Green Development

ICEMGD 2024

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Research on High-Quality Development Strategies for the Homestay Industry from the Perspective of Value Chain

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Abstract: This study uses value chain analysis to examine the basic and supporting activities in the homestay industry, explore the challenges present in the value chain activities, and offer recommendations. The study points out that homestay businesses should focus on core competencies and implement a series of measures to achieve value creation and cost control. Additionally, optimizing the policy environment and applying sustainable development are crucial for the transformation and upgrading of the homestay industry. The results provide practical guidance for the industry to achieve sustainable development in an increasingly competitive market.

Keywords: Homestay Industry, High-Quality Development, Value Chain.

1. Introduction

The homestay industry, as an important branch of the tourism sector, has experienced rapid growth in China in recent years. With the increasing demand from consumers for personalized and experiential tourism, homestays have gained popularity due to their unique cultural features, warm family atmosphere, and close-to-nature accommodation experiences. Homestays not only provide travelers with distinctive lodging options but have also become an important force in promoting local economic development and cultural preservation. However, several challenges have emerged, including intensified competition within the industry, inconsistent service quality, insufficient legal regulations, and the pressing need for sustainable development. You Shangdeng identified issues related to the inadequate regulation of rural homestays and the lack of management skills among operators [1]. Zhu Shuangyue pointed out the opportunities and challenges faced by rural tourism homestays in the context of the sharing economy [2]. Zhang You proposed a coordinated "government-business-association-operator" model to advance the development of the homestay industry [3].

Currently, many scholars have studied the development of the tourism industry from the value chain perspective. For example, Chen Xuejun and colleagues researched the development model of the tourism and elderly care industries from a value chain perspective [4]. Zhang Zhenjia analyzed the restructuring path of the tourism value chain in the post-pandemic era [5]. Zhang Xiaolei and others explored the high-quality integration of China's sports industry with the cultural and tourism sectors from a value network perspective [6]. Zou Lei studied the enhancement of agricultural product value from an agritourism perspective [7]. Lu Zhiqin and colleagues conducted an analysis and

practical investigation of the integration of sports and tourism in characteristic towns of leisure sports in China, using the value chain model [8].

This study aims to analyze the value chain of the homestay industry, discuss the challenges it faces, and propose corresponding development strategies. This paper will provide theoretical support and practical guidance for the high-quality development of the homestay industry.

2. The Value Chain and Structure of the Homestay Industry

The value chain of the homestay industry can be divided using Michael Porter's value chain analysis model, which categorizes business activities into primary and supporting activities. Therefore, the structure of the homestay industry's value chain consists of these two categories, which can be further detailed as follows:

2.1. Primary Activities in the Homestay Industry Value Chain

2.1.1. Internal Logistics and Production Services

To ensure the smooth daily operation of a homestay, activities such as room cleaning, linen changes, material procurement, and inventory management are necessary. In addition, the quality and maintenance of the accommodation services provided by the homestay are crucial, including the regular upkeep of guest rooms, the updating and upgrading of facilities and equipment, and ensuring the comfort and safety of the rooms.

2.1.2. External Logistics and Marketing Strategies

This stage involves interactions with tourists, such as managing the booking system and providing customer service. These tasks require efficient communication and coordination skills to meet customer needs and deliver personalized services. In terms of marketing, it is essential to establish the brand image of the homestay, attract customers through marketing activities, develop effective pricing strategies, and manage sales channels.

2.2. Supporting Activities in the Homestay Industry Value Chain

2.2.1. Organizational Infrastructure and Human Resource Management

Building a strong organizational foundation includes aspects such as the management structure, financial management, and legal affairs of the homestay, providing a solid basis for stable operations. Human resource management covers employee recruitment, training, performance evaluation, and incentive mechanisms, as the professional quality and service level of the staff directly impact the service quality of the homestay.

2.2.2. Technological Development and Procurement Management

Information technology support for homestays, such as reservation systems, customer relationship management (CRM) systems, and smart home devices, enhances operational efficiency and customer experience. Procurement management involves sourcing the materials and services needed by the homestay, such as furniture, decorations, and cleaning supplies.

In value chain analysis, homestay businesses need to identify which activities can create value for customers and invest in and optimize these activities to improve competitiveness and customer satisfaction. Additionally, value chain analysis can help homestay enterprises discover issues in various links of the chain, allowing them to take targeted measures to address these problems.

3. Challenges Faced by the Homestay Industry from the Perspective of the Value Chain

As the homestay industry rapidly develops, it faces numerous challenges, which can be analyzed from the perspective of various activities within the value chain, as well as the influence of external policies and the environment. To address the ever-evolving challenges, homestay operators must continuously innovate and adapt to market changes to achieve long-term sustainable development.

3.1. Challenges in the Primary Activities of the Homestay Industry Value Chain

3.1.1. Challenges in Internal Logistics and Production Services

Efficient internal management is essential for maintaining cleanliness and upkeep within homestays. Key challenges include optimizing internal processes to reduce costs, offering personalized and high-quality services to enhance core competitiveness, and developing and maintaining value-added services related to local culture and experiences.

3.1.2. Challenges in External Logistics, Marketing, and Sales

As market competition intensifies, homestays require effective marketing strategies to attract and retain customers. Critical issues include how to leverage digital marketing and social media tools to increase brand awareness and how to improve sales efficiency through online booking platforms and direct sales channels.

3.2. Challenges in the Supporting Activities of the Homestay Industry Value Chain

3.2.1. Challenges in Organizational Infrastructure and Technological Development

Homestays need a stable management structure and advanced information technology support to enhance operational efficiency. Key challenges include deciding how to invest in technological infrastructure, such as booking systems and customer relationship management (CRM) systems, and ensuring data security.

3.2.2. Challenges in Human Resource Management and Procurement

The rapid growth of the homestay industry requires sufficient professional talent to support it. The main challenges involve how to improve service levels through effective training and development programs, establishing a stable supply chain, and finding cost-effective suppliers while ensuring quality.

3.3. Challenges in Responding to External Environmental Changes

3.3.1. Challenges in Market Competition and Policy Regulation

The competition in the homestay industry is becoming increasingly fierce, and regulatory oversight is also tightening. For homestay operators, the challenge lies in how to stand out amidst the competition and how to adapt to the changing policy environment to ensure compliance with regulations.

3.3.2. Challenges in Sustainable Development

With consumers paying more attention to environmental protection, the homestay industry faces challenges in achieving green operations and sustainable development. This includes the use of eco-

friendly materials and energy-saving technologies, as well as finding ways to protect local culture and the environment.

4. Measures for High-Quality Development of the Homestay Industry from the Perspective of the Value Chain

4.1. Government Support, Standardized Management, and Industry Standards

The government should establish relevant policies to regulate the scale, projects, and funding of homestay development through macro-control, providing favorable conditions such as land use incentives, tax breaks, and financial support. These measures would create a better environment for the growth of the homestay industry. Additionally, the government should establish unified industry standards and management norms, increasing oversight of homestay operations and service quality to promote healthy industry development. The homestay industry must also adapt to the constantly evolving policy environment to ensure compliance with regulations.

4.2. Implement Differentiated Operations, Strengthen Marketing and Brand Building

Homestay operators should integrate resources, leverage regional and industrial advantages, and capitalize on unique local characteristics to create distinct cultural experiences that enhance competitiveness. In terms of branding, homestays can innovate by combining regional advantages and cultural characteristics to establish a unique brand image and increase market recognition. Actively engaging in promotional marketing activities and utilizing new marketing methods, such as social media and influencer live-streaming, can help expand the market influence of homestays and attract more customers.

4.3. Strengthen Infrastructure Development and Continuously Improve Service Quality

Improving infrastructure is essential to ensure the comfort and safety of guest experiences. The application of advanced technologies, such as big data, the Internet of Things (IoT), and cloud computing, can enhance operational efficiency and service quality while reducing costs. Furthermore, it is crucial to strengthen the development of human resources by providing training to enhance the professional skills and comprehensive abilities of homestay staff. Additional services for guests, such as dining, tourism consultation, and cultural experience activities, can improve customer satisfaction and increase the added value of the homestay.

4.4. Innovate and Diversify, Adhere to the Concept of Sustainable Development

Product innovation and the coordinated development of different business models should be encouraged. Homestays can integrate closely with local specialty industries, introducing diversified business models to extend the industry chain and expand the value chain. For example, homestays can combine with local industries through models like "homestay + culture" or "homestay + agriculture," creating new revenue streams and market opportunities. By adopting green management practices, using eco-friendly materials, and implementing energy-saving technologies, homestays can enhance their brand image and meet the growing consumer demand for sustainable tourism.

5. Conclusion

From the perspective of the value chain, the homestay industry can effectively enhance its competitiveness and market position through optimizing internal management, improving service quality, strengthening brand building, integrating resources, and fostering technological innovation.

This paper emphasizes the critical role of the government in planning, guiding, providing policy support, and setting industry standards, as well as the importance of businesses taking the initiative in talent development, marketing, and sustainable development practices. The conclusion points out that only by comprehensively improving all aspects of the value chain can the homestay industry achieve long-term high-quality development, meet market demands, and contribute to the prosperity of the local economy and culture.

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Cross-border M&A Motivations and Performance Evaluation in the Healthcare Industry under the RCEP Framework

— A Case Study of China Resources Pharmaceutical

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Abstract: The research utilizes case analysis techniques to examine the driving forces behind, and the effectiveness of, the international corporate mergers and acquisitions (M&A) in China Resources Pharmaceutical within the RCEP structure. Research indicates that international mergers and acquisitions markedly improved the firm's expertise in market expansion, technology acquisition, resource integration, and synergy effects. Such initiatives have stimulated an increase in revenue and profits, streamlined the cost framework, and further enhanced the firm's brand prominence, innovative prowess, and competitive edge in the market. Enacting RCEP presents not only prospects for China Resources Pharmaceutical but also introduces obstacles including adherence to policies, cultural assimilation, and the merging of operations. The research suggests related strategic approaches to tackle these issues and boost the firm's global competitive edge and market impact.

Keywords: RCEP, Cross-border M&A, M&A Motivations, Performance Evaluation

1. Introduction

Initiated in 2012 by ASEAN nations, the Regional Comprehensive Economic Partnership (RCEP) is designed to enhance regional economic ties and secure regional free trade through a multilateral commerce framework. Following prolonged talks, the agreement was eventually inked on November 15, 2020, and its official implementation commenced on January 1, 2022. With RCEP representing nearly 30% of the global population and GDP, it ranks as a major free trade region worldwide. RCEP, through lowering tariffs and uniforming trade regulations, seeks to foster economic collaboration, boost trade expansion, and ease investment restrictions among member nations, strengthen the cohesion and robustness of local supply chains, and foster fresh drive and chances for economic progress in the Asia-Pacific area [1]. The RCEP encompasses 15 member nations in the Asia-Pacific and intends to progressively abolish approximately 90% of tariffs in the upcoming century. RCEP's objective, through the adoption of unified origin rules and the lowering of non-tariff restrictions, is to foster conducive trade-off and investment conditions among its participating nations [2]. Research indicates that introducing RCEP will yield substantial economic gains for the whole Asia-Pacific area, stimulate trade expansion among member states, enhance job creation rates, and strengthen the robustness of worldwide supply networks [3]. Specifically, RCEP's tariff cutbacks and trade easing

strategies will empower Chinese drug manufacturers to enhance regional market growth, encourage pharmaceutical product distribution, and encourage tech collaboration [4]. Being a member of the RCEP, China boasts various pharmaceutical sector representatives, within which China Resources Pharmaceutical stands as a significant, all-encompassing pharmaceutical enterprise group. The company engages in pharmaceuticals, medical equipment, pharmaceutical distribution, and healthcare services. The subsidiary, China Resources Sanjiu, is vigorously broadening its global footprint by taking over both local and international pharmaceutical firms, thus creating a market strategy with global competitiveness [5].

The goal of this research is to examine the reasons and assessment of China Resources Pharmaceutical's cross-border mergers and takeovers within the RCEP structure via case studies. A scrutiny of China Resources Pharmaceutical's international mergers and acquisitions uncovers its strategies, market growth, technology procurement, resource amalgamation, and synergistic impacts, and scrutinizes its outcomes from economic, strategic, and creative angles [6].

2. Research Methodology

This research utilizes a case study approach to delve into the driving forces and performance analysis behind China Resources Pharmaceutical's cross-border mergers & acquisitions [7], within the context of the RCEP model. Data sources include financial reports, industry reports, and company announcements of China Resources Pharmaceutical.

3. Case Analysis

China Resources Pharmaceutical Group Limited conducted a series of cross-border acquisitions, including Kedrion Biopharmaceuticals in Italy in January 2020, Simcere Pharmaceuticals US Inc. in February 2021, Actavis Generics in Ireland in July 2021, Pluristem in Israel in January 2022, Aradigm Pharmaceuticals in the US in April 2022, Blackmores in Australia in March 2023, Medline Industries' medical device business in the US in June 2023, and Dermapharm in Germany in August 2023.

3.1. Motivations for Cross-border M&A

3.1.1. Market Expansion: Creating a Worldwide Market Structure

Through the purchase of international firms, China Resources Pharmaceutical can rapidly penetrate new markets, broaden its worldwide business scope, and augment its share market. China Resources Pharmaceutical's acquisition of Simcere Pharmaceuticals US Inc. in 2021 for USD 450 million and Actavis Generics for USD 2.3 billion markedly boosted its market position in Europe and America. These firms' sales channels further extended China Resources Pharmaceutical's international market influence. The strategy for expanding the market enables China Resources Pharmaceutical to rapidly penetrate rapidly expanding markets, thereby minimizing the risks linked to dependency on one market.

Venturing into fresh markets via acquisitions broadens China Resources Pharmaceutical's marketing avenues and facilitates direct targeting of domestic healthcare facilities and clients, thus boosting its brand recognition and share of the market. Ye Sheng [5] discovered that the growth of the market play a pivotal role in M&A within the pharmaceutical sector, emphasizing that venturing into uncharted markets can significantly enhance a firm's market share and competitive edge. In a like manner, through the purchase of Blackmores, China Resources Pharmaceutical penetrated the health product sphere in Australia and the Asia-Pacific, further broadening its global market structure.

Through transnational mergers and acquisitions, China Resources Pharmaceutical can capitalize on domestic market strengths and policy backing, diminishing barriers and expenses in penetrating

new markets. The acquisition of Dermapharm, for instance, enabled China Resources Pharmaceutical's entry into the European marketplace, capitalizing on Europe's strict compliance and superior production methods to boost its product competitiveness and market acknowledgment. The approach serves to widen market scope while also bolstering the firm's worldwide competitive edge and robustness against risks.

3.1.2. Technology Acquisition: Enhancing Skills for Advanced Technology and Innovation

Through international mergers and acquisitions, China Resources Pharmaceutical leverages the advanced technology and research and development skills of its businesses, allowing it to swiftly elevate its technological capabilities and innovative potential, thus preserving its dominant role in the fiercely competitive marketplace. According to Dunning's OLI model [8], companies should maintain distinct proprietary technological or branding benefits in their cross-border mergers and acquisitions, laying the groundwork for China Resources Pharmaceutical to acquire technology via mergers and acquisitions.

China Resources Pharmaceutical took over Pluristem, a Israeli biotech firm focused on regenerative medicine, in 2022, renowned for its core technologies and comprehensive clinical trial records. This acquisition not only allowed China Resources Pharmaceutical to enter the regenerative medicine field but also gained critical technologies and innovation capabilities. Additionally, by acquiring Aradigm Pharmaceuticals, China Resources Pharmaceutical obtained inhalation therapy development technologies and patents, supporting its layout and development in the respiratory disease field. The technology and innovation capabilities acquired through cross-border M&A optimize R&D processes, improve R&D efficiency and success rates, and accelerate the launch and market promotion of new products. Such actions not only boost the market competitiveness of China Resources Pharmaceutical's current products but also offer robust technological assistance for creating and marketing new products, thus strengthening its dominant role in the worldwide pharmaceutical industry [9].

3.1.3. Resource Integration: Enhancing Overall Resource Distribution

Li Jinping [10] suggests that firms can enhance their overall operational performance and realize scale economies via mergers and acquisitions. Central to China Resources Pharmaceutical's international mergers and acquisitions, resource integration involves merging acquired firms' resources and skills to boost operational effectiveness and lower expenses, thus optimizing worldwide resource distribution.

The year 2023 saw China Resources Pharmaceutical securing Medline Industries' medical device division for a sum of USD 3.4 billion. China Resources Pharmaceutical widened its strategic edge in the worldwide medical device market by amalgamating Medline's wide range of products with a robust sales chain. Moreover, acquiring Dermapharm enabled China Resources Pharmaceutical to expand its dermatology and urology product line and amalgamate its production and sales processes in Europe, thereby enhancing its operational effectiveness and competitiveness in the European markets.

Resource integration also enables China Resources Pharmaceutical to optimize supply chain management, enhancing production and distribution efficiency. By acquiring Medline Industries and integrating its global production facilities and logistics network, China Resources Pharmaceutical optimized supply chain management, increasing production and distribution efficiency. This resource integration not only reduced operational costs but also improved overall operational efficiency and market responsiveness. Resource integration enhances operational efficiency and competitiveness,

optimizes supply chain management, and reduces operational costs, providing strong support for the company's sustainable development and global layout.

3.1.4. Synergy Effects: Achieving Financial and Operational Synergies

Ni Weiqin, in his study on the synergy effects of M&A among listed companies in China [11], points out that synergy is a crucial indicator of M&A success. By integrating resources and capabilities, companies can achieve financial, operational, and managerial synergies, enhancing overall operational efficiency and competitiveness. In 2020, China Resources Pharmaceutical acquired a 55% controlling stake in Italian company Kedrion Biopharmaceuticals for EUR 1 billion. By integrating Kedrion's plasma products business, optimizing supply chain management, and product line layout, China Resources Pharmaceutical achieved significant operational synergies. Through the acquisition of Aradigm Pharmaceuticals and the integration of its R&D capabilities and technology patents, China Resources Pharmaceutical optimized R&D processes and management, improving overall R&D efficiency and success rates. These synergies not only enhanced operational efficiency and financial performance but also optimized management processes and corporate culture, boosting the company's overall competitiveness.

3.2. Performance Evaluation

3.2.1. Financial Performance Analysis: Revenue, Profit, and Market Share Improvement

Cross-border M&A has significantly impacted the financial performance of China Resources Pharmaceutical. A detailed analysis of the 2023 financial report data clearly shows the contributions and changes resulting from M&A activities in terms of revenue, profit, and market share. Although China Resources Pharmaceutical's total revenue in 2023 was HKD 244.704 billion, a slight decrease of 3.70% compared to HKD 254.106 billion in the previous year, this decline was primarily due to global economic conditions and market demand fluctuations.

Through the acquisitions of Medline Industries and Dermapharm, China Resources Pharmaceutical significantly expanded its product line and market coverage, with notable revenue growth in its pharmaceutical business. The total revenue from the pharmaceutical business in 2023 was HKD 43.465 billion, an increase of 14.3% compared to HKD 38.033 billion in 2022. Among this, traditional Chinese medicine revenue was HKD 21.592 billion, a year-over-year increase of 19.7%; chemical pharmaceuticals revenue was HKD 17.032 billion, a year-over-year increase of 9.4%; and biopharmaceuticals and nutritional supplements revenue was HKD 2.135 billion, a year-over-year increase of 12.5%. These growths were primarily driven by the expansion into the European market following the acquisition of Dermapharm, and the enhancement of technology and product portfolio in the biopharmaceutical and nutritional supplements sectors.

The synergies brought about by mergers and acquisitions are also reflected in the profits. As shown in Figure 1, the company's gross profit in 2023 was HKD 38.337 billion, a year-over-year increase of 15.2%. The gross margin rose from 15.40% in the previous year to 15.67%, demonstrating the company's effectiveness in cost control and product pricing. Acquisitions not only directly increased the company's revenue sources but also reduced operating costs and improved profit margins by optimizing supply chain management and integrating production resources. China Resources Pharmaceutical's market share has also significantly increased. For instance, through the acquisition of Medline Industries' medical device business, China Resources Pharmaceutical's share in the global medical device market has significantly increased, enhancing its market influence and boosting its innovation capability and technological level in the medical devices and consumables field. The total assets of China Resources Pharmaceutical at the end of 2023 were HKD 246.77 billion, an increase of 2.27% compared to HKD 241.286 billion in the previous year. This growth was mainly due to the

increase in assets brought about by the acquisition activities. Although total liabilities have also increased, the growth rate is slightly lower than that of total assets. This indicates that the company has optimized its asset allocation through acquisition activities, improving asset utilization efficiency. The debt ratio at the end of this reporting period was 62.32%, compared to 62.62% in the previous year, a slight decrease of 0.48%, indicating a slight improvement in the company's long-term solvency.

3.2.2.Strategic Outcomes Analysis

The multinational mergers and acquisitions sector has been instrumental in boosting the brand's impact, research and development potential, and global activities of China Resources Pharmaceutical. By engaging in strategic acquisitions, China Resources Pharmaceutical has fortified its hold in the local market and markedly expanded its impact globally. By acquiring Medline Industries and Dermapharm, China Resources Pharmaceutical carved a niche for itself in advanced markets like Europe and the United States, enhancing global fame and market dominance.

China Resources Pharmaceutical's mergers and acquisitions have resulted in substantial worldwide acclaim for its brand's influence. In the year 2024, China Resources Pharmaceutical rejoined the list of the Top 50 on the China Listed Companies Brand Value List and was among the Top 55 on the Vitality List, boasting a brand worth of RMB 97.006 billion. This accomplishment signifies not just the capital market's acknowledgment of China Resources Pharmaceutical's brand but also the firm's effectiveness in brand development and promoting the market. By executing acquisitions, China Resources Pharmaceutical can capitalize on the influence and resources of the companies it has taken over, thereby increasing its brand's worth and market stance.

In terms of research and development capabilities, the acquisition of firms with sophisticated technology and research skills has greatly enhanced the innovative scope and tech proficiency of China Resources Pharmaceutical. As an instance, the takeover of Aradigm Pharmaceuticals and Pluristem led to China Resources Pharmaceutical acquiring cutting-edge technologies and research and development in inhalation therapy and regenerative medicine. Such acquisitions have bolstered the firm's research and development proficiency and hastened the creation and market debut of novel products. For example, the tally of novel medications introduced by China Resources Pharmaceutical saw a substantial rise, evolving from 5 in 2019 to 10 by 2023, indicative of robust advancements in innovation and research and development. Pertaining to its global activities, China Resources Pharmaceutical has effectively penetrated several international markets and enlarged its worldwide network via acquisitions. Procuring Medline Industries' medical device division notably augmented the position of China Resources Pharmaceutical in worldwide healthcare, boosting its market dominance and elevating its capacity for innovation and technological prowess in the field of medical devices and consumables. China Resources Pharmaceutical has broadened its global business scope and market channels by acquiring others, thus expanding its international operational strengths and competitive edge in the market.

3.2.3.Innovation Performance Analysis

M&A activities across borders have also yielded impressive outcomes, significantly bolstering China Resources Pharmaceutical's innovation capabilities. The effectiveness of innovation can be evaluated by assessing its absorption capacity and the results. Research by Wang Jiang and Huang Jiayi [12] indicates that transnational mergers and acquisitions can markedly boost a firm's capacity to absorb and its innovative accomplishments. Through mergers and acquisitions, China Resources Pharmaceutical has garnered significant technological and knowledge assets, enhancing its

technological innovation prowess and streamlining the creation and market introduction of novel products.

Through strategic acquisitions, China Resources Pharmaceutical has not only secured sophisticated technologies and research and development capabilities but also improved its capacity for innovation and outcomes by amalgamating and utilizing these resources. As an illustration, by acquiring Pluristem, China Resources Pharmaceutical markedly boosted its technological prowess and research and development in regenerative medicine. By utilizing these technological assets, the firm can innovate in drug and treatment product development, thus improving its market standing and inventive capacity. The annual reports illustrates an uptick in patent filings by China Resources Pharmaceutical, surging from 50 in 2019 to 90 by 2023, alongside an increase in new product quantities from 10 to 20 over that interval. This suggests that merging and acquisition efforts have markedly improved the company's creative prowess and results. The data showcase the firm's achievements in assimilating fresh technology and knowledge, achieving notable progress in developing and commercializing new products.

4. Conclusion and Discussion

The present study analyzes the cross-border mergers and acquisitions (M&A) motives and performance of CR Pharma within the framework of RCEP, highlighting the significance and potential of such M&A activities for corporate development. It identifies motivations including market expansion, technology acquisition, resource integration, and synergy effects, while demonstrating that cross-border M&A significantly enhances CR Pharma's financial, strategic, and innovative performance. The implementation of RCEP provides unique opportunities and challenges for cross-border M&A in the healthcare industry. The specificity of the healthcare sector determines its importance in international trade. RCEP's trade liberalization and reduction of tariff barriers create a favorable environment for international trade of healthcare products. Healthcare enterprises can more easily introduce innovative drugs, medical devices, and technologies into RCEP member markets, promoting the international development of products and thereby expanding market reach and brand influence.

However, cross-border M&A in the healthcare industry also faces a series of complex challenges. Firstly, the strict regulatory and legal requirements for healthcare products necessitate a thorough understanding of the target country's pharmaceutical regulatory policies and legal systems to ensure compliance and stability throughout the M&A process. Particularly for products involving patient health, such as medical devices and drugs, compliance requirements are stricter, requiring comprehensive risk consideration by enterprises. Secondly, cultural differences pose an important challenge for cross-border M&A in the healthcare industry. The cultural characteristics and business models of the healthcare sector differ significantly from other industries, making it crucial for enterprises to address how to achieve cultural integration and coordinate organizational structures post-merger. Detailed cultural integration plans, enhanced employee training, facilitated team communication, and the establishment of cultural consensus for multinational cooperation are necessary for achieving harmonious integration among organizations. Lastly, cross-border M&A in the healthcare industry requires addressing diverse challenges related to business processes, management systems, and information systems. Enterprises need to develop detailed integration plans to ensure data uniformity and interoperability, enhance operational efficiency, and improve decision-making support capabilities to meet post-merger operational challenges. Thus, while RCEP presents significant opportunities for cross-border M&A in the healthcare industry, it also requires enterprises to earnestly address corresponding challenges to achieve long-term stable development goals.

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Cuteness Catalyst: Fostering Pro-Social Motivation and Enhancing Donating Behaviors

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Abstract: This study investigated the impact of product characteristics, specifically cuteness, on consumer pro-social motivation and donating behaviours. I predict that cute product would elicit consumer's pro-social motivations and thus increase their willingness to donate. To test these hypotheses, I conducted an experiment, in which participants were presents with a scenario involving the sale of cakes for fundraising. Participants were randomly presented with either a cute cake or an ordinary cake and were asked to indicate their pro-social motivation and their willingness to buy (donate). Results indicate the cute products can evoke pro-social motivation, thereby enhancing donating behaviour. This research provides valuable insights into the dynamics of consumer donating behaviour, specifically elucidating the role of product characteristics, such as cuteness, in fostering pro-social responses.

Keywords: Cute Product, Pro-social motivation, Donating behaviour

1. Introduction

Engaging in donations not only brings about considerable benefits to society but also yields numerous advantages for individuals, encompassing enhanced mental and physical well-being. Research has consistently highlighted the positive correlation between charitable actions and improved health outcomes [1-3]. Numerous charitable organizations grapple with the task of selecting an appealing product that resonates with potential donors. In this context, strategic marketing and product design play pivotal roles. Studies by Peterson and Smith underscore the importance of creating a connection between the charitable product and the target audience's values and preferences. Tailoring the product's appearance to align with these factors significantly enhances its appeal and drives increased donations.

One of the prominent product attributes is "cuteness." The phenomenon known as the "cuteness factor" has garnered significant attention in recent academic discourse. Researchers (have demonstrated that products featuring adorable or endearing elements not only capture attention but also evoke positive emotions [4,5]. When people see a baby, their facial muscles associated with positive emotions are automatically activated, and similar emotional responses occur when people see cute animals or even inanimate object. Hence impulsive spending behavior. Consumers get the product not only for its functional benefit, but also for the emotional experience that is integrated with the product [6]. These experiences may be related to the emotional bonding between some of the physical features of the product and its consumer. Past research found that product that can elicit

positive emotions will encourage donating behavior [7]. Therefore, in this study, we propose that cute product can increase donating behavior.

To test this hypothesis and explore the mechanism, we conducted an experiment. Participants were randomly allocated to a 2 by 2 (High vs. Low price & Cute vs. Ordinary product) experiment design. Participants were shown a cake and then we measured participants' pro-social motivation. At the end, they expressed their willingness to donate. We found that cute products can elicit pro-social motivation, and thus increase donating behaviour.

The findings of this research yield multifaceted contributions to the existing literature. Firstly, it unveils the pivotal role of product characteristics, particularly cuteness, in eliciting pro-social motivation among consumers. This sheds light on the potential of visually pleasing elements to serve as catalysts for heightened pro-social behaviors in charitable contexts. Secondly, the study advances our understanding of the interplay between product pricing and consumer donating behavior. By exploring the impact of different price points on consumers' decisions to contribute, the research provides insights into the economic considerations influencing charitable actions. Collectively, these contributions enhance our comprehension of consumer behavior in the realm of charitable giving and offer practical implications for organizations seeking to optimize fundraising strategies.

2. Theory and Hypotheses

2.1. Cute product and prosocial motivation

We argue that exposure to cute product will increase consumers' prosocial motivation with the two reasons as follow. First, cuteness is associated with a more other-directed focus [8]. This orientation towards others cultivates a greater likelihood of developing sympathy. Pro-social behavior, encompassing actions that alleviate another's needs or enhance their well-being [9], is thereby stimulated.

Second, the perception of cuteness would elicit a mental representation of fun. When people have positive affect, they are more likely to do good for others. Positive affect, as established in prior research on the perception-behavior link, correlates with an increased likelihood of altruistic action [10]. Cuteness is proposed to activate brain networks associated with emotion and pleasure, triggering empathy and compassion [11]. The positive affect derived from the perception of fun aligns with a rich body of literature over the past three decades, illustrating that positive feelings foster helpful and generous behaviors, such as charitable donations and volunteering [12].

Therefore, we propose through the prosocial motivation consumers would like to consume more cute product for helping others in the society.

H1: Exposure to cute product increase consumers' prosocial motivation.

2.2. Cute product and willingness to donate

Exposure to cute products amplifies consumers' inclination to donate, driven by two key factors. Firstly, product attributes serve as activators of perceptions that significantly influence subsequent behaviour. In this study, particular emphasis is placed on cute products, which evoke a perception of vulnerability. The observation of vulnerability naturally triggers donating behaviour, as evidenced by the well-established phenomenon where advertisements featuring vulnerability prompt increased donations to charities. Hence, the presence of cute products correlates with heightened donating behaviours among customers.

Secondly, cute products serve as primers for a mental representation imbued with fun and playfulness. Research by Dunn et al. demonstrates that experiences of fun and playfulness increase the likelihood of individuals spending money on others [13]. Such expenditures, in turn, induce happiness, creating a positive spiral effect. Furthermore, customers derive enjoyment not only from

the act of giving but also from the satisfaction of their own needs, such as indulging in the delightful experience of consuming the cake. This reinforcement of positive affect during decision-making contributes to a lasting positive disposition towards charitable actions. Therefore, we propose:

H2: Exposure to cute product increase consumers' willingness to donate.

The mediation role of prosocial motivation

Prosocial motivation—the desire to protect and promote the well-being of others—is distinct from altruism and independent of self-interested motivations. Pro-social motivation serves as a cognitive and emotional mechanism that bridges the gap between the perception of cuteness and the subsequent decision to contribute to a charitable cause. In essence, the positive and empathetic responses evoked by cute products create a motivational impetus, compelling individuals to act in ways that benefit others, manifesting in an increased willingness to donate. Combining Hypotheses 1 and 2, we propose:

H3: Exposure to cute product increase consumers' willingness to donate and prosocial motivation will mediate the relationship between cuteness and willingness to donate.

3. Method and Results

To test the hypotheses, we conducted a 2(Cute vs. Ordinary)×2 (High price vs. Low Price) between-subject design. Participants were randomly allocated to one condition and they were instructed to read scenarios and make purchasing decisions.

3.1. Participants and Procedure

We recruited 180 participants (59.4% female) from Credemo, a Chinese data platform that is similar to Prolific. Among them 68.9% get the Bachelor's degree. The average age was 29.61 years, the standard deviation was 7.47 years.

First, participants were informed that we represent a charitable organization dedicated to aiding those affected by COVID-19 and raising funds through cake sales. Then, they were presented with either a cute cake or an ordinary cake associated with a specific price, depending on the randomly allocated conditions. Then, they were instructed to express their willing to buy the cake. Finally, they indicated their pro-social motivation and demographic details.

3.2. Measures

Cuteness manipulation. Participants viewed either the cute or ordinary cake and rated the extent to which the cakes were cute. The item was measured on a 7-point scale (1: not cute at all, 7: very cute). The manipulation was successful. Participants who viewed the cute cake ($M_{\text{cute}} = 5.42$, $SD_{\text{cute}} = 1.62$) rated significantly higher than those who viewed the neutral cake ($M_{\text{neutral}} = 3.73$, $SD_{\text{neutral}} = 1.32$, $t(178) = 7.66$, $p < .001$).

Expensiveness manipulation. After participants rated the cuteness of the cakes, they will be asking the question: "To what extent this cake is expensive". The size of this cake is 6 inches and the price is 240 rmb (80 rmb in the cheap condition). The item was measured on a 7-point scale (1: not expensive, 7: very expensive). The manipulation was successful. Participants who viewed the expensive cake ($M_{\text{expensive}} = 5.62$, $SD_{\text{expensive}} = 1.00$) rated the manipulation check question significantly higher than those who viewed the cheap cake ($M_{\text{cheap}} = 4.72$, $SD_{\text{cheap}} = 1.33$, $t(178) = 5.12$, $p < .001$).

Pro-social motivation. We adapted Grant & Berry's scale to measure pro-social motivation of donating behaviour [14]. The scale included 4 items. The sample item was "I want to purchase the cake to benefit others.". The items were rated on a 5-point scale (1: Do not agree at all; 5: Definitely agree). The Cronbach's alpha for this scale was 0.91.

Willingness to buy(donate). We asked participants to what extent they are willing to buy the cake, which will be donated to the charity. The item was measured on a 7-point scale (1: never want to buy, 7: very willing to buy). We also asked about how many cakes they are willing to buy (range: 1-10 or more than 10 cakes).

3.3. Results

We provide descriptive statistics in Table 1.

Table 1: Univariate and Bivariate Statistics for Key Variables

Variable	Mean	SD	1	2	3	4	5	6
1. Condition: Cuteness	4.58	1.71						
2. Condition: Expensiveness	5.17	1.26	-.26**					
3. Prosocial motivation	3.82	0.98	.42**	-.32**				
4. Donation	4.38	1.61	.50**	-.49**	.73**			
5. Age	29.6	7.47	.08	-.09	.13	.24**		
6. Gender	0.59	0.49	-.24**	.14	-.15*	-.25**	-.05	
12.Income ^a	12.86	10.02	.07	-.16*	.15*	.21**	.03	-.12

Note. N = 180. *p <.05 **p <.01. a thousand yuan.

Cuteness and prosocial motivation. We ran an analysis of covariance (ANCOVA) on the prosocial motivation, with age, income, and gender as covariates. Analysis revealed that participants who were given the cute cake showed higher level of pro-social motivation ($M_{cute} = 3.95$, $SD_{cute} = 0.87$) than those who were given the normal cake ($M_{ordinary} = 3.69$, $SD_{ordinary} = 1.06$; $F(1, 173) = 2.82$, $p = .095$). The covariates showed a marginally significant effect. These results demonstrate that exposure to cute products has increased the customers' prosocial motivation, which partially supports Hypothesis 1. The data is Shown in Figure 1.

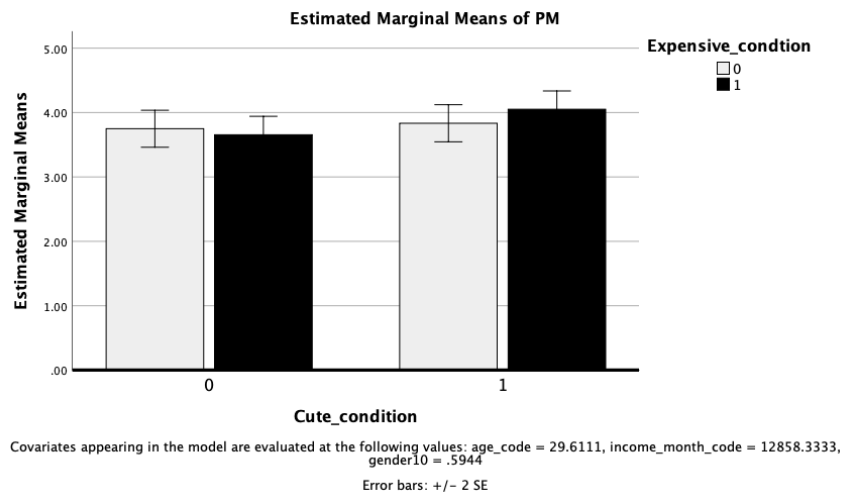


Figure 1: The effect of Cuteness and Expensiveness on Prosocial Motivation

Note: For the Cute_Condition, "0" means normal product; "1" means cute product. For Expensiveness_condition, "0" means the price is low; "1" means the price is high.

Cuteness and willingness to donate. We also ran an analysis of covariance (ANCOVA) on the willingness to donate, with age, income, and gender as covariates. Analysis revealed that participants who were given the cute cake are more willing to donate ($M_{\text{cute}} = 4.62$, $SD_{\text{cute}} = 1.48$) than those who were given the normal cake ($M_{\text{normal}} = 4.13$, $SD_{\text{normal}} = 1.71$; $F(1, 173) = 3.65$, $p = .058$). The covariates showed a marginally significant effect. These results demonstrate that exposure to cute products has increased the customers' willingness to donate, which supports Hypothesis 2. The data is Shown in Figure 2.

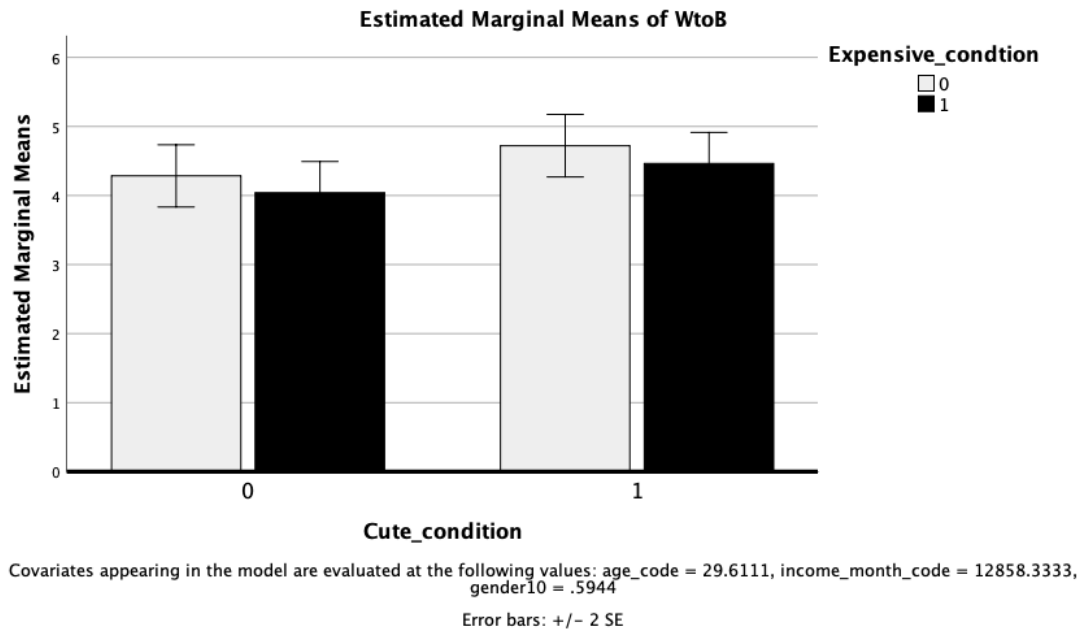


Figure 2: The effect of Cuteness and Expensiveness on Willingness to Donate

Note: For the Cute_Condition, “0” means normal product; “1” means cute product. For Expensiveness_condition, “0” means the price is low; “1” means the price is high.

Mediation model. We used PROCESS to test the mediation model using a bootstrap estimation approach with 5000 samples [15,16]. The results indicate the indirect coefficient was significant ($b = .22$, $SE = .05$, 95% CI = [.14,.33]) We found that the cuteness of product positively related with the willingness to buy(donate) and prosocial motivation mediated the relationship, which supports Hypothesis 3.

4. Discussion and Conclusion

The research in this article found that consumers are more willing to spend money on cute products than ordinary products through one experiment. The results indicate that regardless of price, people are more likely to donate when they find the product is cute, underscoring the unique appeal of cuteness in consumer choices. This research highlights that the impact of cute products on pro-social motivation.

The theoretical contribution of this research lies in its illumination of the impact of cute products on consumer behavior, particularly in the context of charitable contributions. By conducting a singular experiment, the study establishes a compelling link between consumers' heightened willingness to spend on cute products compared to ordinary ones. Significantly, the findings reveal that this preference for cuteness transcends price considerations, as individuals are more inclined to donate when the product is perceived as cute.

The research enriches existing theoretical frameworks by emphasizing the role of cuteness in stimulating pro-social motivation. The observed phenomenon underscores that the aesthetic appeal of cute products serves as a powerful motivator for individuals to engage in altruistic actions, such as making donations. This contributes to a deeper understanding of the intricate interplay between product characteristics, emotional responses, and pro-social behavior.

In essence, this study extends the theory by elucidating how cuteness functions as a unique and potent factor in shaping consumer choices and, more notably, influencing pro-social motivations. The identified link between cuteness and heightened pro-social behavior provides a valuable theoretical foundation for future research exploring the psychological mechanisms underlying consumer preferences and charitable actions.

Therefore, in conclusion, consumers' donation behavior can be achieved through the cute appearance of the product, the consumer's prosocial motivation, and the consumer's empathy.

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Economic Decisions and Cultural Trauma: A Sociological Exploration of Macro-level Policies and Societal Perceptions

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Abstract: The article delves into the intricate relationship between macroeconomic policies and cultural trauma. It argues that economic decisions, typically confined to corporate and legislative realms, significantly impact communities by shaping collective memories, identities, and psychological distress. The study highlights historical events like The Great Depression and the COVID-19 pandemic, underscoring their transformative impacts on societal consciousness and cultural narratives. The article emphasizes the role of macroeconomic choices, such as fiscal policies and trade agreements, in creating collective experiences that transcend economic outcomes. Using examples like trade liberalization in Brazil, it demonstrates how economic policies can lead to diverse societal perceptions and narratives. The article also examines the role of media, public discourse, and societal leaders in shaping public perceptions of these decisions. Central to the study are the contributions of cultural sociologists like Jeffrey C. Alexander, who propose that cultural trauma arises more from societal narratives around an event rather than the event itself. The study stresses the need for a comprehensive approach that integrates economic analysis with sociological insights, highlighting the importance of understanding economic decisions beyond their immediate financial implications. Conclusively, the article posits that macroeconomic decisions have profound and lasting impacts on societies, influencing collective identities and memories. It advocates for policies and scholarly approaches that acknowledge the broader societal ramifications of these decisions.

Keywords: Macroeconomic Policies, Cultural Trauma, Sociology

1. Introduction

Globalised society's macroeconomic decisions affect financial outcomes and community social and psychological fabric. Corporate and political practices affect collective memories, identities, and traumas. This study examines how national and international policies shape society views and narratives through the complicated link between economic choices and cultural trauma. World crises like the Great Depression and government-induced famines changed cultural narratives and identities. Economic events became generational, cultural tragedies. The recent COVID-19 pandemic has further highlighted the links between globalization, health, economic stability, environmental justice, and collective trauma, particularly impacting marginalized groups and people of colour [1].

Studies on economic decisions and cultural trauma are scarce despite their importance. This paper analyses macroeconomic strategies and social frameworks to close this gap. It uses cultural sociology,

interactionism, and economic theories to explain how economic policy affects cultural trauma. This knowledge is essential in our fast-changing economy, from academia to society.

The notion of cultural trauma explores the profound impact on the collective psyche of communities, encompassing their common emotional and psychological reactions to momentous societal occurrences [2]. War, recession, and social unrest are not temporary phenomena in history. Alternatively, these imprints last and shape communal identities. Establishing narratives, ideas, and values shapes how groups see themselves and their cultural place. National or global macroeconomic decisions shape these collective experiences. Economic growth and stability are the goals of fiscal policy, trade agreements, and monetary interventions. They often have non-economic effects. Specific industries may lose jobs due to trade liberalisation. In contrast, Brazil's 1988–1995 trade liberalisation reduced pay discrepancy. Instead of reducing employment in some sectors, trade liberalisation in Brazil changed employment across industries and formal classifications [3]. Surprisingly, this move reduced social unhappiness, showing the complex effects of macroeconomic policy. Economic policy results and how societies perceive and narrate them matter. While policies enacted in diverse cultures may result in public dissatisfaction or cultural trauma, perception and narration are equally essential. To attain economic stability, austerity may unintentionally cause social unrest. How the people experience and incorporate economic effects into the societal narrative is just as necessary. Over time, these policies' tangible effects and collective feelings of betrayal, deprivation, and disappointment may change. Societal changes, public discourse, and policy changes can cause this phylogeny. Acknowledging this dynamic interplay is essential in sympathy for the undefined relationship between macroeconomic decisions and their impact on social group structures and perceptions.

In addition, the media, public discourse, and societal leaders all significantly influence the public's perception and interpretation of these economic decisions. While potentially exacerbating the emotional distress linked to trauma, these experiences may also provide valuable perspectives that contribute to mitigating the negative repercussions. For instance, the media's depiction of human rights violations can impact decisions regarding foreign policy, including the imposition of economic sanctions. According to a study by Dursun Peksen, public pressure on leaders to intervene against abusive regimes increases the threat and imposition of sanctions in response to press coverage of human rights violations [4]. This underscores the critical significance of the media in influencing public opinion and subsequent policy reactions.

The interplay between cultural trauma and macroeconomic decisions encompasses more than mere occurrences and actions. This discourse pertains to the various interpretations, collective experiences, and enduring impacts that shape the very essence of communal identities. Comprehending this correlation holds significant importance for politicians, sociologists, and broader communities, as it provides valuable insights into the diverse consequences of economic choices on the overall welfare of society.

Scholars have studied cultural trauma's causes, expressions, and long-term impacts. Jeffrey C. Alexander posits that the designation of an event as an appreciation trauma hinges on its capacity to take exception or disrupt the undefined values of a society [5]. Disruptions can cause collective identity re-evaluation and social change. This perspective emphasizes the transforming potential of tales from care conflicts and economic downturns. This job relies on 'carrying groups' including philosophers, politicians, artists, and media specialists. These organisations create and spread event narratives. For example, academics may examine and interpret the event to contextualise its impact on society. Politicians may utilise the event to influence public opinion or policy changing. Artists and media professionals can boost the emotional and symbolic aspects of the event, ingraining it in the communal psyche. Since they impact how society sees, internalises, and remembers disruptions,

these carrier groups are crucial to identifying cultural traumas. This summary emphasises the moral force of these groups in societal events and collective personal identity modifications.

Meanwhile, economic theory illuminates macro-level decisions' socioeconomic effects. Classical perspectives emphasise market efficiency and the invisible hand in economic growth. However, modern perspectives emphasise these decisions' societal effects. Amartya Sen, an economist, favours a broader assessment paradigm that prioritises social well-being over economic growth [6]. Sen's capability approach holds that economic acts should be valued for their prospects, not only their riches.

2. Mechanisms of Influence

Currently, the media plays a significant role in influencing public opinions, particularly in the aftermath of significant economic determinations. The public's attitudes and collective comprehension can be significantly influenced by the media's representation of many events, including recessions, policy shifts, and trade agreements. During the period of the 2008 financial crisis, media sources across the globe were inundated with visual depictions that portrayed the state of collapsing institutions, unemployed individuals, and protesting masses. These representations served as illustrative portrayals of the prevailing situations during that time. The detailed depictions of the ongoing crisis not only served to educate the general population, but also intensified feelings of uncertainty, unease, and collective distress. However, it is important to note that the role of the media goes beyond mere reportage of everyday events. The media could amplify the perceived severity of an economic recession or adopt a more balanced perspective that emphasises recovery and resilience through their editorial choices, framing, and emphasis. According to a study conducted by Soroka et al., negative news has a greater impact on public sentiments than positive news [7]. This finding suggests that the media's focus has the potential to influence public perceptions and emotions significantly.

Simultaneously, the way society reacts to economic decisions is powerfully shaped by public discourse, encompassing scholarly forums, town hall discussions, debates, and informal talks. The painful experiences associated with these decisions can be either intensified or alleviated using counter-narratives that engage in public discourse by offering criticism, support, or analysis of these actions. During the Brexit vote, the economic consequences of the United Kingdom's departure from the European Union were the central focus of public discourse in the country [8]. Town hall gatherings, television discussions, and social media platforms have evolved as outlets for expressing concerns, goals, and critiques. Several news reports contributed to increased public concern by highlighting the potential occurrence of an economic crisis, job downsizing, and disruptions in commerce. In contrast, a contrasting perspective aimed at alleviating concerns presented a potential scenario of achieving financial independence and prosperity outside of the European Union. The outcome of the Brexit referendum was significantly wrought by the shared sentience and beliefs of the British population, rising from the conflicting narratives bestowed in public discussions. This event exemplifies how economic decisions and their societal implications turn into the subject of intense deliberate and public discourse. In the context of Brexit, various narratives competed for dominance inside the UK. On one side, some argued that leaving the European Union would lead to worldly turmoil, job losses, and trade disruptions. This view was supported by a throng of worldly analyses and forecasts that painted a somewhat cutting picture of the post-Brexit economic landscape.

Conversely, a contrasting narrative emerged, focusing on the potency of economic independence, self-determination, and reclaiming control over national policies. This perspective was championed by politicians and groups advocating for Brexit, who presented it as an opportunity for the UK to forge its economic path free from EU regulations. The public discourse around Brexit was a debate over economic policies and a struggle over national identity, sovereignty, and the UK's role in the world arena. The referendum's outcome, therefore, was not merely a reflectivity of economic

considerations but also of deeper societal and taste undercurrents within the British populace. This example underscores the complex interplay between worldly decision-making, world perception, and cultural narratives in shaping substantial societal events.

3. Case Studies

The Asian Financial Crisis that occurred from 1997 to 1998 serves as a poignant illustration of the complex interplay between macroeconomic choices and their broader social consequences [9]. The crisis began in Thailand due to the government's decision to introduce a floating exchange rate for the Thai baht. It then spread fast to neighbouring East and Southeast Asian countries, threatening their fundamental structures. The "Asian Tigers," a group of nations that experienced economic growth before the crisis, were lauded as development models. However, structural weaknesses remained beneath the surface. A drop in investor confidence highlighted vulnerabilities such as high short-term debt, overreliance on foreign capital, and real estate and stock market bubbles. The impact of Indonesia makes it an intriguing topic for analysis. Corporations who borrowed heavily in US dollars struggled to pay their financial obligations due to the rupiah's depreciation. The recession caused widespread unemployment and rising commodity prices. However, the crisis affected many aspects of Indonesian society, not only the economy. Nationwide protests ousted President Suharto, who had ruled for over 30 years. Many regions saw communal violence due to economic turmoil, which deepened ethnic and religious differences. Cultural trauma during and after the crisis is immense. After the "Asian Miracle" was discredited, disillusionment spread. National and international institutions are losing public trust. The International Monetary Fund (IMF), which provided funding, had strict restrictions.

Implementing austerity measures during the Asian business enterprise crisis, which was characterized by significant reductions in world expenditures, induced widespread disapproval and was perceived as an infringement on the subjects' sovereignty and this period marked a pivotal moment for contrived nations, suggesting a deep self-examination and re-evaluation of their economic and governance models.

For instance, the crisis led to profound political and economic reforms in Indonesia. According to a study by Thomas Pepinsky in the 'World Development Journal, the crisis played a critical role in Indonesia's passage from a dictatorship to a democracy [10]. The study highlights how the economic collapse undermined the Suharto regime's legitimacy, leading to its eventual downfall and the establishment of more transparent and accountable governance structures.

Similarly, in South Korea, the undefined spurred substantial financial and corporate sector reforms. A 2003 International Monetary Fund (IMF) report noted that South Korea's post-crisis reforms focused on enhancing corporate governance, financial sphere transparency, and accountability. These changes were driven by societal demands for more equitable and sustainable global practices, as evidenced by widespread public protests and the emergence of civil society groups advocating for reform.

There was a notable move towards more timid financial liberalization and a re-emphasis on the role of the state in the global direction in some Asian countries. This shift was a direct response to the vulnerabilities exposed by the crisis, leading to a broader social and professional discourse on sustainable global growth and financial stability.

The Asian Financial undefined not only highlighted the substantial socioeconomic and discernment consequences of macroeconomic decisions but also acted as a catalyst for profound changes in governance, fiscal regulation, and economic policies across affected nations. This transformation was marked by a redoubled emphasis on transparency, accountability, and sustainability, driven by societal demands and empirical proof of the need for a more balanced economic management. This statement stands as evidence that the consequences of these decisions

extend well beyond financial markets and currency transactions, influencing the construction of narratives, formation of identities, and fundamental nature of communities.

4. Counterarguments

The relationship between socioeconomic decisions and cultural trauma is multifaceted, with various scholars offering insights that enrich our understanding of this complex dynamic. The perspectives of sociologists like Bokkos Eyerman and Neil J. Smelser provide valuable layers of understanding without necessarily contradicting the bearing upon economic decisions on cultural trauma.

Ron Eyerman's work, for instance, emphasizes the role of historical retention in forming cultural trauma [11]. He posits that how society remembers and organizes its past is integral to sympathy for how cultural trauma develops. This position does not negate the influence of economic decisions; instead, it adds a layer of depth by suggesting that societies' undefined memories and the narratives they undefined also play a substantial role in experiencing trauma. This idea complements the sympathy that economic downturns or decisions can become part of these collective memories and narratives, contributing to taste trauma.

Similarly, Neil J. Smelser's research into collective behavior underscores the importance of ambiguity and social connections in shaping societal responses to various events [12]. His emphasis on the undefined interplay of factors like pre-existing tensions, interpersonal relationships, and the implicit uncertainty surrounding events adds nuance to the discussion. This vantage point supports the idea that the societal impact of worldly decisions involves more than straightforward cause-and-effect relationships. Instead, it interacts with a web of societal factors and pre-existing conditions, further forming the collective experience of trauma.

Incorporating these perspectives into the analysis acknowledges the broad spectrum of factors contributing to cultural trauma. It demonstrates that while worldly decisions are influential, they operate within a significant context of historical memory, undefined narratives, and social dynamics. This comprehensive approach underlines the necessity of considering both the place impact of economic decisions and the more subtle, nuanced factors that influence how societies experience and recount these events.

5. Implications

In analyzing the impact of economic decisions, it is imperative to follow the approach of cultural sociologists, such as Jeffrey C. Alexander the Great and others, and focus on how the consequences of these decisions are perceived, experienced, represented, and narrated within societies. Rather than merely assessing the immediate monetary system outcomes or the implications for GDP growth, the emphasis should be on understanding the narration and experiential aspects of these decisions.

Policymakers, while guiding the economy, must recognize that their choices are echoed in financial prosody but also the stories and experiences of the people. Economic strategies, while appearing beneficial in fiscal terms, Crataegus laevigata weave complex narratives that influence societal perceptions and experiences over time. For instance, policies that inadvertently contribute to global inequality can become part of a societal narrative that underscores atomization and discord, affecting the undefined soul and sociable cohesion.

Similarly, sociologists respect examining how economic decisions organically fit into the framework of societal narratives and collective memories. This requires a knowledge-based approach, where the rigor of economic psychoanalysis is combined with the depth of sociological understanding to explore the nuances of how worldly policies are experienced and represented in public discourse.

Moreover, the role of individuals in society extends beyond mere observers of these economic changes. People actively interpret and narrate these experiences, contributing to the collective

understanding of economic phenomena. Individuals informed about trade agreements, fiscal policies, and monetary interventions play a material role in shaping how these decisions are sensed and discussed in the public domain. This collective narration and rendering ensure that economic decisions are evaluated for their commercial enterprise outcomes and their broader effect on social narratives and identities.

6. Conclusion

The relationship between economic decision-making and cultural trauma is intricate and profoundly influential in shaping societal structures and perceptions. Economic decisions, typically aimed at fostering undefined stability, often have ripple effects that transcend specified financial metrics, affecting the social fabric and undefined consciousness. According to Alexander, it is not just the economic events that matter but how they are interpreted, narrated, and integrated into the undefined memory that ultimately defines their traumatic impact.

This tale-twisting and integration work is complex and involves various stakeholders and influencers. The media plays a critical role here, as it reports on economic decisions and their outcomes and frames these events in a way that can either amplify or mitigate their perceived impact. How the media symbolizes economic downturns, policy changes, or financial crises can significantly influence public perception, either exacerbating uncertainty and anxiety or fostering a sense of resilience and hope.

Public deliberation and discourse, facilitated by social leaders, intellectuals, and undefined voices, further contribute to shaping these narratives. Discussions in public forums, social media, and academic circles can dissect, challenge, or subscribe to the narratives presented by the media, adding layers of interpretation and meaning. These debates can foreground the human element of worldly decisions, bringing to the forefront stories of individual and community impacts that macroeconomic analyses would otherwise overshadow.

Moreover, social leaders, including politicians, activists, and thought leaders, play a crucial role in shaping societal responses to economic decisions. Their viewpoints and reactions can reinforce the dominant narratives or introduce alternative perspectives, thereby influencing the collective sympathy and response to these economic events.

Understanding this interplay is crucial in the academic context and for making informed social decisions. Recognizing the power of narratives in forming societal responses to economic decisions enables policymakers and leaders to appreciate the broader implications of their actions. It also empowers individuals and communities to engage critically with these narratives, fostering a more nuanced and comprehensive sympathy for the impact of economic policies.

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Expatriates Management of Mengniu

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Abstract: With the development of the globalization of the world market, the study of cross-cultural communication is becoming more and more important. This report is discussing about the expatriate Management of a China's company Mengniu. Mengniu is one of the largest Milk companies in China, At present, Mengniu has established factories in several countries, and also acquired a number of foreign companies, and has operations in several countries. The report is mainly based on Mengniu's analysis in Australia. This report has two parts. In the first part, the Hofstede Model is used to evaluate Mengniu's overseas employee management in Australia, including overseas employee failure (about culture shock and ethics), performance and reward Management, talent management and other aspects. The second part discusses the selection of Mengniu's global staffing, including Mengniu's business strategy, the selection of EPRG, international staffing methods and the formulation of effective international staffing plans. Finally, it is suggested that Mengniu should improve and adjust its overseas staff training, rewards, talent management and international personnel allocation.

Keywords: Expatriate, international staffing, management, culture

1. Introduction

The market is rapidly globalizing, and competition among enterprises has led to a surge in demand for effective international human resource management (IHRM) practices. Therefore, the success of international enterprises largely depends on their ability to manage international human resources flexibly.

Founded in 1999 in the Inner Mongolia Autonomous Region and headquartered in Hohhot, Mengniu is one of the top seven dairy companies in the world. It is a large multinational company with overseas production bases in New Zealand, Indonesia and Australia, and a total of 68 factories worldwide [1].

The purpose of this report is to critically evaluate the expatriate management and international personnel practices at Mengniu [2]. This report is divided into two parts. The first part mainly uses Hofstede theory introducing Expatriate Management, expatriate personnel and the challenges they may encounter in management. The second part will discuss the choice of Mengniu in EPRG, and how they will and should choose the recruitment of personnel from different countries. In the end, the article will give suggestions to Mengniu.

2. Expatriate Management

In the first part, the emphasis is to critically evaluate Mengniu's Expatriate management in Australia, considering such aspects as Expatriate Failure, Performance and Reward, Talent Management.

2.1. Expatriate Failure

An expatriate is an employee who is sent abroad to work for a long time. Most of the shares of Mengniu are held by Chinese state-owned enterprises, and as such, the company has a strong characteristic of ethnocentrism [3][4]. As a result, the headquarters of Mengniu often send expatriates who are mostly PCNs to other countries because they often believe that expatriates appear to have a better understanding of the company's strategy, objectives and operations [5]. However, expatriates may encounter many difficulties and challenges in areas with different cultures.

According to Hofstede Insights, there are 6 cultural differences between Australia and China [6], shown in Figure 1.

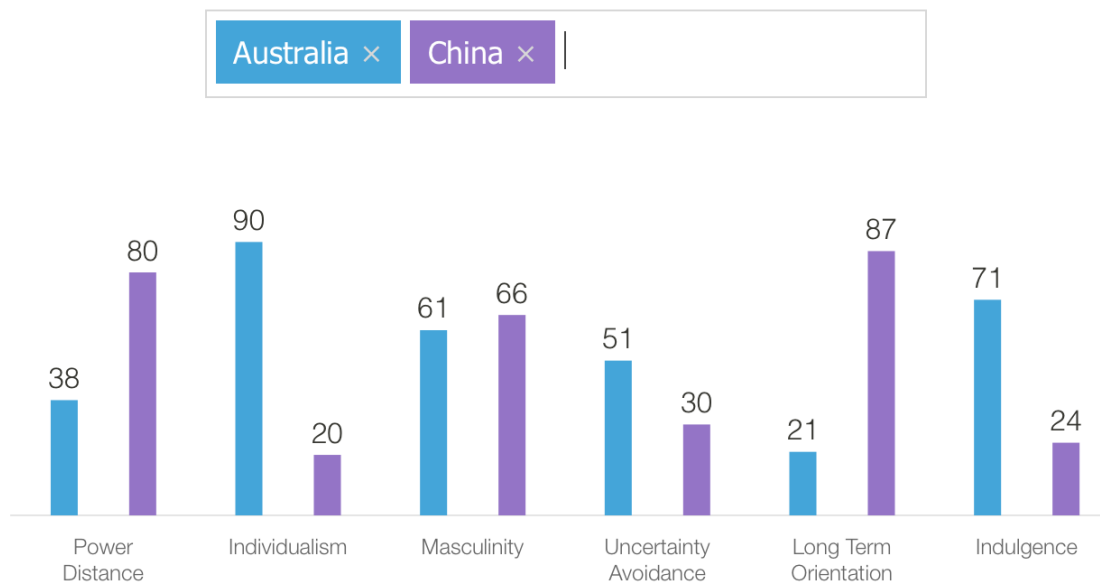


Figure 1: Culture differences

There are great differences between the two cultures, among which many factors may lead to many difficulties and challenges for Mengniu expatriates in Australia [7].

2.1.1. Culture Shock

Culture shock refers to when people are transferred from one cultural background to another, their quality of life and work efficiency may be affected due to the inadaptation and unfamiliarity with different cultures.

China has a high-power Distance, which indicates that the management has higher power in China. When they assign tasks, the employees will easily comply with them, while Australians expect equal communication rather than being ordered. Meanwhile, because Australia scores much higher than China in terms of Individualism, which indicates that Australia puts more emphasis on individual interests and independence, they are encouraged to participate in the decision-making process and put forward their views and suggestions. In contrast, Chinese employees seldom participate in

decision-making [8]. This may be because of the differences in Assertiveness. Chinese people are more modest and diplomatic than the Australians [9].

For these reasons, when PCNs of Mengniu work as managers in Australia, they may not know how to communicate with employees. For example, when they give orders to employees in Australia or require employees to work overtime for special reasons, they may be rejected, which is unlikely to happen in China. They will feel different views of authority between different cultures, as well as the Australian emphasis on personal freedom, which may lead to anxiety and discomfort for expatriates [7].

2.1.2. Ethics

High power distance is more likely to lead to moral problems, such as corruption and abuse of power. For example, in Chinese culture, gift-giving has long been recognized as a customary practice that facilitates relationship building. According to Transparency International, China's Corruption Perceptions Index (CPI) ranks 65th out of 180 countries, while Australia ranks 13th. At Mengniu [10], which is controlled by Chinese state-owned enterprises, the problem may be even worse. This is likely to lead to ethical challenges for Chinese employees abroad.

First, Chinese employees may not be familiar with Australian laws and regulations. In China, gift-giving on a small scale may be ordinary or even necessary, but in Australia, it may be regarded as bribery or illegal. Secondly, Chinese people may be good at building interpersonal relationships to promote the development of business, but it may be considered as immoral behavior in Australia.

To deal with these problems, Mengniu's expatriates must consider the cultural differences between Australia and the company's headquarters and implement tailored employee training programs accordingly. For instance, incorporating expatriate induction programs that focus on enhancing communication skills, providing ethics training, and offering legal education can better equip expatriates to adapt to the Australian working environment.

2.2. Expatriate Performance and Reward Management

Performance management is setting goals, evaluating performance, providing feedback, and making plans. Reasonable performance management can improve the work efficiency of employees. Expatriates are sent to regions with different cultures so that they may need different performance management methods [2].

Mengniu's performance management in China is mainly based on performance indicators. For example, in 2004, the target of liquid milk sales revenue was 6.885 billion yuan. Every 30 million yuan more, the annual salary of the person in charge can be increased by 1%, and vice versa by 2% [11]. This type of management could run into problems in Australia.

Due to the high-power distance in China, employees may be less likely to give opinions on how performance management is conducted. Also, China is good at maintaining interpersonal relations, such as gift giving, which may lead to unfair performance management.

On the contrary, in Australia, this management method may be considered unreasonable and unfair. Australian employees attach more importance to individual development and are more inclined to make decisions, which differs from Chinese culture [8]. If this type of management is used in Australia, it may lead to increased dissatisfaction and turnover rates. At the same time, Australians are more inclined to non-monetary rewards, such as flexible working hours, training and development opportunities, rather than simply increasing or reducing wages [12].

These are the challenges that IHRM may encounter due to the cultural differences between the two countries.

2.3. Talent Management

Talent is a unique strategic resource, and the rational use of talented employees can achieve sustainable competition [13]. As Mengniu's operations expand in Australia, the choice of expatriates will become increasingly important.

There are two Philosophies of talent management, which are the inclusive approach and the exclusive approach. An Inclusive approach means providing relatively equal opportunities for learning and growth regardless of their current level of performance and future potential. And the Exclusive approach refers to focusing on developing employees with more talent and potential [14]. Mengniu uses an Exclusive approach in China, where they hire and select people who have talent in breeding, veterinary medicine, milk source management, etc., rather than treating everyone equally [15].

The segmentation approach and the Global HRM approach are two approaches to Global Talent management. The segmentation approach is similar to the Exclusive approach, which focuses on developing high-potential employees or people in influential positions. Global Talent Management takes a more holistic view and considers an organization's talent needs on a global scale [16]. The talent strategy of Mengniu seems to be more inclined to the Segmentation approach. Mengniu focuses on developing individuals critical to an organization's sustainable development strategy. This may be related to China's large population base and Mengniu's ethnocentrism [4][15].

3. International Staffing

In MNCs, global staffing refers to the process of filling key positions in the head office joint venture [17].

3.1. Business Strategy of Mengniu

According to Yip, there are three kinds of strategies for transnational corporations: Global strategy, international strategy, and multi-domestic strategy [18]. The main goal of global strategy is to establish a consistent brand image and to use the same products even if they are different. Multi domestic strategy refers to the selection of products and strategies based on the needs and preferences of the local market. Transnational strategy is a mixed one.

Mengniu uses transnational strategies because it has different products and strategies in different countries but retains a part of its culture. For example, in China, because most Chinese people are lactose intolerant, Chinese milk is unique, while Australians prefer fresh milk. They have different favorites. Every country has both similarities and differences. Different cultures should be balanced, and a shared corporate culture should be developed [19].

In this case, for the company to adapt to the local culture, the company must be able to recognize the importance of local talents in the market and consider balancing the number of expatriates and HCNs. However, since Mengniu is a company controlled by the Central Committee of the Communist Party of China, it may encounter some obstacles in its transnational strategy [3].

3.2. International Staffing Approach of Mengniu

EPRG represents Ethnocentrism, Polycentrism, Regiocentrism, and Geocentrism. In ethnocentrism, the head office of a multinational company is the dominant force, and staffing is centered around employees in the home country, but this may restrict the global company from adapting to local market conditions. Polycentrism focuses on the local responsiveness of a country. Regiocentrism is region-centered and chooses to employ staff in the region to manage subsidiaries, such as Hong Kong

and Macao, which are part of China but have different cultures. Geocentrism is an earth-centric approach that hires the best person for the job, regardless of the manager's nationality [4].

Mengniu has an intense ethnocentrism, so most of its acquired subsidiaries would have Chinese CEOs. For example, Andrew Cohen was the CEO of Bellamy's, and after it was acquired by Mengniu in 2019, the CEO is now Zhendong Gu [20].

In line with the local culture, Mengniu has often adopted Polycentrism. For instance, there are 157 employees in Mengniu's Indonesian factory, among which 115 are Indonesian nationals, and local employees account for 73%. All of them are management and technical workers [4][21]. However, The decision to employ a majority of local employees could also be attributed to the relatively low labor costs in Indonesia. Also, these employees are unlikely to have much power.

3.3. Effective International Staffing Plan for Mengniu

Expatriates include Parents country national (PCN) and Third country national (TCN). Host country national (HCN) is a local employee who holds a local position in an overseas branch of a multinational company [4].

Mengniu mainly employs PCNs and HCNs, and due to the limitations of milk enterprises, it is difficult for Mengniu to entirely rely on PCNs. For example, in breeding pastures in other countries, it is better to employ more HCNs familiar with local technologies.

As mentioned before, Mengniu is a company that prefers ethnocentrism, so most of the senior executives of its subsidiaries are Chinese. However, when implementing transnational strategies, Mengniu needs to consider the adaptability of PCNs in other countries.

In this case, Mengniu can choose a hybrid approach, that is, let PCNs and HCNs form a close team to manage the company jointly. At this time, PCNs can carry out the strategy or project that the parent company wants its subsidiaries to do. At the same time, HCNs can judge the possibility of this project and how to adjust it by taking advantage of its better understanding of the domestic market and culture. For example, the main product of Mengniu is packaged milk with a long shelf life. If this product is to enter the Australian market, Australians may reject it. In this case, suggestions from HCNs are needed [22].

Meanwhile, TCNs is also a critical choice. Mengniu used TCNs less, but hiring American or Japanese experts may bring higher returns in some specific areas, such as international marketing and brand management [23].

4. Conclusion and Recommendations

To sum up, Mengniu is a successful multinational company, but due to cultural differences and strong ethnic center culture, Mengniu meets many difficulties and challenges in expatriate personnel management and international staffing [4]. Expatriates may encounter cultural difficulties, such as differences in communication style and ethics. In addition, China's performance management system may not be applicable to other countries.

Mengniu mainly adopts ethnocentrism, but also polycentrism when necessary. Personnel management may need to be adjusted. The method combining HCNs and PCNs may be more suitable for foreign markets. In some special aspects, employing TCNs is also effective [23].

It is suggested that Mengniu should provide training programs for Expatriates to adapt to local culture. Create appropriate performance and reward management systems in Australia, such as offering more non-monetary rewards, balancing work and balance for employees, and more training and development opportunities would be better for Australia [12]. Meanwhile, as Mengniu expands its presence in Australia, it may need to adopt a more inclusive approach to talent management, to achieve CSR.

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Digital Transformation for Cultural Sustainability: The Bolshoi Theatre Experience

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Abstract: This paper studies the Bolshoi Theatre's digital transformation in cultural sustainability, focusing on innovation management and technology utilization, explores the critical need for cultural institutions to overcome hurdles and capitalize on opportunities provided by modern technologies, investigates the Bolshoi Theatre's strategic ways of managing its digital transformation while preserving and improving its cultural history, its historical relevance and its digital projects, to reveal managerial obstacles, opportunities, and deep influences on both internal techniques and audience reviews. Key findings highlight the transformative significance of innovation management in changing market involvement via virtual performances, virtual reality reviews, and augmented reality programs. The study also emphasizes the need for knowing usage, as indicated by creating a centralized digital archive and combining device learning algorithms for customized target market interactions. This research contributes insights into managing cultural institutions in the digital age, with broader implications for strategic use of digital technology in cultural management.

Keywords: Digital Transformation, Knowledge Management, Innovation Management, Cultural Sustainability

1. Introduction

Cultural institutions symbolizing history and culture are navigating a significant digital transition. An illustrious cultural icon, the Bolshoi Theatre, exemplifies the challenges and opportunities of the digital age for cultural sustainability. This study focuses on the Bolshoi Theatre's adaptive strategies and creative management in the digital revolution [1].

Technology management, key in conserving and improving cultural heritage inside the virtual environment, leverages information control intentionally to integrate digital technologies with its cultural legacy. A methodical framework combines qualitative and quantitative assessments to examine digital engagement tactics and understand control protocols and their overall impact on organizational control and target market research. This research contributes to the topic of powerful cultural group control by being customized explicitly to the Bolshoi Theatre experience. This file at the Bolshoi Theatre's digital transformation is poised to impact the trajectory of cultural management in a generation marked by chronic evolution as a lighthouse for strategic selection-making [2].

2. Literature Review

2.1. Cultural Sustainability and Digitalization

Cultural sustainability, a priority for the Bolshoi Theatre, intertwines with modern technology's impact on heritage. The arts, which are strongly anchored in culture, are at a crossroads where the preservation of cultural identity intersects with the opportunities and difficulties provided by the digital age. The Bolshoi Theatre, founded in 1776, epitomized Russia's rich cultural history, showing creative quality and serving as a curator of ancient narratives [3]. The sturdiness of the theatre emphasizes its persistence, a testament to its ability to adapt to changing circumstances while retaining its cultural essence. The Bolshoi Theatre's approach to sustainability balances subculture and innovation, carefully adopting technical innovations to supplement its cultural preservation efforts. Digital technologies serve as tools to record and digitize previous performances and interact with a global audience across geographical boundaries.

In this dynamic paradigm that ensures the cultural heritage, the Bolshoi Theatre remains vibrant and relevant in the digital age and is an effective integration model. By embracing digital technology, the theatre protects its historical assets and democratizes access, allowing a broader target population to participate in its cultural history. This strategic strategy places the Bolshoi Theatre at the forefront of cultural organizations, balancing the delicate balance of maintaining culture while embracing the revolutionary power of the digital age [4].

2.2. Key Academic Perspectives on Innovation Management and Knowledge Dissemination in the Cultural Sector

Key academic perspectives in the cultural sector advocate for strategic innovation management, cultural entrepreneurship, and collaborative knowledge dissemination. Scholars in the cultural zone emphasize strategic innovation management in navigating the changing terrain. They advocate linking innovation initiatives with broader cultural objectives, ensuring new practices contribute to restoring tradition. Scholarly literature suggests a balance between adopting innovative technologies and protecting the history contained in cultural organizations [5].

Another fundamental perspective focuses on cultural entrepreneurship, viewing institutions as dynamic and capable of entrepreneurship. This viewpoint promotes proactively using innovation to create cultural value. The role of management in cultivating an entrepreneurial subculture inside cultural organizations, allowing them to adapt, innovate, and prosper in technological and social changes [6].

Academic discourse highlights the transformational power of collaborative knowledge dissemination in the cultural sector. They emphasize transitioning from traditional, hierarchical knowledge systems towards more collaborative and inclusive approaches. Cultural organizations can disseminate knowledge by creating collaborations and engaging different stakeholders. This aligns with the growing character of cultural institutions as centers for communal getting to know and sharing cultural tales.

2.3. Transformation of Practices by Digital Technologies

Digital technology is changing knowledge sharing in cultural institutions through immersive storytelling. Visitors to virtual exhibits and augmented reality may engage with cultural artifacts in novel ways that transcend physical boundaries. This shift enhances accessibility and participatory learning, redefining cultural distribution.

Digital technologies have transformed target audience interaction by exchanging knowledge via online frameworks. Social media, digital activities, and online forums are dynamic means for

disseminating cultural records. Institutions enable a global audience connection, encouraging understanding of varied cultural manifestations. This movement alters technology diffusion into a more interactive, participatory, and globally accessible form[7].

Data analytics and artificial intelligence in cultural institutions alter knowledge distribution via informed decision-making. Digital technology collects and analyzes target market preferences, behaviors, and trends. This strategy customizes cultural products by ensuring knowledge dissemination coincides with varied audiences' changing interests and expectations. This shift highlights the dynamic and responsive character of contemporary cultural practices developed via digital insights [8].

3. Bolshoi Analysis

3.1. Innovation in Digital Engagement

In its quest for Digital Transformation for Cultural Sustainability, the Bolshoi Theatre has pioneered virtual approaches to redefine target market interaction. The theatre has revolutionized the traditional spectatorship paradigm by adopting a forward-thinking strategy. The introduction of virtual performances stands out as a flagship project, overcoming physical limits and enabling spectators all over the globe to appreciate the magnificence of the Bolshoi's cultural offerings. These digital adaptations, accessible via dedicated online platforms, provide an immersive experience with Russian dramatic arts, generating a sense of connection and cultural enrichment. The Bolshoi Theatre has successfully used virtual reality (VR) experiences in addition to digital performances. Audiences may travel through the Bolshoi's sacred halls, immersing themselves in its historical grandeur. This creative usage of VR expands the Bolshoi's reach and provides a wholly distinct viewpoint on its rich past, creating an interactive connection between the target audience and the cultural heritage inside the organization [9].

In addition, the Bolshoi Theatre has dabbled with augmented reality (AR) apps, boosting both the in-person and virtual audience experience. AR components blend smoothly with live performances, adding layers of data and storytelling to the cultural narrative. This use of AR technology deepens participation, changing passive onlookers into active participants in the evolving cultural spectacle. Beyond total performance spaces, the Bolshoi's digital activities include social media structures as dynamic pathways for target market interaction. Regular updates, behind-the-scenes peeks, and interactive content material enable a continuous dialogue between the theatre and its audience. This smart use of social media generates a sense of community and functions as a promotional instrument, bringing a diversified international target market eager to participate in the Bolshoi delight. As a result, the Bolshoi Theatre's current virtual engagement measures, which include digital performances, VR reporting, AR programs, and smart social media use, provide a comprehensive approach to cultural sustainability via virtual transformation. By harmoniously mixing history and modernity, the Bolshoi Theatre guarantees its cultural heritage survives and thrives in the digital age, transcending corporeal and geographical boundaries to fascinate a global audience.

3.2. Knowledge Management and Digital Implementation

As part of its Digital Transformation for Cultural Sustainability, the Bolshoi Theatre has implemented intelligent knowledge control procedures, which serve as the foundation for its flawless integration of virtual technology. The theatre has created a centralized virtual archive in which past performances, archival papers, and artifacts are scrupulously cataloged. This archive protects the Bolshoi's cultural past and is a solid foundation for digital activities. Access to this virtual archive isn't necessarily limited to internal stakeholders; academics, educators, and the general public may engage with this richness of cultural information, enabling more democratic access to the Bolshoi's historic riches.

Machine learning algorithms are critical in creating customized rules for audiences. The Bolshoi Theatre has deliberately used such algorithms to analyze target market preferences, allowing it to customize its digital offers. This dynamic method ensures that the digital transformation matches a diverse target market's changing preferences and expectations, resulting in a more appealing and relevant cultural experience. The Bolshoi's virtual implementation is built on collaborative know-how distribution. The theatre expands its reach and impact by collaborating with virtual systems, academic institutions, and cultural companies. These partnerships improve the Bolshoi's influence and promote a symbiotic exchange of knowledge, ensuring a continual flow of cultural insights between the theatre and its varied community of collaborators [10].

Furthermore, the Bolshoi Theatre has carefully incorporated data analytics into its virtual ecology. The gathering and analysis of target market engagement data enables informed decision-making. Statistics-driven insights guarantee that the Bolshoi stays nimble in reacting to the shifting panorama of audience expectations, from perfecting virtual procedures to personalizing digital evaluations. The Bolshoi Theatre's digital transformation strategy is defined by the precise integration of centralized archive management, device learning for customized reporting, collaborative knowledge sharing, and data-driven decision-making. It encompasses preserving cultural history and strategically applying knowledge in developing a resilient and vibrant cultural community in the digital era. The Bolshoi Theatre's commitment to technology administration is a guiding force, ensuring the digital journey stays anchored in cultural sustainability [11].

3.3. Challenges and Opportunities in Innovation

The Bolshoi Theatre faces various administrative challenges and opportunities in its digital transformation journey for cultural sustainability.

Table 1: Challenges and Opportunities in Innovation

Challenges		Opportunities	
Cultural Change and Training:	Digital transformation requires a culture shift and innovation mindset, demanding comprehensive training for digital proficiency.	Diversified Revenue sources:	Digitalization opens avenues for alternative revenues like digital subscriptions and event sponsorships, reducing reliance on physical attendance.
Data Security and Privacy:	Growing virtual projects necessitate enhanced data security and privacy measures, a significant ongoing effort for Bolshoi Theatre[12].	Global Audience Reach:	Digital strategies extend the theatre's global reach, supported by a new ticketing system for easier access.
Cooperation across Departments:	Extensive digital shift calls for seamless inter-departmental collaboration, aligning activities with sustainability goals[13].	Strategic collaborations:	Adopting digital methods facilitates strategic partnerships, expanding the theatre's reach and resource pool[14].

3.4. Impact of Digital Transformation

The Bolshoi Theatre's embrace of digital technology has dramatically transformed both management and audience engagement. On the managerial front, digital integration has streamlined processes, optimized resource allocation, and fostered a responsive organizational structure. The use of real-time data analytics for statistics-driven decision-making aligns the theatre's operations with its

cultural sustainability goals, enhancing both strategic and operational effectiveness [15]. In terms of audience impact, digital initiatives have revolutionized how the theatre interacts with its audience, breaking geographical barriers and democratizing cultural experiences globally. Machine learning algorithms have been instrumental in personalizing user experiences, shifting passive viewers to active participants in the Bolshoi's cultural narrative. These advancements not only make the Bolshoi's cultural offerings globally accessible but also reinforce its status as a leading cultural beacon in the digital era [16].

4. Suggestions from the Bolshoi Theatre Case Study

The Bolshoi Theatre case study highlights the importance of innovation management in digital transformation, demonstrating how the integration of VR and AR enhances audience interaction and maintains cultural relevance [17]. Moreover, the theatre's effective use of knowledge, especially through a centralized virtual archive and machine learning algorithms, aligns its digital innovations with cultural sustainability goals.

Additionally, forming a Digital Innovation Task Force, as seen in the Bolshoi Theatre's strategy, is crucial for overseeing digital initiatives and ensuring alignment with cultural objectives. This approach is complemented by continual staff training, emphasizing the need for a digitally proficient workforce to maximize the potential of digital tools and foster an innovation-centric culture [18].

Furthermore, the Bolshoi Theatre's success also underscores the value of forging strategic partnerships in the digital landscape. Collaborations with online platforms, academic institutions, and cultural organizations expand reach, provide access to new resources, and enhance digital capabilities, proving essential for cultural institutions in the digital era [19].

5. Conclusion

The Bolshoi Theatre case study highlights the transformative impact of innovation and strategic knowledge utilization in cultural organizations. It illustrates the importance of embracing constant innovation, with the theatre's use of virtual technology and centralized virtual archives as prime examples of effective digital integration. The Bolshoi Theatre's approach provides a roadmap for cultural institutions to navigate digital transformation while maintaining cultural integrity. Its success in engaging international audiences, optimizing operations, and fostering a vibrant cultural environment stands as a model for achieving relevance and resilience in the digital age.

However, the unique nature of the Bolshoi Theatre means its experiences may not fully represent the diverse landscape of cultural institutions worldwide. Future research should explore the applicability of these findings in varied cultural contexts, acknowledging the different challenges and opportunities each organization faces. Additionally, a longitudinal study could offer deeper insights into the long-term impacts of digital transformation on cultural institutions.

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Analysis of the Impact of China's Carbon Neutrality Policy on the Environment and Economy at Home and Abroad

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Abstract: China has made remarkable achievements in reducing greenhouse gas emissions, especially in achieving the emission reduction targets set for 2020. This progress is mainly due to China's reduced dependence on coal and other fossil fuels, which not only promotes significant improvements in air quality but also lays the foundation for the transformation of China's economic structure. Especially in the energy and industrial fields, carbon neutrality policies are driving companies to transform into greener and more sustainable operating models. Facing the economic challenges brought about by the COVID-19 epidemic, China is actively seeking a path to low-carbon economic recovery by increasing public investment in renewable energy and other fields. From an international perspective, China's carbon neutrality commitment has the potential to inspire other large carbon-emitting countries, especially countries along the Belt and Road and neighboring countries, to strengthen their emission reduction efforts. At the same time, Southeast Asian countries face shortages of technology, equipment, and raw materials, as well as insufficient investment when developing renewable energy. In this regard, China's experience and investment have a significant impact on Southeast Asian countries' carbon neutrality policies and renewable energy development. China can use its technological and manufacturing advantages to share resources with neighboring countries in renewable energy technology and equipment manufacturing, and provide support for ASEAN countries to achieve their renewable energy goals.

Keywords: China, carbon neutrality, climate, economy, Southeast Asia

1. Introduction

In the early 21st century, global climate change has become an urgent global challenge. According to the "Special Report on Global Temperature Rise of 1.5°C" published by the IPCC [1], carbon neutrality is defined as the ability of man-made CO₂ removal to offset man-made CO₂ emissions on a global scale during a specific period, thereby achieving net zero CO₂ emission. The report also emphasizes that only by achieving global net-zero carbon emissions—the goal of carbon neutrality—by the mid-21st century will it be possible to limit global warming to 1.5°C, thereby mitigating the extreme harm caused by climate change. However, the United Nations Environment Program (UNEP) pointed out in its "Emissions Gap Report 2019" [2] that there is a significant gap between countries' emission reduction ambitions at this stage and the requirements of the 1.5°C target.

In this scenario, as the world's largest emitter of greenhouse gases, China's role in addressing climate change has attracted widespread attention from the international community. In recent years, the Chinese government has gradually realized the seriousness of this problem and has formulated and implemented a series of policies and measures to address climate change. Among them, the most prominent one is China's goal of "carbon peaking and carbon neutrality" [3]. In short, the goal means that by 2060, China's carbon emissions will peak and gradually decrease, eventually achieving carbon neutrality, that is, a balance between annual carbon emissions and absorption. This ambitious goal demonstrates China's determination and sense of responsibility in global climate governance. But at the same time, it also brings a series of challenges and problems. In addition, what impact will China's goal have on its neighboring countries, especially its economic partners such as Southeast Asian countries?

This article aims to delve into the possible impacts of China's carbon neutrality policy. First, this article will examine the positive environmental impacts of this policy, including reductions in greenhouse gas emissions and improvements in air quality. Next, the impact of this policy on China's economy will be analyzed, especially in terms of industrial structure transformation and investment and innovation promotion. Finally, this article will explore the impact of this policy on neighboring countries, especially Southeast Asian countries, to provide valuable references and suggestions for these countries.

2. The impact of China's carbon neutrality on the atmosphere

The relationship between China's development and climate change is complex and closely related. As one of the world's largest emitters of greenhouse gases, China plays a vital role in the intensification of global warming. At the same time, it is also profoundly affected by the negative impacts of climate change. Like other major greenhouse gas emitters, China plays a critical role in reducing global climate risks. However, for a carbon-intensive industrialized economy like China, reducing greenhouse gas emissions and improving air quality is no easy task. This requires not only technological innovation and policy adjustments but also profound changes in economic structure and energy use patterns.

2.1. Greenhouse gas emissions

Before 1970, China's total CO₂ emissions were less than 0.9 Gt, and per capita emissions were about a quarter of the global average. Since the reform and opening up in the 1970s, especially after joining the World Trade Organization in 2000, CO₂ emissions have increased with the rapid growth of the economic aggregate (as shown in Figure 1). China's CO₂ emissions grew at an average annual rate of 10% in the 1970s, 5% in the 1980s, 3% in the 1990s, 9% in the 2000s, and 3% in the 2010s (Figure 1 shown). At the same time, per capita CO₂ emissions have also increased, snowballing from 2000 to 2013 and then stabilizing (shown in Figure 2). In terms of carbon emission intensity, it has gradually shown a downward trend since 1980 (see Figure 2). As of 2019, the national CO₂ emissions are 10.3 Gt ($\pm 13\%$, confidence interval (CI) = 90%), and the per capita CO₂ emissions are approximately 7.4 t [4, 5, 6, 7].

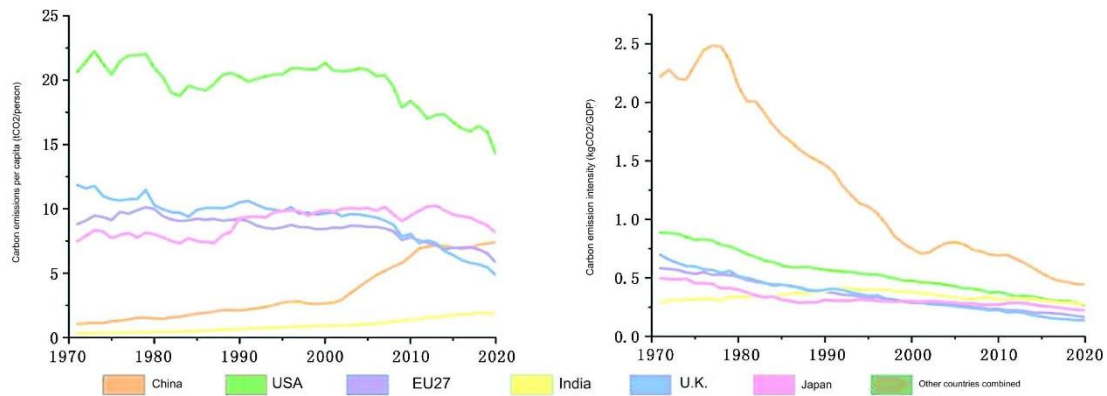


Figure 1: China's carbon emission trend chart [4,5].

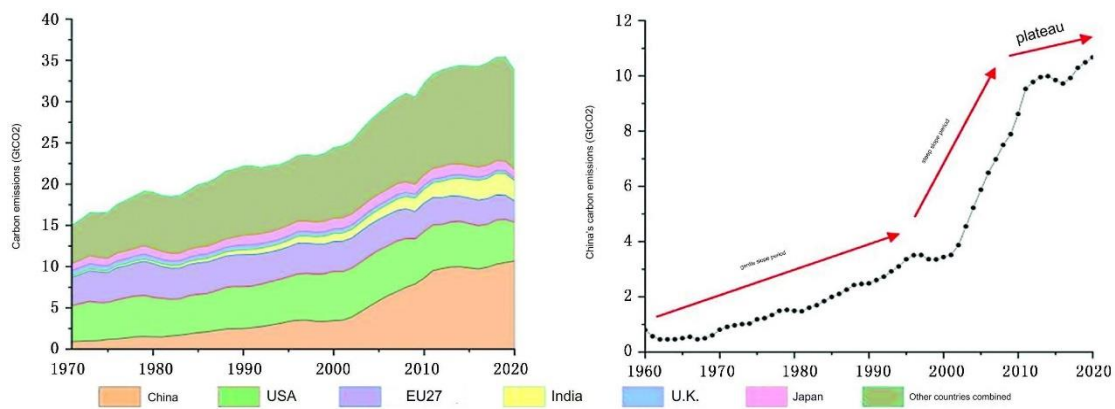


Figure 2: Comparison of per capita carbon emissions and carbon emission intensity [5,6].

2020 is a critical time point for China's carbon emission reduction goals, that is, the carbon emission intensity will decrease by 40% to 45% compared with the same period in 2005, and the energy intensity and carbon emission intensity of the "13th Five-Year Plan" will be reduced by 15% and 18% respectively compared with the same period in 2015. %, China has now achieved the above goals. As of 2019, China's carbon emission intensity has been reduced by 48.1% compared with 2005. By 2020, this indicator has reached 48.4%, fully completing the target of 40% to 45% [8]. In 2020, the proportion of non-fossil energy in the country's primary energy consumption reached 15.9%, and the corresponding target was also achieved. The corresponding goals in the "Thirteenth Five-Year Plan" outline have also been achieved. As of 2020, compared with 2015, carbon emission intensity has been reduced by 18.8%, exceeding the 18% target; the proportion of non-fossil energy consumption in primary energy consumption has increased to 15.9%, exceeding the 15% target.

2.2. Improvement of air quality

As the dependence on coal and other fossil fuels diminishes, there is a corresponding decline in the release of associated pollutants like sulfur dioxide, nitrogen oxides, and particulate matter. According to statistics from China's Environmental Monitoring Center [9], there has been an approximate 30% reduction in PM_{2.5} concentrations in the ten largest cities of China since 2013. This positive change is particularly evident in expansive urban areas. Historically, severe smog in large urban areas resulted from the extensive use of coal and significant emissions from vehicle exhaust. Nevertheless, in recent years, there has been a notable enhancement in air quality in Beijing, attributed to China's implementation of green energy policies and stringent pollution control measures. The data illustrates

that Beijing's average PM_{2.5} concentration was 89.5 micrograms per cubic meter in 2013, but by 2020, this figure had decreased significantly to 38 micrograms per cubic meter.

As air quality improves, many cities in China are starting to become more livable. Shanghai, China's economic center, has also made efforts to improve its air quality in recent years. By promoting electric vehicles, strengthening industrial emission standards, and improving fuel quality, we achieved 300 consecutive days of good air quality in 2018, a significant improvement from 220 days in 2013 five years ago, and improved people's health. It has also been improved. According to a World Bank report, due to improved air quality, the number of premature deaths caused by air pollution decreased by more than 100,000 in China in 2019 compared with 2012. Globally, China's carbon neutrality can reduce global warming by about 0.2-0.3°C and save about 1.8 million people from premature death due to air pollution [10].

3. The economic impact of China's carbon neutrality

The "China Country Climate and Development Report" (CCDR) [11] conducts an in-depth analysis of how China can strike a balance between high-quality economic development and achieving emission reduction, as well as enhancing climate adaptability. It presents relevant suggestions to address these challenges. According to the report, China faces the risk of hindering its long-term economic growth and prosperity if it fails to implement effective strategies for climate change mitigation and adaptation. Climate risks could even offset its development achievements. However, the report also cautions that measures taken to address climate risks should not result in slower economic growth and increased social inequality. Such outcomes could undermine opportunities for millions of people and decrease public support for the reforms necessary to drive long-term economic transformation. Therefore, China must navigate towards a reasonable equilibrium between economic growth and green development.

3.1. Transformation of economy and enterprises

China's transition towards carbon neutrality and resilient development will bring transition risks. Although addressing climate risks is extremely important to ensure long-term development, China also encounters unique challenges in achieving its climate and development goals: compared with developed economies, China needs to achieve economic growth at a lower income level and a faster pace. Decoupling from carbon emissions. This means that China's economic structure will undergo fundamental changes: energy, industrial, and transportation systems, and urban and land use patterns will all undergo major transformations.

3.1.1. Energy transition

Among the pivotal challenges in China's energy transition, achieving decarbonization in the energy supply sector stands out as particularly crucial. When examining shifts in China's energy landscape, two prominent features emerge the widespread adoption of renewable energy and the gradual reduction of coal utilization. Presently, China has surpassed the peak of coal consumption and is experiencing a gradual decline. Projections suggest that post-2025, as coal consumption rapidly diminishes, both primary energy consumption and carbon dioxide emissions will reach their zenith [12]. Simultaneously, renewable energy presently constitutes approximately 10% of primary energy consumption. Although its growth is gradual, its primary objective is to meet the escalating energy demand. In the forthcoming energy framework, renewable energy will play a pivotal role in bridging the energy deficit resulting from reduced coal consumption and holds the potential to emerge as the primary energy source, supplanting fossil fuels.

3.1.2. Enterprise transformation

The carbon neutrality target set by China is pushing companies to transform towards greener and more sustainable operating models. This transformation encompasses measures such as adopting clean technologies, improving energy efficiency, and reducing greenhouse gas emissions. Professor Zhang Zhongxiang pointed out that although the increase in carbon costs will cause pain to enterprises in the short term, the government should not be affected by the emotions that may be amplified by enterprises [13]. When considering its stance on coal power and coal control, China must not only consider following global climate change agreements but also consider its economic development level and the actual situation of its energy structure. The CBAM proposal in the EU's Green New Deal, which aims to prevent carbon leakage, may have a greater impact on China and should attract attention.

3.2. Carbon neutrality and low-carbon recovery

The global COVID-19 pandemic has triggered the most profound economic contraction since the Great Depression. Governments worldwide are actively devising economic recovery policies in response to this impact. However, conventional economic stimulus measures reliant on energy consumption may worsen the irreversible trend of climate change and other environmental risks. In contrast, a low-carbon recovery, achieved through heightened public spending, particularly in areas like renewable energy investment, can establish a sustainable, low-carbon trajectory. The extended shift from a carbon-centric economy and the initiation of a low-carbon economy presents an opportunity to continue advancing global climate action [14]. For instance, in July 2020, the EU secured consensus on a \$500 billion economic stimulus policy, with 30% earmarked for supporting climate action and implementing the European Green Deal, a pivotal policy document for the EU's carbon neutrality goal [15]. On June 3, 2020, the German government approved a €130 billion economic recovery plan, allocating €50 billion to "future programs" concentrating on "climate transition" and "digital transformation." This includes various climate change combating measures, such as initiatives in electric mobility, hydrogen technology, rail transport, and construction [16].

4. The impact of China's carbon neutrality policy on neighboring countries—Southeast Asia

China's commitment to carbon neutrality is not only a major shift in its climate policy but also sets a new standard for global climate action and can be regarded as a "game changer" for global climate governance. China's efforts to reduce emissions have the potential to inspire other large carbon emitters, especially countries along the Belt and Road and neighboring countries, to increase their emissions reduction efforts. In addition, China can leverage its technological and capital advantages to share emissions reduction technologies and make green investments in neighboring countries. For Southeast Asian countries, China has strong capital strength and maintains close economic and trade relations. Especially under the framework of the "China-ASEAN Free Trade Area", the trade and investment ties between the two sides are increasing daily. This economic linkage allows China to share its green development experience in the region and promote sustainable development. These measures taken by China will play an important role in promoting low-carbon transformation and sustainable development in the region.

4.1. Current Situation in Southeast Asia

Southeast Asia is one of the most climate-vulnerable regions on Earth - it faces brutal tropical storms, rising sea levels that threaten coastlines and cities, as well as massive flooding and severe droughts. According to the global climate risk index recently released by German Watch [17], three of the 10 countries most affected by climate risks from 2000 to 2019 are Myanmar, the Philippines, and Thailand. Furthermore, climate risk is removed from current projections unless governments implement more ambitious policies, provide stronger budget support, enact stricter measures to reduce fossil fuel use, and attract higher levels of investment, otherwise, Southeast Asia will not be able to achieve its net-zero emissions target by 2050.

4.2. Renewable energy technologies

The Association of Southeast Asian Nations (ASEAN) aims to achieve an ambitious target: 23% of its total primary energy supply should come from renewable energy (RE) within the next five years. This objective holds significance as the region experiences rapid growth in renewable energy alongside the decline of traditional power generation. By 2020, renewable energy generation constituted 31.4% of total electricity generation in the region. However, meeting the 2025 regional target necessitates increasing generation capacity to 166 GW. In this context, China possesses the opportunity to assist ASEAN countries in reaching their renewable energy goals through collaborative projects and technology transfer. China boasts advanced technology and extensive experience in traditional power technology, new energy development, and power grid construction and operation. A noteworthy regional cooperation project is the China-ASEAN Clean Energy Capacity Building Project [18], initiated by China within the China-ASEAN mechanism. The plan aims to enhance clean energy capabilities. While specific technical details remain unclear, this initiative underscores China's proactive role in regional clean energy cooperation.

4.3. Equipment and raw materials

Upgrading systems and aligning them for grid connection poses significant challenges for all ASEAN countries, requiring technical expertise, robust infrastructure, and integration with the Internet of Things [19]. Despite solar power emerging as the fastest-growing renewable energy source in the region, ASEAN heavily relies on China for equipment manufacturing and raw materials, a dependency exacerbated since the recent outbreak. Shortages in materials and photovoltaic equipment in the ASEAN market have led to the suspension of solar panel projects [20]. Concurrently, China's solar panel manufacturers, including Longi, Jinko Solar, Trina Solar, JA Solar, and Risen Energy, jointly appealed for increased electricity flexibility from the central government's energy department on September 30, 2021 [21]. Despite a decline in China's solar panel production capacity due to ordered reductions in electricity consumption, the country persists in constructing a renewable energy power system, guided by long-term planning. A similar approach to long-term planning may also be instrumental in shaping ASEAN's power system. In major ASEAN countries, state-owned power companies, acting as the "sole buyer" in the power market, can propel power system development by collaborating with energy authorities to formulate enduring industrial development plans. China and ASEAN could build upon existing foundations, expanding energy cooperation from project construction to sharing transformation experiences to aid ASEAN in reshaping its power system centered on renewable energy.

4.4. Investment in renewable fields

A report indicates that the collective aim of all ASEAN nations is to achieve a renewable energy supply constituting 23% of their overall energy provision [22]. The Asian Development Bank approximates a requirement of \$290 billion for attaining this objective. The fiscal circumstances of participating ASEAN countries vary, making such an investment unattainable for every nation within the group. China presently holds the distinction of being the world's primary manufacturer of solar panels, wind turbines, batteries, and electric vehicles. Additionally, for nine of the past ten years, China has ranked as the globe's largest investor in clean energy, as per the Frankfurt School of Finance and Management. Greenpeace's latest research reveals that since 2014, Chinese equity investment alone has supported a cumulative 12,622 MW of wind and solar projects exclusively in South and Southeast Asia [23]. Furthermore, these green investments align significantly with Chinese President Xi Jinping's prominent Belt and Road Initiative due to substantial geostrategic implications. In support of renewable energy projects in Southeast Asia, China's major banks are obligated to furnish preferential loans, with specialized cash pools like the Silk Road Fund currently earmarking tens of billions of dollars [24].

5. Conclusion

The primary direct benefit of carbon neutrality is reflected in the stability of the global climate. By reducing greenhouse gas emissions, especially carbon dioxide, China not only mitigates global warming but also reduces the risk of climate-related natural disasters. In the process of implementing carbon neutrality policies, China has made remarkable achievements and positive contributions to the response to regional and global climate change. At the same time, air quality has improved significantly, with reduced levels of pollutants and particulate matter, especially in large cities, making cities more livable.

Carbon neutrality also promotes the development of a green economy, transforming economies and businesses, creating new jobs, and improving energy efficiency. Reducing reliance on fossil fuels and gradually increasing the use of renewable energy not only improves the country's economic security but also becomes a key driving force for restarting economic recovery in the later stages of the epidemic and creating new economic growth points. Although China faces many challenges in its pursuit of carbon neutrality, such as the pressure to transform traditional high-carbon industries that may lead to unemployment and social instability, the government should remain committed to its environmental policies and goals. China's leadership in the clean technology market provides huge opportunities for it to become a leader in the global green revolution.

Southeast Asia is one of the most dynamic regions in the global economy. In the ten years before the outbreak of the epidemic, the annual growth rate of per capita GDP remained above 3.5%, which was higher than that of the United States, Japan, and Europe. Although rapid growth has improved people's living standards, it has also brought serious environmental problems. Therefore, ASEAN countries such as Indonesia, Vietnam, and Thailand have made "carbon neutrality" commitments and introduced policies to promote low-carbon transformation. However, these countries still face challenges and lack adequate investment in renewable energy technologies, equipment, and raw materials. China's experience and cooperation can provide valuable inspiration and strategies for Southeast Asian countries. Carbon neutrality is not only an environmental goal, but should also be integrated with the country's economic and social development strategies, requiring long-term planning and investment from the government. In terms of renewable energy, Southeast Asian countries can alleviate their shortcomings through technical cooperation and trade, as well as increased investment in clean technology research and development and deployment. In the Asia-

Pacific region, Chinese investment is particularly important for promoting sustainable development. Southeast Asia and China have achieved certain results in achieving carbon neutrality, but there is still much room for improvement in future cooperation. All in all, carbon neutrality is not a simple task, but its long-term benefits far outweigh its short-term costs. Through collective efforts, China can have a profound impact on the environment, economy, and neighboring countries through carbon neutrality, and the country, businesses, and individuals can all benefit from a cleaner and more sustainable future.

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A Study on Energy Production and Consumption Based on Seasonal ARIMA and REAO

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Abstract: In the face of the global energy challenge, this study delves into the intricate landscape of energy dynamics within the rapidly evolving global economy and technological sphere. Recognizing energy as a pivotal driver of societal progress, we present a comprehensive evaluation and optimization model for China's energy sources, emphasizing economic, cost, electric energy, and environmental considerations. Employing time series models, specifically ARIMA and gray scale forecasting, we meticulously analyze wind and solar power generation, as well as overall power consumption. The results showcase nuclear power and hydropower as significant contributors to the energy landscape. Leveraging a linear programming model, we simulate and optimize the future energy development structure, considering constraints such as cost, energy, capacity, and carbon emissions. Our findings reveal the optimal quota contributions of thermal power, hydro power, nuclear power, wind power, and solar power as 13.7%, 14.2%, 17.6%, 54.5%, and 0%. Building upon these insights, we propose strategic recommendations for sustainable electric energy development. Emphasizing wind and solar energy's potential, we advocate for continued interest and increased support for technological advancements. Additionally, we call for the establishment of comprehensive power and energy development plans, integrating economic and environmental goals. To address imperfections in China's electricity tariff system, we recommend ongoing reforms aligned with market dynamics and environmental considerations.

Keywords: Electric Energy, Seasonal ARIMA model, Time Series, Analysis REAO model

1. Introduction

In the rapidly evolving global economy and technological landscape, the energy challenge is a universal concern. Energy is a fundamental driver of societal progress, and its absence would hinder development. With profound implications for all aspects of human life and production, energy is a linchpin for each country's political and economic security[1], directly influencing future development and survival.

As an important part of energy, electric energy plays a key role in every country and plays an irreplaceable role in ensuring industrial and agricultural production, military defense and people's livelihood. Therefore, we need to deeply understand the current situation of electricity consumption, and make a scientific prediction of power consumption, then explore the causes of power

consumption changes and finally take targeted scientific measures. Only in this way can we achieve the sustainable development of electric energy, which is of great significance to the sustainable development of the country and the economy.

In this paper, the available data is preprocessed by spss software, and appropriate methods are selected to fill in the missing values and deal with the outliers. Then, the processed data are used to forecast and analyze the power generation and total power consumption of different energy sources at different resolutions based on seasonal ARIMA model and grey prediction model. Finally, the evaluation system and optimization model of energy allocation strategy are established based on REAO model, and the policy recommendations are given according to the final conclusions.

To avoid complex descriptions and to visualize our work process, the flow chart is shown in Figure 1.

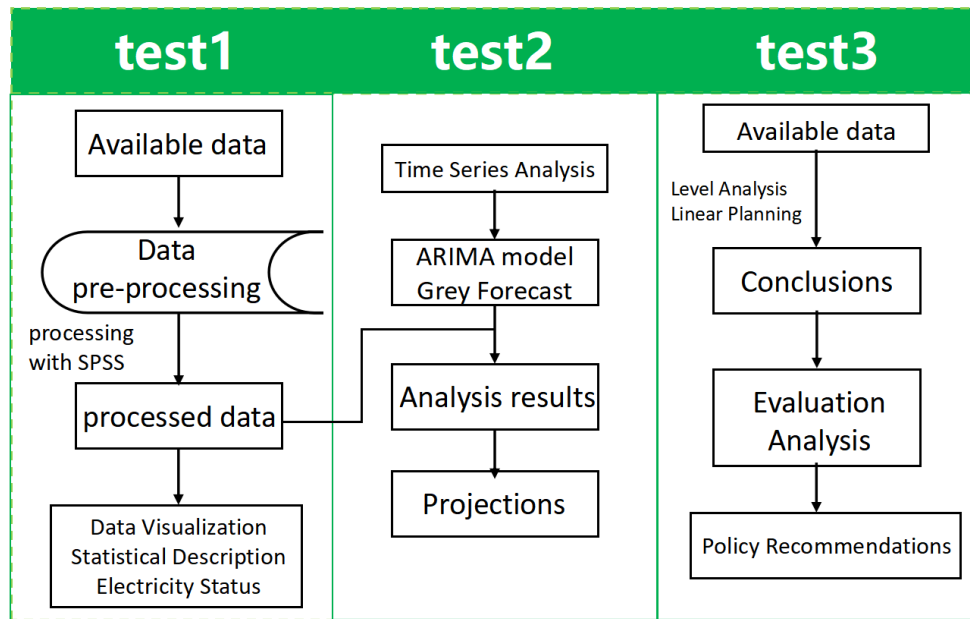


Figure 1: Workflow diagram.

2. Time Series Models

2.1. Data pre-processing

We utilize Coordinated Universal Time (UTC) as the standard and exclude European Union time. Additionally, we simplify the time format.

(1) Initially, columns with missing values exceeding 50% were eliminated. The abundance of missing data made reasonable filling impractical.

(2) Regarding the data columns "BE_wind_offshore_generation_actual," "BE_wind_onshore_generation_actual," and "BE_wind_generation_actual," wherein the total wind production electricity equals land wind production electricity plus offshore wind production electricity, a triadic relationship is established among these three columns.

(3) Data columns with minimal missing values underwent weighted average imputation based on the temporal proximity, utilizing both periodic and before-and-after weighted mean methods.

(4) Data columns with a higher prevalence of missing values were treated using the periodic and linear interpolation method to fill in values aligned with the overall trend.

(5) Addressing anomalous data, such as the "price_day_ahead" column with negative data column weights, necessitates correction. For other conspicuous anomalies, the regression interpolation method was applied.

2.2. Analysis Results Presentation

Based on the processed data, the mean values of the hourly, monthly and yearly data are calculated to analyze this question. The graph is shown below[2].

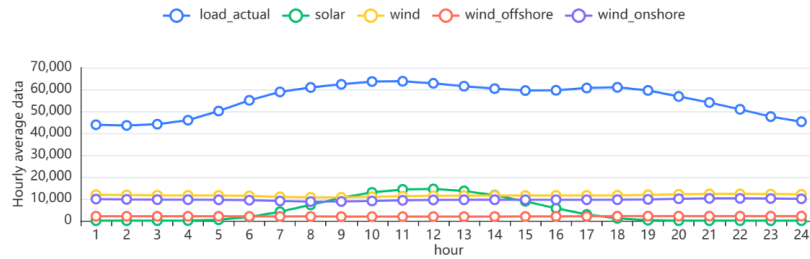


Figure 2: Hourly data averages.

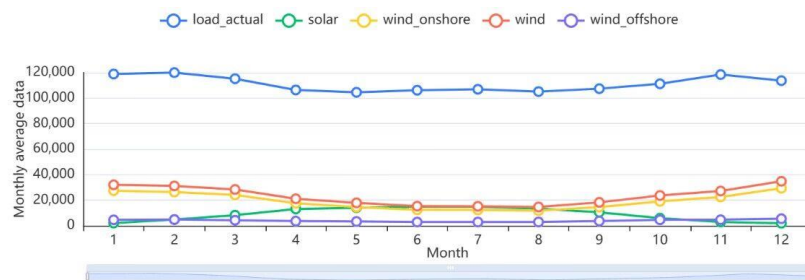


Figure 3: Daily data averages.

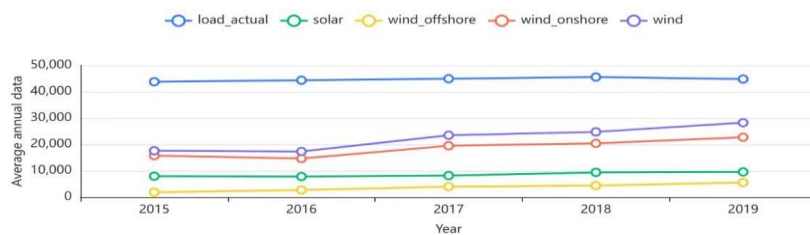


Figure 4: Average volume of data per year.

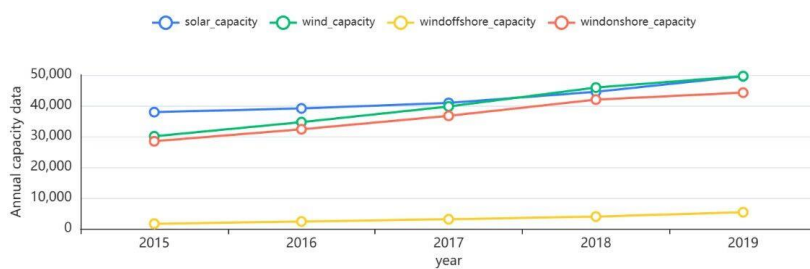


Figure 5: Average amount of capacity per year.

Regarding the average value of each year's data, the 2020 data was discarded because it only goes up to September and the size of the data will change with the month, which will result in errors in calculating the average value.

2.3. Analyzing Time Series Models for Energy Consumption

We primarily employ time series analysis, utilizing the ARIMA model[3] and gray scale forecasting, to address the issue at hand.

In the context of wind power generation time series, we decompose the data into trend, seasonal, and stochastic components to preliminarily ascertain the seasonal effects. The significance p-value is 0.000***, indicating significance at the specified level and leading to the rejection of the original hypothesis that the series is a smooth time series.

For the variable wind_generation_actual, analysis of the residual Q statistic yields the following insights: Q6 lacks significance at the specified level, indicating that the hypothesis of residuals conforming to a white noise series cannot be rejected, and the model generally meets the requirements. However, the goodness-of-fit R^2 of the model is 0.414, signifying suboptimal performance.

The ensuing figure depicts the raw data plot, model-fitted values, and model-predicted values for this time series model.

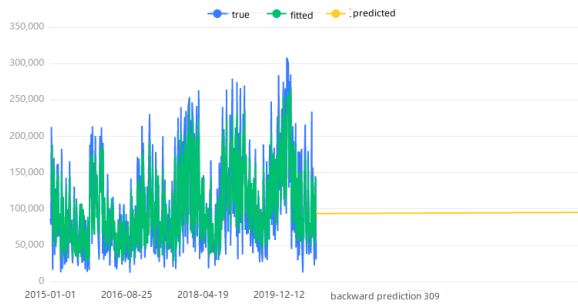


Figure 6: Time series chart of wind energy generation.

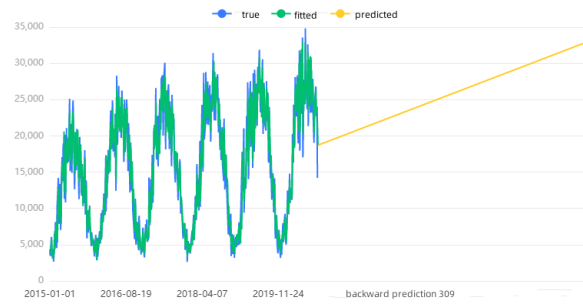


Figure 7: Time series chart of wind energy generation.

For the solar power time series, the analytical approach aligns with the previous subsection. Focusing on the variable solar_generation_actual, the Q statistic analysis reveals that Q6 lacks significance at the specified level. The hypothesis that the residuals of the model conform to a white noise series cannot be rejected. Additionally, the model's goodness of fit, R^2 , stands at 0.935, signifying excellent performance and general adherence to requirements.

In the context of solar_generation_actual, the system automatically determines optimal parameters through the AIC information criterion. The resulting ARIMA model (1,1,2)[4] is applied to 1-differenced data, yielding the following model equation

$$y(t) = 6.754 + 0.445y(t-1) - 0.649\varepsilon(t-1) - 0.157\varepsilon(t-2) \quad (1)$$

For the power consumption time series, the system automatically identifies optimal parameters using the AIC information criterion. The resulting ARIMA model (2,1,1) is applied to the variable load_actual_entsoe_transparency. The analysis of the Q statistic reveals that Q6 lacks significance at the specified level, and the hypothesis that the residuals conform to a white noise series cannot be rejected. The model's goodness-of-fit, R^2 , stands at 0.735, indicating satisfactory performance that essentially meets the requirements.

The ensuing figure illustrates the raw data plot, model-fitted values, and model-predicted values for this time series model.



Figure 8: Electricity consumption time series chart.



Figure 9: Time series chart of wind energy generation.

For wind power generation time series, the same ARIMA model was used. The analysis reveals a stable time series for wind power with a suboptimal model performance ($R^2 = 0.401$). Conversely, solar power exhibits a smooth time series with a well-performing model ($R^2 = 0.918$). Visualizations depict the original data, model fitted values, and predictions for each respective time series.

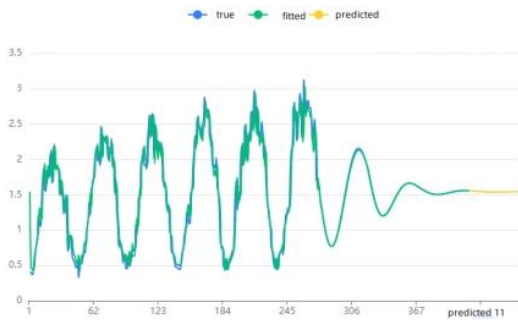


Figure 10: Time series graph of solar power.

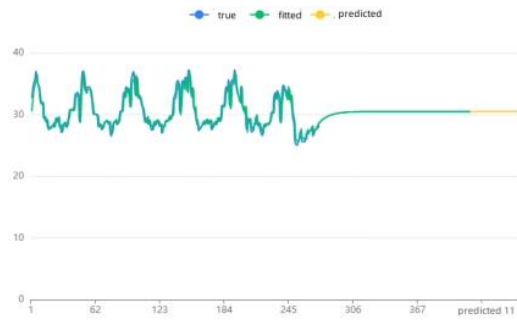


Figure 11: Electricity consumption time series chart.

The power consumption time series exhibits a smooth pattern with a well-performing model ($R^2 = 0.831$), while the wind power generation time series displays a smooth pattern with suboptimal model performance ($R^2 = 0.414$). Visualizations depict the original data, model fitted values, and predictions for each respective time series.

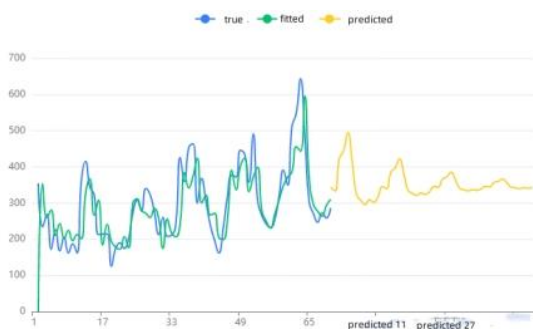


Figure 12: Time series chart of wind energy generation.

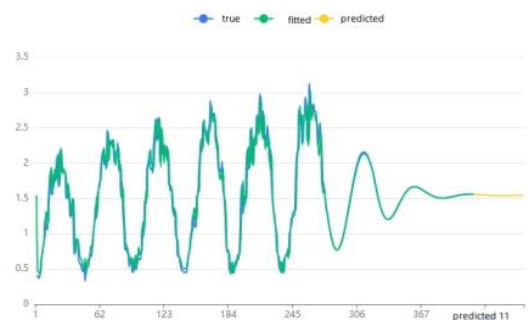


Figure 13: Time series graph of solar power.

The solar power time series exhibits a smooth pattern, but the model's performance is suboptimal with an R^2 of 0.496. In contrast, the power consumption time series also demonstrates a smooth pattern, but the model performs poorly, with an unusually high R^2 of 2.115. Visualizations depict the original data, model fitted values, and predictions for each respective time series.

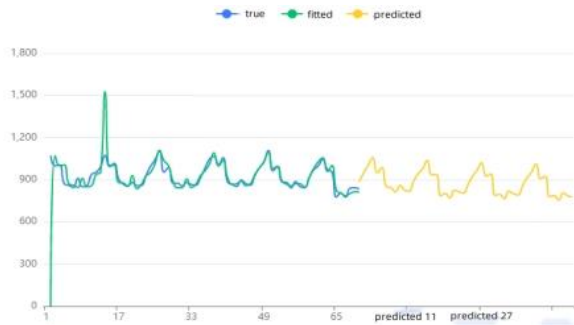


Figure 14: Electricity consumption time series chart.



Figure 15: Fitted prediction graph of gray prediction model.

For wind power generation, the application of the gray prediction GM (1, 1) model proves effective in handling limited annual data, yielding a qualified model with a posterior difference ratio of 0.516 and an average relative error of 8.823%. Similarly, for solar power and power consumption time series, the same model exhibits high accuracy with posterior difference ratios of 0.246 and 0.623, and average relative errors of 3.607% and 0.33%, respectively. Visualizations depict the fitted prediction graphs for each time series.

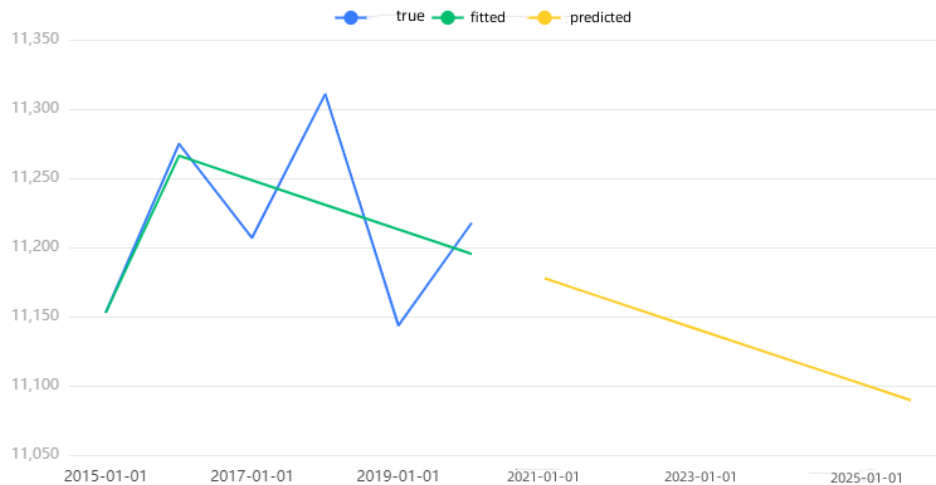


Figure 16: Fitted prediction graph of gray prediction model.

3. Strategic Evaluation and Optimization Framework for Renewable Energy Allocation

Firstly, based on the hierarchical analysis (AHP)[5], a comprehensive evaluation module is built to set core indicators from four aspects: electric energy, economy, environment, and cost, and start to subdivide them level by level to establish a hierarchical structure and generate a judgment matrix with affiliation scale. Second, based on the comprehensive evaluation results and linear programming model, the optimization module is constructed to optimize the allocation of quota weights for development. The structure diagram is shown below.

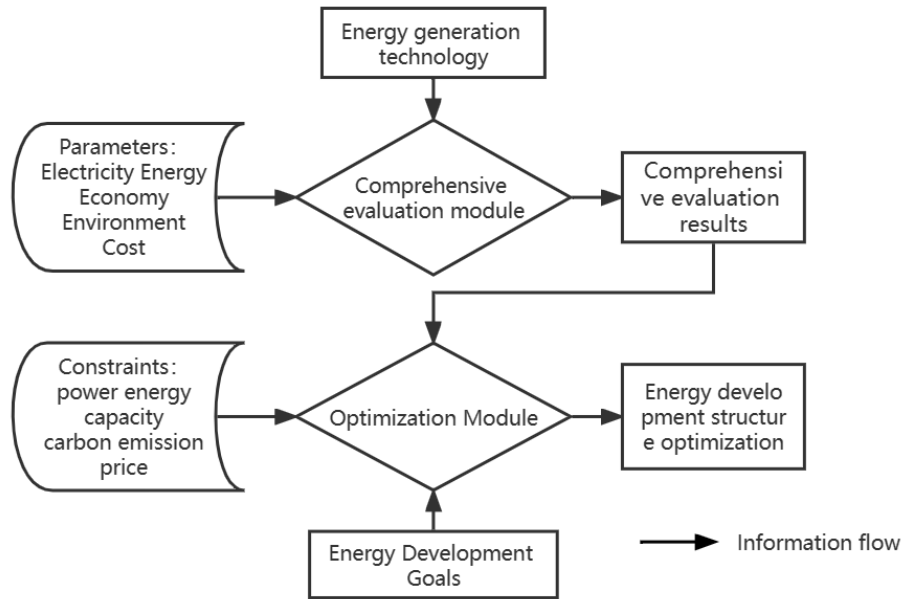


Figure 17: REAO Model Framework.

We establish a systematic link among influencing factors, categorizing indicators into quantitative and qualitative aspects. Thermal power, hydropower, nuclear power, wind power, and solar power generation serve as evaluation objects. Indicators, including actual electricity generation, economic considerations based on energy reserves and distribution characteristics, environmental impact metrics like carbon emissions, and cost indicators, are analyzed using a qualitative and quantitative approach. Data standardization employs the efficacy coefficient method to reflect the relative merits of each indicator in the series.

We take the maximization of the combined evaluation score portfolio as the objective function, and add four constraints of electric energy, capacity, carbon emission and price to maximize the combined benefits of the renewable energy portfolio to establish a linear programming portfolio.

The following table shows the judgment matrix constructed.

Table 1: Weight judgment matrix.

Indicators	power energy	economy	environment	cost
power energy	1	5/4	3/4	4/3
economy	4/5	1	2/3	4/5
environment	4/3	3/2	1	3/2
cost	3/4	5/4	2/3	1

The weight calculation result of hierarchical analysis showed that the weight of power energy was 25.975%, the weight of economy was 19.854%, the weight of environment was 32.33%, and the weight of cost was 21.842%. Moreover, the maximum characteristic root is 4.011, and the corresponding RI value is 0.882 according to the RI table, so $CR=CI/RI=0.004<0.1$, which passes the one-time test.

The index assignment, data standardization and comprehensive evaluation results are shown in the following table. It can be seen that, considering the four dimensions of electricity, economy, cost, and environment, the five energy utilization indices are, from highest to lowest, nuclear power, hydro

power, solar power, wind power, and thermal power. This is consistent with the results of relevant studies done by the Chinese Academy of Sciences and the National Development and Reform Commission (hydropower is first, wind is second), but slightly different from the results of international studies (wind is more sustainable than hydropower), the reason being that China's nuclear and hydropower development time and cost and technology maturity advantages are much higher than other energy sources, given the small difference in resource endowment and environmental impact.

Table 2: Comprehensive index assignment.

Energy	Electricity Generation (billion kilowatts)	Reserves (qualitative)	Distribution Characteristic (qualitative)	Carbon emission (g/kwh)	Power generation Cost (yuan/kwh)
Thermal Power	28200	3	7	975.3	0.29
Utilities	4826	7	5	25.707	0.1
Nuclear Power	1950	7	6	11.9	0.22
Wind Power	2819	8	7	13.53	0.34
Solar Power	858	9	10	62.5086	0.44

Table 3: Comprehensive evaluation results.

Energy	Electricity	Economy	Environment	Cost	Overall Score
Thermal Power	10	4.2	6	7.76471	7.0670
Utilities	6.5805	6.4	9.94267	10	8.5432
Nuclear Power	6.59754	6.7	10	8.58824	8.6253
Wind Power	6.86885	7.7	9.99323	7.1764	8.1321
Solar Power	6	9.3	9.78988	6	8.2882
Weights	0.2598	0.1985	0.3233	0.2184	

The evaluation module gives comprehensive evaluation results based on a series of core indicators, but in actual policy formulation, it is necessary not only to optimize various energy development structures under the premise of meeting the energy demand for sustainable economic development, but also to consider a series of objective constraints faced in actual energy development. In this section, based on the evaluation, the optimization module is further applied to optimize the development scenarios of different energy sources.

Specific constraints explained:

- (1) The weight of each energy source is greater than or equal to 0.
- (2) The sum of the weights of the five energy sources is equal to 1.
- (3) Cost constraint: the development of energy sources must bring cost improvement, and the future average cost of optimized energy sources is less than or equal to the existing average cost.
- (4) Carbon emission constraint: make the future total energy CO₂ emissions above the average level of the current 5 energy sources CO₂ emissions.
- (5) Economic constraint: the future economic development of the optimized energy source is above the average level of the current economic development of the five energy sources.
- (6) Electric energy constraint: the electric energy production of the optimized energy source is above the average level of the electric energy production of the current five energy sources.

Substituting the data, the following system of equations is obtained:

$$\begin{aligned} \max z &= 7.067 \times X_1 + 8.5432 \times X_2 + 8.6253 \times X_3 + 8.1321 \times X_4 + 8.2883 \times X_5 \\ \text{s.t.} &\begin{cases} X_1 + X_2 + X_3 + X_4 + X_5 = 1 \\ X_1 > 0; X_2 > 0; X_3 > 0; X_4 > 0; X_5 > 0 \\ 10X_1 + 6.58X_2 + 6.598X_3 + 6.869X_4 + 6X_5 \geq 7.209 \\ 4.2X_1 + 6.4X_2 + 6.7X_3 + 7.7X_4 + 9.3X_5 \geq 6.86 \\ 6X_1 + 9.943X_2 + 10X_3 + 9.993X_4 + 9.79X_5 \geq 9.145 \\ 7.765X_1 + 10X_2 + 8.588X_3 + 7.176X_4 + 6X_5 \geq 7.906 \end{cases} \end{aligned} \quad (2)$$

z denotes the objective function to optimize the comprehensive evaluation score, $X_1 \sim X_5$ denote the energy share of thermal, hydro, nuclear, wind and solar power respectively.

The optimal weights for the five renewable energy sources can be obtained by solving the linear programming as shown in the table below.

Table 4: Weighting ratio optimization results.

Parameters	Solve for the value
z (Target value)	8.132
X_1 (Thermal power)	0.137
X_2 (Hydropower)	0.142
X_3 (Nuclear Power)	0.176
X_4 (Wind Power)	0.545
X_5 (Solar Power)	0

4. Conclusions and Recommendations

We have developed a comprehensive model for evaluating and optimizing the structure of China's energy sources. This model encompasses four key dimensions: economic, cost, electric energy, and environmental considerations. We have analyzed the current status of each evaluation criterion and systematically assessed the five major energy sources. The findings indicate that both nuclear power and hydropower rank highly. Utilizing the evaluation results, we applied a linear programming model to simulate and optimize the future energy development structure. This optimization considered constraints related to cost, energy, capacity, and carbon emissions. The results reveal that thermal power, hydro power, nuclear power, wind power, and solar power contribute 13.7%, 14.2%, 17.6%, 54.5%, and 0% of the quota, respectively.

Drawing on the comprehensive evaluation and optimization outcomes, we propose the following recommendations for promoting sustainable electric energy development:

(1) **Harnessing Wind and Solar Energy:** Wind and solar energy exhibit significant development potential. We advocate for a sustained interest analysis, emphasizing the vigorous development of wind energy. Furthermore, enhancing the conversion efficiency of solar energy through increased support for technological research and development within the solar industry is crucial. To foster a more extensive domestic market in China, it is imperative to establish clear resource development goals and implement initiatives supporting the solar energy industry.

(2) **Establishment of Power and Energy Development Plans:** The Chinese government should formulate overarching sustainable development goals that integrate economic and environmental planning. Collaborating with various departments, the power industry, and the public, the government should set binding targets for power energy development. Implementing comprehensive

measurement, supervision, and assessment measures is essential. Government departments at all levels should establish an information-sharing platform to monitor power companies' real-time carbon emissions and conduct regular assessments.

(3) Reform of the Electricity Tariff System: China's electricity tariff mechanism, particularly in the pricing of new energy tariffs, is imperfect. The government should persist in deepening the reform of the electricity tariff system to establish a rational mechanism that aligns with market supply and demand while considering resource and environmental costs.

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Data Visualization of Bike Store Sales in Europe

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Abstract: This paper presents a comprehensive analysis of bike sales and customer demographics in Europe based on a dataset obtained from Kaggle.com. The dataset covers the period from 2011 to 2016 and includes information on customer age, gender, product categories, order quantities, unit costs, unit prices, profit, and revenue. The analysis utilizes data visualization techniques to identify key trends, including the top-selling products, customer purchasing power across different age groups and customer genders, and product profit margins. The findings suggest opportunities for retailers to target specific customer segments and product categories to maximize profits. Additionally, the report highlights the growing popularity of cycling as a sport and a healthy lifestyle choice, indicating a potential for increased demand in the bike retail market. Overall, the insights provided in this report aim to assist retailer chains in developing effective strategies to capitalize on the opportunities presented by the European bike sales market.

Keywords: Bike sales, Data visualization, Customer

1. Introduction

The target audience of this paper is retailer chains in bikes and relating accessories.

The dataset is derived from Kaggle.com [1]. The name of dataset is “Bike sales in Europe”. The author was SADIQ SHAH, and the upload date was 2020. The dataset has 18 columns, including date, day, month, year, customer age, age group, customer gender, country, state, product category, subcategory, product, order quantity, unit cost, unit price, profit, cost, and revenue. The data ranges from 2011 to 2016. With a total of 113k customers’ information.

Bike riding has become a popular sport, both for leisure audiences and athletics. It features a healthy lifestyle, as riding can boost cardiovascular health. It is a form of aerobic exercise [2]. Also, riding is a way to improve environment [3]. With choosing riding whether for going to work or for a rest, it would not generate carbon dioxide. Goodman et al.’s [4] study found that more cycling infrastructures are helpful to promote physical activity. In recent years, with the development of modern industry, better technology has been applied on bikes, and make bikes cheaper and more comfortable to use [5]. These reasons can attract more customers to begin cycling. In brief, it contributes to a good chance to gain more profit for retailer chains in bikes and relating accessories. Moreover, Sælensminde’s study supported this opinion as the benefits of investments in cycle networks were estimated to be at least 4 to 5 times the costs [6]. Also, it is worthy to mention that men are more likely to enjoy cycling, meaning that more men can be involved in buying commodities relating to bikes [7].

Before the visualization starts, two things need to be mentioned. One is the categorization of age groups. The other is the profit margin that I calculated based on the dataset. The author of this dataset categorized age groups by four: youth (age under 25 years old), young adults (age between 25 and 34 years old), adults (age between 35 and 64 years old), seniors (age above 64 years old). For profit margin, it is calculated that dividing profit by cost.

As this paper aims at finding some methods that help retailers to gain more profits, four questions were made: What products are bought relatively more often by customers? Which customer group has the most purchasing power? Which product has the most profit margins? Will gender be a factor when designing products? These will be discussed in the following part.

2. Data visualization and analysis

What products are bought relatively more often by customers?

For the time period included in our dataset, the top five most popular products are tires and tubes, bottles and cages, helmets, jerseys and caps.

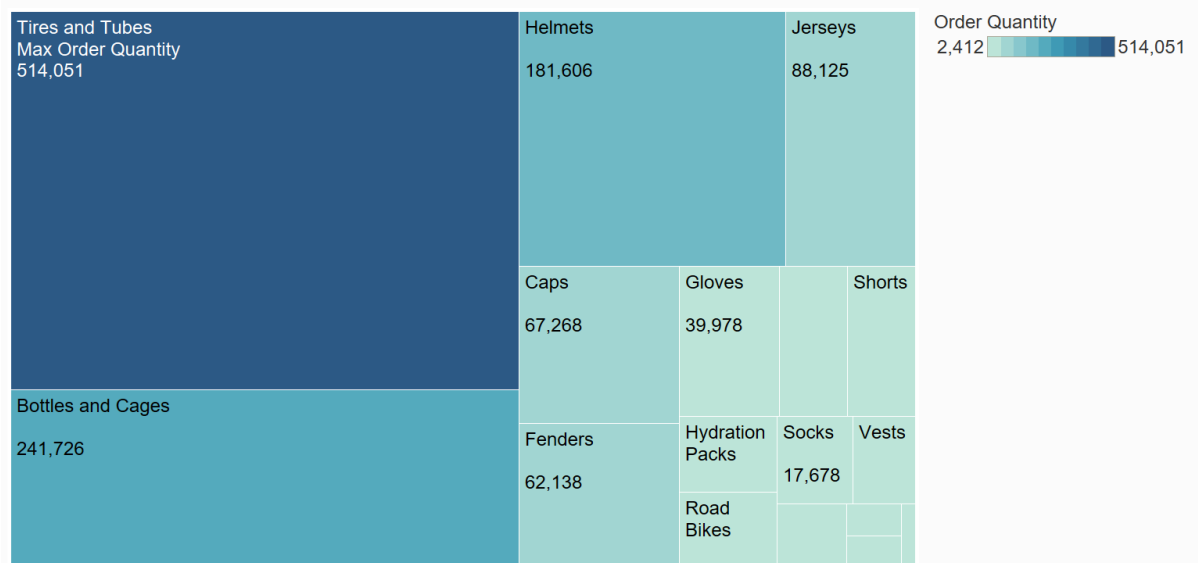


Figure 1: The Heatmap showing the purchasing numbers by customers.

The order quantities of each product by customers were examined across all the timelines including in the dataset. The results are shown in figure 1, and a heatmap was used to display the relationship between order quantities and products. The darker the colour and the larger the space is, meaning that that products were bought more by customers. From this figure, the top five best sellers are concluded: tires and tubes, bottles and cages, helmets, jerseys, and caps. To generalise the common features of these best sellers, they are essential to a rider, and to highlight, tires and tubes are consumables compared to other four commodities. This means that tires and tubes need to be replaced periodically, and this can be the reason that it is preferred by riders most.

Which customer group has the most purchasing power?

For the time period included in our dataset, the adults group (aged from 35 to 64) contributed the most costs. However, regardless of the extreme low costs by seniors (aged 64+), their average costs were not as low as expected from total costs. Regarding to average costs, it seems that young adults (aged from 25 to 34) have the most purchasing power.

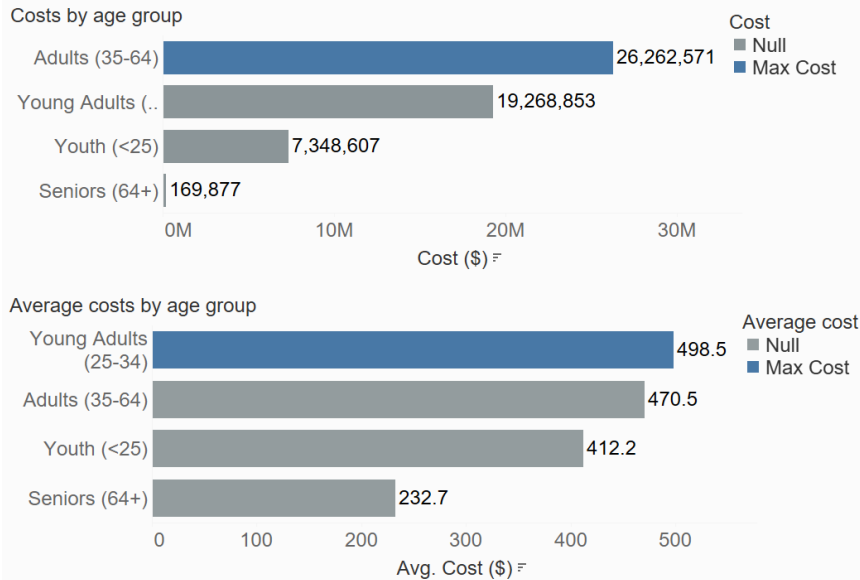


Figure 2: Tow bar figures showing costs and average costs by age groups

The horizontal bar figure listed the costs by age group to compare the purchasing power of different age groups. From the figure in the upper part of figure 2, it is known that adults contributed the most in bike and relating accessories sales. However, considering that the number of each age group customers may differ, the average costs by age group was compared in the lower figure. In this figure, young adults were more likely to spend more than adults in average. Also, senior customers spent not as little as the total cost showed. The number of customers from each age group did influence the total cost of them. Young adults are the age group has the most average payment costs, but the large number of adult customers contributed to the most costs.

Which product has the most profit margins?

For the time period included in our dataset, socks has the most profit margins (172.5%). Also, it is worthy to note that helmets, tires and tubes and bottles and cages (among the top five best sellers) have good profit margins.

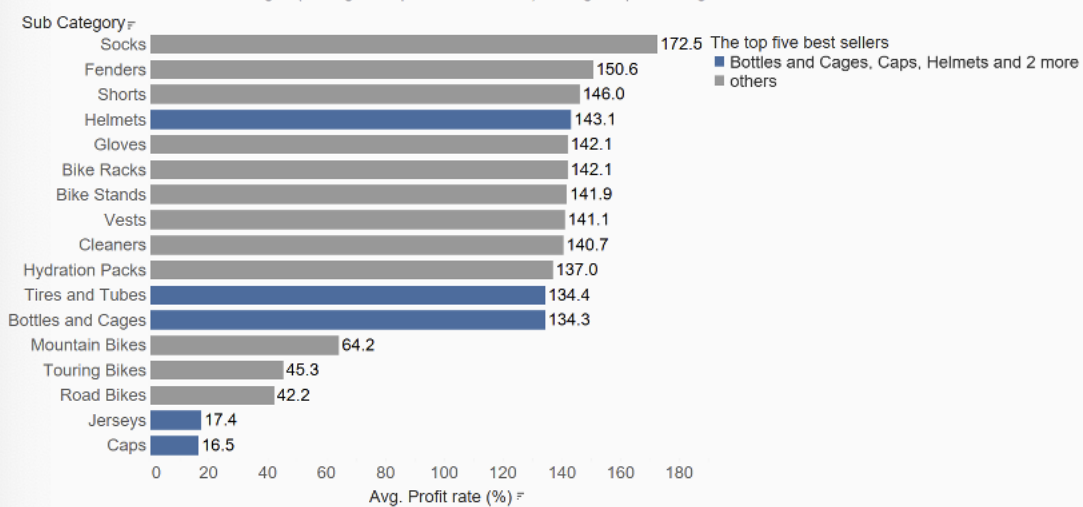


Figure 3: The bar figure showing the profit margins by subcategories

The third step, checking which products have higher profit margins would be useful to integrate with order quantities. The figure results are shown in figure 3, and the year range is all the timeline in dataset. The top five best sellers that were generalized in figure 1 are highlighted here in this figure. It can be concluded that helmets, tires and tubes, bottles and cages feature with both high popularity and profit margins. As high profit margins with high demands can make the most profits, the final products that are most worthy to work on have been recognized.

Which gender prefers to pay more on bikes, clothes or accessories?

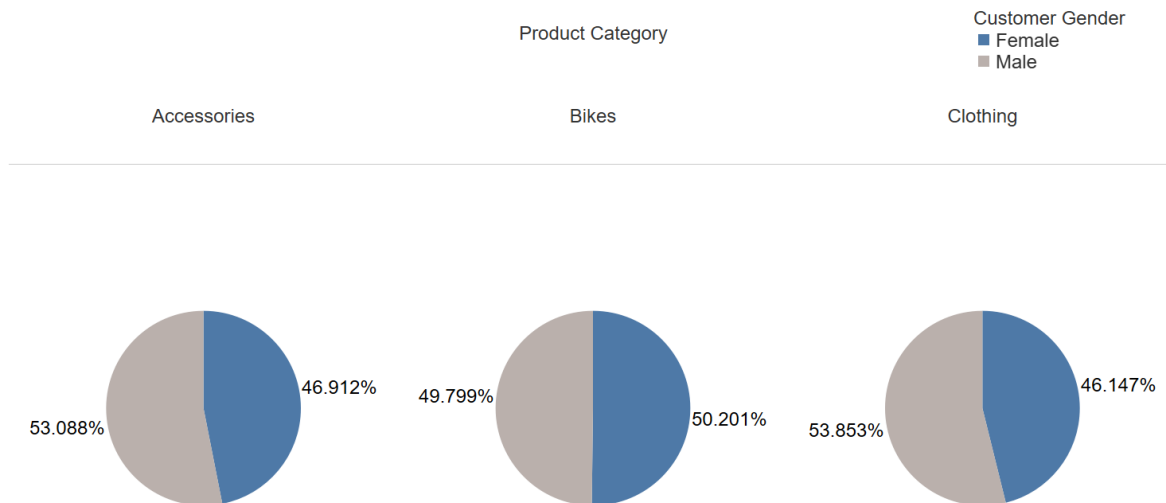


Figure 4: The pie chart showing the percentage of customer gender in buying bike relating commodities.

Finally, the distribution of customers involved in buying bike relating commodities are shown in figure 4. The results are found similar to the phenomenon that was mentioned in the introduction. Male customers were more likely to pay more on accessories and clothing than female customers, while their costs in bikes were almost the same. These data support what Heesch et al. [7] found. It can be argued that designing products that men would like can be more profitable.

3. Conclusion

From the whole four figures, among the top five best sellers, helmets, tires and tubes, bottles and cages have relatively high profit margins. Combining the information generalized from figure 2, among the whole age groups, young adults tend to spend most on bike relating products. Adults, feature in large number of customers, and resulting in the most costs in bike relating products. Also, male customers have more purchasing power than female customers. The conclusion would be making helmets, tires and tubes, bottles and cages that attract young adults and adults can be a feasible way to make more profits. In addition, combining more elements that men would like in accessories and clothing can be a sensible choice.

There leave some problems to think about. One is that the dataset only has bike sale information (without accessory ones) in 2011 and 2012. This means that it can affect the total calculation of figure display. Also, in 2014 and 2016, only 7 months' data were collected, this makes it impossible to check data across years by month. Another one is the definition of age groups. Over time, those who were in the prior age groups, can get older to a superior age group. This can be misleading when showing them in a multi-year figure. For the gender difference in consuming, it is also worth noting that

women may not spend as much as men do, doing some design and products especially for female customers also has potential.

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Sustainable Smart Cities Planning in Conjunction with Environment Governance

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Abstract: In the present age, many issues have been brought to the forefront with the development of cities, hence the concept of sustainable smart cities has been introduced. Based on the methodology of big data analytics and related technologies, this paper gives the planning for sustainable smart cities from several perspectives. Starting from the analysis of urban industries and architecture, this paper analyses the distribution of urban population, presents and analyses the use of renewable energy sources in cities and the use of advanced traffic systems through several successful cases, and introduces the application of internet technology at the end. Many perspectives in this paper start with examples from real cities, thus giving evaluations as well as suggestions for optimisation. The analyses of smart cities throughout the text also deal with environmental governance, aiming to make the topic of sustainable development realisable, so that the economy and environment of the smart cities in the future can be mutually reinforcing.

Keywords: Smart city, Sustainability, Environment governance

1. Introduction

In the rapid urbanisation process of today's society, some irrational planning has led to social problems and environmental pollution has become increasingly prominent. In such circumstances, the shift from traditional urban development models to sustainable smart cities has become a significant research issue, which has a process that includes the upgrading of industrial structures, the upgrading of urban planning, and the use of cleaner energy sources to promote more efficient economic development and environmental improvement, and this is the purpose of the study for which this paper is written. This paper analyses the spatial data of the city in several dimensions in order to derive the characteristics of the distribution of the data in different regions of the city. It covers a wide range of data on the city's industries, architecture, population, energy and environment, traffic and introduces the use of new Internet technologies. By collecting and analysing the data, it identifies the problems in these areas, and purposes targeted enhancement programmes, the monitoring of real-time data can help to identify shortcomings in the programme, so that it can be optimised continually. Thus to find practical development planning for sustainable smart cities in modern society, which can create a suitable living environment for urban citizens, balance environmental protection and urban development at the same time.

2. Urban industries, architecture analysis and environmental management

Cities are the gathering place for all kinds of production and life of human beings, and the planning of land use in each functional area of the city plays a vital role in the development of the city. However, due to the overdevelopment of contemporary cities and the irrational planning of industries, the environmental pollution brought about by urbanisation has become more and more prominent, and one of the major serious problems is air pollution, under these circumstances, the rational planning of urban construction and green space has become an important research object. EBM-DEA model, ArcGIS spatial analysis and the spatial Durbin model with different weight matrices can be used to investigate the evolution pattern of green efficiency of urban construction land and the spatial effects of industrial agglomeration and environmental regulations on it.

For the urban development, architecture is fundamental to all aspects. However, buildings can consume large amounts of resources and emit large amounts of pollutants during their construction and use phases, so how to reduce the resources consumed by buildings and their impact on the environment has become an important research issue nowadays. By using the Building Environmental Performance Assessment System BEPAS, the environmental impacts of buildings can be studied in terms of building materials, energy and water consumption during the use of the building, and building appurtenances. Calculations on 62 samples in Beijing show that in the materialisation phase, the environmental impact of high-rise buildings is higher than that of low-rise buildings, while the difference between residential and office buildings in terms of environmental impact is not significant. In the use phase, office buildings have significantly higher environmental impact values than residential buildings, and buildings with lifts also have a greater environmental impact. The use phase of a building's entire life cycle has the greatest environmental impact, accounting for more than 85% of the total, the vast majority of which is attributable to the consumption of electrical energy [1]. Therefore, in the process of urban building planning, it is necessary to plan the distribution of office buildings and residential buildings rationally, as well as the distribution of high-rise buildings and low-rise buildings, to control the ratios of office buildings and high-rise buildings, and promote green buildings, so that reduce the consumption of traditional energy resources by buildings by renewable energy sources. Such a planning scheme can achieve environmental protection, and reduce the emission of pollutants and greenhouse gases while ensuring economic benefits, which can mitigate global warming and achieve the concept of sustainable development.

In addition, the digital twin model, as an advanced tool for smart city planning, provides a platform for experimentation and prediction for urban decision-makers. By establishing a digital twin model of the city and utilising virtual simulation technology to test the effects of different planning scenarios, it offers a scientific basis for future urban development. The digital twin model is capable of simulating various aspects of the city, including buildings, infrastructure, the environment, and population movements. The establishment of the digital twin model relies on the input of a substantial amount of actual urban data.

Currently, Singapore serves as a typical case where the digital twin model has been successfully applied. Through digital twin technology, the city has established a virtual city model that can simulate changes and developments in real-time. For example, planners can predict the impact of new infrastructure construction on traffic, energy, and the environment through the model, optimising planning scenarios. The digital twin model has become a core tool in Singapore's urban planning, providing a scientific basis for sustainable development. By implementing smart energy management systems and establishing digital twin models, cities can understand and address energy challenges better, while scientifically planning the future development of the city [2]. Digital twin models offer various advantages in urban environmental management. Firstly, they enable precise environmental monitoring, providing high-resolution environmental data such as air quality, noise, and water quality

to identify and address environmental issues promptly. Secondly, they facilitate more accurate sustainable development planning by simulating the impact of different planning decisions on the environment. Digital twin models assist city planners in formulating sustainable development strategies to minimise adverse environmental impacts. Thirdly, they enhance emergency response and management capabilities by providing disaster simulations and emergency response plans, strengthening a city's ability to manage emergencies such as fires, earthquakes, and floods [3]. Fourthly, they optimise resource utilisation more effectively by optimising data related to energy, water resources, and transportation, helping to reduce resource consumption, improve resource efficiency, and promote environmental sustainability.

It is noteworthy that digital twin models also pose four technical challenges in smart city planning, namely, data integration and quality, model complexity and computational resource requirements, real-time updates and synchronisation, and privacy and security. Firstly, due to the specificity of each city's situation, acquiring high-quality real-time data from various aspects of the city and integrating information from different data sources to construct accurate and comprehensive digital twin models is currently challenging. This issue is difficult to address as various departments control and coordinate different data sources in a city, making it challenging to grant developers full access. Additionally, disparities in the format, standards, and update frequencies of different data sources can lead to inconsistent data quality, potentially reducing model accuracy [4]. Secondly, creating detailed and comprehensive digital twin-city models requires substantial computational resources, including high-performance computing and storage capabilities. This poses a significant challenge for some developing countries or underdeveloped regions, limiting the quality of their models. Furthermore, maintaining real-time and detailed accuracy on a large scale within a city imposes high demands on computational capabilities, potentially constrained by hardware and cost limitations. Full coordination and support from decision-makers are necessary in the economic aspect, making widespread implementation challenging for every city [5]. Thirdly, cities are dynamic, requiring real-time updates to digital twin models while ensuring synchronisation among different components to reflect the actual urban state. Synchronising digital twin models with the real city poses challenges in rapidly updating real-time data and dynamically adjusting models. Fourthly, integrating privacy protection measures into digital twin models to balance the conflict between data sharing and individual privacy is a complex and crucial issue [6]. Therefore, ensuring the privacy and security of data is essential when obtaining information about the behaviour and lifestyle of urban citizens to prevent misuse and violation of personal privacy.

3. Analysis of urban population

The development of a city is always centred on people, so it is necessary to study the distribution of a city's population. In the course of the study, by using geo-detectors and applying geographically weighted regressions combined with demographic data provided by various parties, the spatial distribution of a city's population can be obtained. In Nanjing, China, for example, distance from the city centre is negatively correlated with the spatial distribution of the population, while the number of jobs, the mix of land use and the average house price is positively correlated with the spatial distribution of the population. However, when this aspect of distance from the city centre is examined in more detail, it is found that within a certain distance from the city centre, the residential population increases as the distance to the city centre increases, the major part of the reason for this is that housing prices in the city centre are so high that many people are willing to accept commuting further than is reasonable to reduce the cost of living [7]. This case demonstrates the need to take measures to keep housing prices within a reasonable range during urban development, and it will lead to a more rational distribution of population across the city.

The production and living of urban residents generates a large amount of waste, which puts a great deal of pressure on the environment and needs to be disposed of properly. The time series cluster analysis by the K-mean algorithm can get the change of domestic waste removal volume over time in different cities in China, and it can be found that the domestic waste removal volume in most of the cities is increasing. Using the random forest regression model, the Mean Square Error MSE can be calculated based on the values obtained, and the factors with a large increase in MSE have a greater impact on the regression results, and hence are more significant for the model. It can be found that the built-up area and the number of people in the urban area have a high degree of influence on the amount of domestic waste transported in the urban area, while the influence of the factors might be different with the changes in the region [8].

Taking a comprehensive look at the distribution of the urban population and the corresponding amount of domestic waste can derive some inspiration for urban upgrading. In the construction of smart cities, it is necessary to plan the number of people expected to be accommodated in each area rationally, for example, keep a certain proportion of high-rise buildings and low-rise buildings in urban areas, reduce the density of buildings and ensure that low-rise buildings are the mainstay in suburban areas, while planning adequate parks in any area. It is also important to ensure that infrastructure is in place and that roads and undergrounds are built to shorten commuting times so that housing prices in different parts of the city are kept within reasonable limits. In this process, it is necessary to control the size of the built-up area, planning a certain area of green space as a buffer zone, so that the amount of rubbish in the area will not be too large to maintain the carrying capacity of the environment. Such planning can make the population density of the city more reasonable and liveable, thus promoting the improvement of the living standard of urban residents.

4. Urban energy and traffic management

Under the framework of building a smart city and against the backdrop of acquiring dynamic population information, the implementation of a smart energy management system is a crucial component to ensure the sustainable development of cities. Through the monitoring of urban energy consumption using population data models, particular attention is given to electricity, water resources, and renewable energy [9]. Leveraging smart energy systems, cities can monitor and analyse energy consumption in real-time, enabling more effective energy allocation, enhancing energy utilisation efficiency, and mitigating environmental burdens.

Currently, the smart energy management system, based on real-time monitoring of population data, has achieved standardisation in the realm of intelligent transportation. It optimises energy utilisation by comprehensively controlling urban traffic conditions. The key practices and methods of this system can be categorised into four main components: data sourcing and integration, real-time mobility monitoring, traffic signal optimisation and congestion prediction and route planning. The system relies on diverse data sources, including mobile devices, traffic cameras, and geomagnetic sensors, to capture real-time data on population movements and traffic conditions [9]. By establishing a standardised data integration platform, information from various sources is consolidated into a comprehensive urban traffic database. Advanced big data analytics techniques are employed to monitor the real-time movement of people within the city. Utilising location data from mobile devices and real-time images captured by traffic cameras, the system generates population density heat maps and real-time traffic flow diagrams. This information provides city managers with immediate insights into the current traffic conditions. The system leverages big data analytics results to intelligently adjust the traffic signal control systems at intersections. By analysing historical traffic data and real-time mobility information, the timing of traffic signals is dynamically adjusted to accommodate fluctuations in different time periods and traffic volumes. This real-time optimisation contributes to alleviating traffic congestion and improving intersection efficiency. Big data analysis is also applied

to predict the likelihood of traffic congestion. Combining historical data with real-time information, the system can proactively identify potential congestion areas and provide warnings to drivers and city traffic managers. Additionally, intelligent route planning services based on real-time data assist drivers in selecting the optimal routes, reducing travel time [10].

These integrated practices and methods underscore the capability of the system to enhance urban mobility by providing accurate, real-time information and implementing data-driven strategies for traffic management. A notable example of a smart energy system is Copenhagen, Denmark [11]. By deploying smart meters, intelligent grids, and real-time monitoring systems, Copenhagen has successfully achieved a real-time balance in energy supply and demand. Urban planners can adjust electricity generation and distribution based on actual needs and weather forecasts, ensuring the satisfaction of the city's energy demand during peak periods while maximising the utilisation of renewable energy.

Copenhagen has effectively utilised devices such as smart meters and sensors to monitor the use of electricity and water resources in real-time, based on real-time energy data and population movement data. Through data analysis, the city can precisely understand peak and off-peak periods of energy consumption, optimising the energy supply chain accordingly and improving the efficiency of renewable energy utilisation. The smart grid monitoring in Copenhagen indicates that the city has achieved over 70% utilisation of renewable energy, with a significant increase in the share of wind and solar energy [11]. Guided by real-time data, the city is better able to integrate renewable energy into the power grid.

5. Application of internet technology in sustainable smart cities

Smart cities can be implemented with the use of modern information technologies, including Internet of Things (IoT) applications. Putting IoT to practical use in smart cities connects devices in homes and cities to the Internet and deploys many sensors in different places to collect and analyse data. In analysing IoT big data it is necessary to establish an architecture and implementation model and analyse it in layers. Vehicle traffic information, environmental pollution monitoring and security monitoring are included for smart cities. In vehicle traffic data analysis, the density of vehicles in each time period needs to be analysed by region to get the current traffic intensity. At this point the smart city can derive the optimal route and calculate the time required to make people's travelling more efficient and help the concerned government department to control the traffic. These methods can develop smart cities as well as provide ideas for urban planning by analysing simple IoT-based smart city datasets [12]. Taken together, the application of the Internet of Things (IoT) can bring great help to the operation of smart cities, which can collect and analyse real-time data more accurately and integrate a variety of devices. Thus the application can also realise the interconnection of everything, optimise all aspects of the city constantly, which forms a virtuous circle, thereby promoting the intelligence of the city and making it high-quality.

New smart city construction can be realised through IoT-based CIM City Intelligence Model platforms. The CIM can be obtained by combining IoT, BIM and GIS to collect and process urban data, while BIM is Building Information Modelling that is used in urban engineering and construction, and GIS is a Geographic Information System that can derive data on various aspects of the city through spatial and geographic coordinates. CIM-related technologies are being used in Suzhou, China. By collecting and analysing the temporal and spatial data of Suzhou, a multifaceted 3D data model can be constructed to guide the construction of a smart city, which makes the government more efficient and scientific in urban management and public services. The importance of sustainability also becomes prominent in such smart city designs. A sustainable smart city uses technology as a tool to address issues related to the 'people-environment-society-economy-culture' system, and centred on people. A sustainable design system for smart cities can be realised in four dimensions:

management, space, resources and platform. Using these methods, combined with relevant data, a CIM information collection and processing model can be obtained to improve the sustainable development system of the smart city [13]. Therefore, modelling and processing big data through the Internet has become an important part of the construction of new smart cities. This allows data from all areas to be linked together so that problems can be identified and solutions can be optimised in a short period of time. At the same time, there is still a lot of room for improvement in this area as well. With the advancement of Internet technology and the updating of programming languages, data models can continue to be optimised and thus become more efficient and accurate, making the smart city smarter and have a higher level of development.

In addition to the Internet of Things (IoT) technology, 5G technology is gradually being applied to the construction of smart cities. 5G technology, as the fifth generation of mobile communication technology, offers higher bandwidth, lower latency, and greater connection density. It supports high-speed and reliable communication among a large number of IoT devices, enabling faster data transfer speeds, real-time monitoring, and decision-making. It better supports the intelligence of various aspects of the city by facilitating the connection of IoT devices on a large scale. Its advantages in environmental management and resource utilisation include more precise environmental monitoring, aiding in the prevention of natural disasters, optimising resource usage, and providing efficient communication infrastructure to drive innovation in energy management and environmental protection. Currently, Wuxi, China, serves as a successful example of a city utilising 5G technology, achieving intelligent optimisation of traffic signals and improving intersection traffic efficiency. However, challenges such as base station density, construction costs, security, and privacy issues associated with large-scale connectivity need to be addressed [14].

Furthermore, the application of Artificial Intelligence (AI) and machine learning in urban management, including data analysis, predictive modelling, and automated decision systems, enhances the intelligence of city operations, optimises resource allocation and services, and achieves more efficient traffic flow management, safety monitoring, and urban planning. However, scholars have pointed out that data privacy and ethical concerns require further discussion during implementation, particularly in handling massive urban data and ensuring privacy and security. Additionally, algorithm design and model training pose significant challenges in complex urban environments [15].

Edge computing, a method allowing real-time data processing near data sources to reduce transmission latency, finds widespread application in smart city construction. For city developers, it enables faster response times, especially for real-time decision-making applications, reduces reliance on central cloud servers, and enhances system stability. This approach, which reduces data transmission, significantly lowers energy consumption, making it an exemplary eco-friendly smart city technology. In Shanghai, China, for example, edge computing is used in intelligent traffic light control, enhancing the flexibility of signal regulation. However, the limited resources of edge devices necessitate addressing management issues related to computation and storage resources [16].

Lastly, blockchain technology, as a distributed and tamper-resistant data storage method, ensures the security and trustworthiness of data. In smart city construction, it provides decentralised data storage and management, enhancing data transparency and trust [17]. Dubai, UAE, has applied blockchain technology to improve land registration and real estate, increasing the transparency of environmental monitoring and carbon trading, preventing the tampering of environmental data, and facilitating the trade and management of renewable energy. Dubai has introduced blockchain technology in the real estate sector to enhance the transparency and efficiency of land registration [18]. By establishing a decentralised blockchain system, stakeholders such as real estate developers, government agencies, and financial institutions share a unified database, thereby reducing the risks of improper registration and disputes. This initiative has yielded significant advantages. Firstly, the

improved transparency has clarified land ownership and transactions, thereby reducing the likelihood of disputes. Secondly, by eliminating intermediary steps, transaction speeds have greatly increased, accompanied by a corresponding reduction in associated costs. In terms of environmental management and resource utilisation, the digitisation of land registration has minimised paper usage, contributing to the city's progression towards a more environmentally sustainable direction [17].

However, the widespread adoption of this technology faces challenges related to standardisation and interoperability, necessitating collaborative efforts to establish and adhere to relevant standards. Additionally, the Dubai government actively promotes the blockchainisation of government services, encompassing areas such as identity authentication, health records, and education credentials [18]. The objectives of these applications include enhancing data security, reliability, and accessibility. The introduction of blockchain technology enhances data security, ensuring the privacy of personal information. Simultaneously, the digitisation of government service processes improves efficiency, providing citizens with faster and more convenient services. Nevertheless, overcoming challenges related to promotion and acceptance is necessary for the widespread adoption of these services.

Furthermore, Dubai has propelled the use of blockchain technology to optimise trade and logistics processes. By establishing a shared, decentralised trade platform, Dubai facilitates the efficient conduct of cross-border trade. In the realm of trade, the application of blockchain technology reduces fraud and disputes, enhancing the credibility of transactions [18]. In logistics, real-time, shared information aids in optimising the logistics process, reducing delivery times. These transformations also have positive implications for environmental management and resource utilisation. Blockchain technology assists in optimising the supply chain by tracking material sources and transportation processes, thereby reducing resource wastage. However, this application faces challenges, including issues related to international standardisation, necessitating the formulation of international standards to promote the cross-border application of blockchain [19].

In summary, Dubai's successful application of blockchain technology exemplifies an advanced level of smart city development. Despite encountering some challenges, these cases provide valuable experiences for other cities, encouraging more locations to engage in smart city construction and innovation.

6. Conclusion

Urban planning is a long-term process, often measured in years. Therefore, in the construction of smart cities, it is also possible to optimise the programme and propose new plans continuously, thus enabling the city to reach a higher level, and such ideas are present throughout the paper. This paper introduces and evaluates a variety of statistical methods for analysing urban data, analyses the problems of modern cities from a variety of perspectives, and provides recommendations for the construction of future smart cities on this basis. The upgrading of the city's industrial, architectural and transport planning, as well as the extensive use of renewable energies, can contribute to a higher quality of sustainable development while improving the urban environment. Additionally, through the combination of IoT, 5G, AI and machine learning, blockchain and big data technologies, urban infrastructure can be intelligently monitored and managed, and with the support of a large amount of data, analysis can be used to more accurately understand the use of information and the environmental situation of the city, so that it can be more targeted to the optimisation of the city [20]. In the era of the Internet and big data, the relevant technology should be widely used in combination with the actual situation of the city in all aspects based on the huge amount of data, and this is also the core of the smart city construction and development. Another important point is that smart cities are always people-centred, aiming to increase people's productivity, reduce commuting time and improve the living environment, thereby enhancing the quality of life for all. Sustainable smart cities will become mainstream in future urban regeneration and will be improved by local conditions, as well as

promoting social development. In sustainable smart cities, high levels of economic development and environmental enhancement can be realised together.

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Urban Sustainability in the Age of Digital Nomads - Diverse Group Impacts

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Abstract: Digital nomads are a whole new group of people empowered by digital information technology, and although they have a subtle impact on urban change, little attention has been paid to the impact on different urban groups with the influx of digital nomads. The aim of this paper is to examine how the increase in the number of digital nomads in recent years has affected different urban groups in the context of the broader goal of sustainable urban development. The case study comes from the Digital Nomad Commune in Anji, China, and through the literature research method, the urban groups are divided into: digital nomads, profit-driven locals and negatively affected locals, analyzing the various phenomena presented by different groups of people, such as the promotion of local economic development, cultural exchange and cultural diversity by the emergence of digital nomads, the pressure on the price of goods in the neighbouring towns and the irreversible negative impacts on the ecological environment, as well as proposing the strategies for the future construction of the city. It suggests how to build digital nomad-friendly cities from the economic, ecological and social perspectives.

Keywords: Digital nomad, Sustainable urban development, Remote work, stakeholder

1. Introduction

In terms of the global situation, there are an estimated 35 million digital nomads around the world, these digital nomads contribute \$787 billion to the global economy annually, and the number of digital nomads in the US has continued to grow since 2019, according to a study by MBO Partners. The State of Independence in America survey suggests that in the US alone 16.9 million American workers describe themselves as digital nomads with a 131% increase from 2019, the pre-pandemic year. A recent EU27 survey shows that over 60% of employees would like to work remotely at least several times a month [1]. The numerical growth is all closely linked to the epidemic, with COVID-19 offering people the opportunity to enjoy working online, leading many independent workers to become interested in the digital nomad lifestyle, and more senior digital nomads transforming their work and lifestyles through the epidemic. But in 2023 protests broke out in Lisbon, Portugal, against digital nomads, with protesters saying that the arrival of digital nomads had led the Portuguese economy into an inflationary crisis, and some Portuguese politicians saying that they needed to be careful to consider the negative impacts of digital nomads when it comes to the introduction of talent.

In terms of the Chinese situation, there are now potentially thousands of digital nomads across the country, clustered in popular destinations such as Dali in Yunnan province, Anji in Zhejiang province and the tropical island of Hainan. According to a report by Chinese think tank Future of Work Institute, more than 34% of the world's workforce is now permanently telecommuting. According to the "2021 China Residential Holiday White Paper" released by China's "Hornet's Nest", more than 60% of young people aspire to become "digital nomads" with irregular office locations [2]. In 2015, the concept of "Internet+" was first raised in the Chinese government's work report, and in recent years, China's digital nomads have been the first to enjoy the wave of dividends by taking advantage of Internet technology. Unlike the West, although China's digital nomad industry is still in the early stages of development, it shows a "top-down" form of the phenomenon. The "DNA Digital Nomad Commune" in Anji County, Zhejiang Province is built by the government of Anji Xilong Township and Shanghai Aijia Corporation in Xilong Village, and as of the end of 2022, the government of Zhejiang Province has invested in 17 projects in the economic agglomeration area, with an investment amount of 360 million yuan [3]. Chinese digital nomads on the overall have a high level of literacy however, they are still in a complicated circumstance.

This article aims to study the case of a digital nomad village in Anji, China, based on the global goal of sustainable urban development, and divides the article's research objects into: digital nomads, profit-driven locals and negatively affected locals. Through the literature research method, this paper studies the relationship between local residents and digital nomads as well in the benefits and drawbacks of digital nomads in urban growth, such as the promotion of local economic development, cultural exchange and cultural diversity by the emergence of digital nomads, the pressure on the price of goods in the neighbouring towns and the irreversible negative impacts on the ecological environment, and explore how to establish digital nomad-friendly cities to better adapt to the future urban development needs. So far, academic literature has mainly studied digital nomads from a single group, this paper analyses the interactions between diverse groups and bridges the academic gap.

2. Case analysis

The term Digital Nomads was first proposed by former Hitachi CEO Yu Makimoto in his 1997 book Digital Nomad. According to Makimoto, the so-called Digital Nomads refer to people who "earn a first-world income through the Internet, but choose to live in places where prices are at the level of developing countries". With the refinement of the academic literature in recent years, digital nomads are portrayed as young professionals working solely in an online environment while leading a location-independent and often travel-reliant lifestyle where the boundaries between work, leisure and travel appear blurred [4]. They are seeking a life that is characterized by complete liberty, in which the work environment is perceived as satisfying and rewarding, and travel is considered to be a separate type of job. The case selected for this paper is the DNA Digital Nomad Commune located in Anji County, Zhejiang Province, which is the first comprehensive digital nomad commune in China integrating group living, co-working space and public services. Currently, the commune can accommodate 80 people at the same time, and the occupancy rate has been maintained at more than 98% since the trial operation in early 2022 [5]. As the number of people join the community, the digital nomad community has assumed new dimensions, and its impact on the daily lives of the local population is apparent. This paper attempts to explore the pros and cons of digital nomads on urban development through different perspectives.

2.1. Digital Nomads

The data suggests that by 2022, a total of 473 Digital Nomads have stayed in DNA, with an average of 47 days, an average age of 31, 37% of which have a master's degree or higher, and an average of 6.8 hours of work per day [6]. In city life, these people are exactly the hardest hit by the erosion of nine-to-five jobs, city life breaks people apart, everyone is just an island scattered all over the city, and there's a severe lack of time for socializing. In the digital nomad commune, people erase their inherent roles in the city and re-establish new connections. Dominated by the "mobile sense of place", the young digital nomads' escape from the modern urban space is not only a rejection of the stability and institutionalization of the traditional mode of life, but also an embrace of mobility and uncertainty of nomadic life [7]. Physical "mobility" and spatial "sharing" allow digital nomads to establish new relationships with others, particularly under the influence of Internet super-individuals. Every digital nomad has a distinct personal identity, and they desire understanding among themselves and an intimate spiritual connection between people, thus the establishment of DNA provides them with a safe and extensive social platform. However, the DNA is not very "friendly" to newcomers, and there are some obstacles to their integration. The residents who live longer have been in contact with each other over more time and also have the opportunity to have their own interests and friendships, new residents need to socialize and break the ice to integrate into the community, and many of the group chats and social circles are difficult for new residents to integrate into [8].

The broader impact of China's current "rural revitalisation" and "digital village" development plans on digital nomads deserves attention. The influx of digital nomads into Anji Village has also led to the development of the local economy. Digital nomads are generally talented people with higher education backgrounds, who gather in an isolated village and deeply participate in town revitalisation projects with the help of the exposure effect of the Internet. In addition, they have more diversified aesthetics and life needs, the original commercial forms in the village are far behind their needs. Therefore, it is necessary to actively improve the commercial supporting services to meet the needs of digital nomads, it will be able to attract more digital nomads. Some nomads bring their studios to this community, and they use DNA as the "Nomadic Circle Centre", such as the Pinewood Bus set up by Hebaodan and Harry, they moved their RV remodelling workshop to DNA and the Makoto Zi Pottery Workshop's "Making Pottery from Scratch in Unfamiliar Places" programme, etc [9]. Since the creation of the Digital Nomad Commune, it has gathered and attracted more than 400 highly skilled, highly educated, high-income digital nomads to Anji innovation and entrepreneurship, giving rise to a new rural industry. In addition, Xilong Township holiday daily visitors amounted to more than 5,000 people. This drove the collective annual earnings of 200,000 yuan. The village employs around 200 villagers with a monthly salary of 5,000 yuan [10]. From this level, the existence of DNA creates more commercial value for the village resources.

Benjamin describes the Bohemians as "(they are) outsiders to modernity to see what is fascinating about it". Digital nomads also possess similarities to bohemian life. On a social level, their main reason for being nomadic is an escape from modern life and the established scenarios of life, and the freedom they seek though is not really freedom in the true sense of the word. Digital nomadism is not always experienced as autonomous and free but is a way of living that requires high levels of discipline and self-discipline [11]. In the DNA Digital Nomad Commune, Chinese digital nomads continue to break the boundaries between leisure, freedom and work through their continuous exploration of co-working space and work forms. By challenging traditional business models, digital work that does not emphasize physical workplaces has also fostered the phenomenon of "reverse mobility" whereby urban populations are moving to the countryside [12].

The concept of the city is a process of mobility rather than a product, and the boundaries between urban and rural spaces are becoming increasingly blurred, in spatial juxtaposition and interaction.

2.2. Profit-driven Local

Anji is the origin of white tea, and in 2018, the county received 25.045 million domestic and foreign tourists, with a total tourism revenue of 32.47 billion yuan, and the added value of tourism accounted for 13.5% of GDP [13]. Most locals maintain a curious and tolerant attitude towards digital nomads. The emergence of the Digital Nomad Commune as a shared space is a novel experience for locals, as this form of habitation is clearly against the theory of urbanization in traditional Chinese thinking. But there are still many locals who are willing to try to reach out to them, and as locals interact with digital nomads, locals gradually learn new skills and business mindsets, thus enhancing cultural diversity. In traditional forms of rural commerce, many villagers did not know how to expand the reach of their shop signs, so the digital nomads were taught through digital technology to bring new forms of commerce, such as online live streaming with goods. The arrival of the digital nomads has led to a cultural fusion, and the interaction between the aboriginal community and the digital nomads has created a more open and creative community atmosphere. The nomad Zhi Feng restored the street from the local old man's memory by drawing, then recording the interesting events that happened between him and the neighbouring villagers during the seven months he has been living in the community [14]. A sense of isolation and loneliness is rarely seen in Chinese digital nomads, as they engage in activities that interest them, thus building closer ties with local residents.

2.3. Negatively Affected Local

With an eye on the world, the negative impact of digital nomads on the local area is also significant on a global scale, with Nomad List estimating that 15,800 digital nomads had made their home in Lisbon as of December. Some claim that Airbnb, a short-term rental site popular with digital nomads, is forcing residents to be displaced. "We have neighborhoods now that are mainly Airbnb", said Ana, the Portuguese teacher, at a protest on Web Summit's opening night. "We don't have our homes anymore." Nearby, activists from housing advocacy group Habita held placards reading, "1 digital nomad = many forced nomads" [15]. The migration of digital nomads into rural areas can also lead to urban gentrification, with the concentration of digital nomads typically driving up prices in neighbouring towns, which can constitute an economic strain for most aboriginal people. Higher property prices and costs of living may be unaffordable for some local residents, leading to socio-economic imbalances and increased social injustice. In addition, the expansion of the digital nomad community may cause irreversible harm to the ecosystem. As digital nomads take up residence in different areas, they lack a sense of belonging to the local area and therefore a sense of responsibility for environmental protection, and the large-scale expansion of communes may lead to the over-consumption of natural resources. Furthermore, because of increasing activity like cryptocurrency, lawful provisions are not updated in a timely manner, which may make local cybersecurity more risky.

3. Conclusion

In the context of a mobile society, Chinese digital nomads have positively changed their attitudes, bravely breaking the traditional social contract and re-exploring a new way of life. With the support of their high-tech background, they have continuously boosted the local economy, so that most locals have also benefited from them, and the locals have maintained a lenient policy towards the digital nomads and tried to learn new technological knowledge. However, at the same time, the

negative impacts should not be ignored. While bringing in talents, the government needs to consider and manage them carefully.

On the economic level, the government should optimize the corresponding policies and business support services, and the use of digital technology for commune management is also imperative. In addition, the use of big data technology can enrich the business sector from the side, which is not only beneficial to digital nomads, but also promotes the digital transformation of the local community.

On the ecological level, although the basic lifestyle of digital nomads will effectively reduce the carbon footprint, the process of expanding the nomadic commune will cause irreversible harm to the environment. Therefore, it is also necessary to build basic green facilities, for example, more local sustainable building materials can be used and more natural HVAC facilities can be adopted. Furthermore, the establishment of public eco-farms can also realize the cycle of sustainable food systems.

On the social level, digital nomads have their own unique attributes and their identity will change with the environment, so it is important to advocate for more acceptance and tolerance of digital nomads by local residents and to build a harmonious and friendly community.

Finally, the transformation of social structure is a general trend, the key to which lies in the equal distribution of social resources. In the process of urban development, the concept of the city should not be grounded, and the emergence of new communities can be another way to explore urban life. This process stimulates the creativity and inspiration of new communities and maximizes the creation of real value. In this sense, the existence of digital nomads is a revelation for the sustainable development of cities in the future.

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Economic Shifts and Cultural Transitions: Unraveling the Complexities of Gentrification in Urban Landscapes with the Case of SoHo in New York City

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Abstract: With the continuously changing urban landscape since the early 20th century, influenced by various economic and social factors, this paper investigates the impact of urban gentrification on diverse community groups, especially in metropolises. Examining housing, economic, and cultural dimensions, the study explores the challenges and opportunities within dynamic urban landscapes. Focused on SoHo, New York City (NYC), once an artistic haven, the research employs the lens of gentrification to analyze disparities in housing accessibility and cultural preservation. Additionally, it assesses the economic implications of sustainability initiatives on various socioeconomic strata, unraveling their influence on urban community fabric. Through a concise exploration, the study contributes nuanced insights into the complexities of gentrification and sustainable urban development, given the impact on the original artistic community, long-time residents, and small businesses that have faced challenges or displacement in the wake of rising property values, using SoHo as a case study to deepen our understanding of economic shifts and cultural transitions in urban landscapes.

Keywords: Sustainability, Gentrification, Economic and cultural shift, Urban renewal

1. Introduction

Gentrification, a term coined in the mid-20th century, encapsulates a complex urban phenomenon that has reverberated through neighborhoods worldwide. It embodies the transformative process wherein areas, often characterized by disinvestment or neglect, undergo economic revitalization and cultural renaissance. Gentrification mainly consists of four parts: capital reinvestment, social upgrading by high-income in-movers, landscape changes, and displacement of low-income groups, finally reshaping the physical and social landscape, so various communities affected by gentrification often exhibit resilience and resistance [1]. Researching its patterns and outcomes contributes to a better understanding of global urbanization trends with several crucial events such as the economic recession during WWII and the development of globalization, at the same time, allowing for cross-cultural comparisons and the development of strategies applicable in various contexts [2].

At its core, gentrification is a double-edged sword. While it brings economic growth and aesthetic enhancements, it frequently leads to the displacement of longstanding communities, altering the social fabric and cultural identity of a place [3]. The allure of SoHo's unique character, coupled with strategic urban development initiatives, ignited multiple stages of gentrification. Originally an

industrial hub, SoHo evolved into a haven for artists in the 1960s and 1970s, drawing creative minds into its expansive lofts and repurposed spaces [4]. Nowadays, the district is characterized by eclectic galleries, avant-garde boutiques, and an atmosphere teeming with luxury outlets. This paper embarks on an exploration of the historical layers embedded in SoHo's streets, with the investigation of mainstream community and individual costs such as house rent, to understand how economic shifts and cultural transitions in the US have shaped and continue to shape the district's identity. By unraveling the complexities of SoHo's past, this study aims to shed light on the broader implications for urban planning and development in an ever-evolving global landscape, the insights gained from studying SoHo have implications for understanding and addressing similar issues in other cities worldwide, contributing to a more comprehensive understanding of urbanization.

2. Double stages of gentrification in SoHo

The narrative of gentrification in SoHo unfolds as a layered tale, marked by not one, but two distinct stages of transformation. As a microcosm of urban evolution, SoHo's journey from an industrial landscape to an artistic enclave, and subsequently to a thriving commercial district, showcases the nuanced dynamics of double-staged gentrification, and this paragraph is going to introduce three different stages from the 1900s to now, evaluate how does the gentrification start to take shape from two distinctive communities respectively.

2.1. Stage1: Industrial community (Early 1900s – 1960s)

In the early 20th century, SoHo underwent a transformative shift from its industrial roots tied to the Industrial Revolution [5]. As the bustling heart of industrial activity, the district was witness to the dynamic changes spurred by the upward migration of New York City residents, with expanded job opportunities in the burgeoning commercial industries located in the northern parts of Manhattan, middle-class denizens steadily moved northward on Manhattan Island during the late 19th century. On top of that, the northern neighborhoods offered a perceived escape from the congestion and pollution associated with industrial areas. This migration caused a decline in SoHo's population during that era, as a significant portion of its residents relocated to the burgeoning northern neighborhoods, somehow became one of the reasons, other than geological factors, that there is a cluster of skyscrapers downtown and another one in Midtown, but few in between nowadays. This demographic shift opened the doors for businesses and corporations to seize opportunities in the vacated spaces, not only the loft buildings and warehouses that are well-suited for the storage and display of goods, making them ideal for businesses involved in the trade of mercantile and dry goods but also the access to major transportation networks such as the South Street Seaport and various rail lines facilitated the movement of goods in and out of the district. Therefore, SoHo swiftly evolved into a hub for the mercantile and dry goods trades. However, the aftermath of World War II brought about a significant change in the district's landscape. The textile industry, a major player in the area, underwent a mass exodus to the South, known as the "Southern textile boom." Industries were drawn to the South due to favorable economic conditions. Southern parts were less unionized than their northern counterparts, providing textile manufacturers with a more flexible and cost-effective labor force, leading to the establishment of new manufacturing centers in states like North Carolina, South Carolina, and Georgia [6]. Moreover, lower Manhattan experienced challenges related to aging infrastructure and rising urbanization costs, leaving numerous large buildings in SoHo unoccupied. In response to this vacancy, warehouses and printing plants found a new home within some of these structures, altering the character of the district. By the 1950s, SoHo had earned the moniker "Hell's Hundred Acres", a desolate industrial wasteland characterized by sweatshops and small factories

during the day, but eerily empty at night. Paradoxically, this desolation inadvertently laid the groundwork for a different kind of transformation.

Meanwhile, New York City embarked on an ambitious journey to rejuvenate the SoHo district through an aggressive urban renewal initiative. The concept of urban renewal, prevalent across the United States during the mid-20th century, aimed to revitalize urban spaces by implementing strategic changes [7]. In practice, however, this often translated to the wholesale demolition of existing neighborhoods deemed as slums. The city's overarching objective during the 20th century was to reshape and reconstruct neighborhoods to align with modern ideals. Yet, this vision inadvertently inflicted significant harm upon the SoHo area, primarily due to its unique industrial landscape. Although the area seems like an industrial wasteland as mentioned before, more than half of the structures in SoHo served as vital hubs for small business activities [8]. The repercussions of the urban renewal process were keenly felt by the industries and their employees, as the very essence of the community was upended. At the same time, businesses, deeply rooted in the historic edifices of SoHo, found themselves displaced, faced challenges in finding affordable alternative spaces, and struggled to adapt to changing economic landscapes, contributing to a disintegration of the vibrant economic ecosystem that had thrived for years. The intricate tapestry of commerce that had woven its way through the narrow streets was unraveled, leaving behind a void that echoed the loss of a once-bustling community [4]. Simultaneously, several features and ambiances from this once-prosperous block somehow brought several benefits to the local artists, reforming the SoHo district into the next stage and concluding the industrial era.

2.2. Stage 2 (First gentrification): Art Community (1960s-1975)

In the tumultuous landscape of the late 1960s, the SoHo area became an unexpected heaven for artists, albeit in a somewhat clandestine manner. The allure lay in the affordable rent and the capacious interiors of former Loft-style spaces that provided artists with ample room to pursue their craft. The spacious lofts in SoHo, a stark contrast to the living spaces available in Brooklyn and Midtown Manhattan, proved advantageous for artists whose work demanded significant room [9]. Firstly, Loft-style buildings typically feature open floor plans and high ceilings, providing artists with expansive and unobstructed spaces, allowing for greater flexibility in arranging workspaces and accommodating large canvases, sculptures, or other artistic endeavors, the absence of dividing walls also fosters a sense of freedom and encourages experimentation. Secondly, loft spaces are often blank canvases themselves, allowing artists to tailor the environment to suit their needs, and the open design facilitates easy modification of the space, enabling artists to create dedicated work areas, studios, and exhibition spaces [10].

However, the city, staunch in its enforcement of eviction policies, and more notably, the landlords of these unconventional living spaces, exhibited a less-than-hospitable attitude toward their artist tenants.

In defiance of zoning regulations, these creative minds established their abodes in zones designated for business purposes, a technically illicit but financially pragmatic choice [11]. After that, faced with the looming threat of eviction and the inhospitable actions of their landlords, SoHo's artistic denizens united in the early 1960s, forming coalitions to champion their cause. One notable entity that emerged from this collective spirit was the Artists Tenant Association (ATA), a formidable coalition comprising approximately 500 artists. The ATA, born out of necessity, sought to challenge the city's stringent eviction policies and advocate for the rights of artists in unconventional living and working spaces. In a bold and unprecedented move, the artists of SoHo, under the banner of the ATA, initiated a form of peaceful resistance in the early 1960s. Frustrated by the antagonistic policies they faced, this coalition decided to leverage the power of their creations by withholding their art from the traditional art galleries nestled within the confines of New York City. This act of protest not only

symbolized their solidarity but also underscored their determination to be recognized as integral contributors to the city's cultural landscape, challenging the status quo and setting the stage for a transformative chapter in the history of artistic expression in New York City.

This initial success fueled the aspirations of artists in SoHo, propelling the establishment of the SoHo Artists Association (SAA) in 1968. The SAA aimed to further redefine the zoning regulations for SoHo buildings, specifically advocating for residential designation [12]. In a noteworthy triumph, the City Planning Commission responded positively, opening up over a thousand lofts in SoHo for residential purposes. While this marked a victorious moment for the artistic community, the ensuing decades witnessed transformative shifts within the area. This transformative period brought about not only changes in the demographic composition of SoHo but also in its overall character. The influx of diverse residents and interests contributed to the evolution of the neighborhood's cultural and socioeconomic landscape, becoming a focal point for urban development and cultural dynamism, navigating the delicate balance between preserving its artistic roots and adapting to the evolving demands of a burgeoning metropolis.

2.3. Stage 3 (Second gentrification): Luxury district (1975 – Now)

In the early 1970s, many people who wanted to live in the heart of New York City were drawn to SoHo by the allure of stylish lofts. These expansive spaces, originally used by artists as creative havens, became emblematic of a unique and avant-garde lifestyle. Life in the lofts of SoHo was passionately promoted by various newspapers and magazines, a newspaper article from the New York Times written in 1971 details this. The article states that “SoHo zoning, approved by the commission eased existing restrictions on the use of loft space for residential use...the neighborhood is not one that would be generally considered residential but for many artists, the lofts’ space and light more than compensates for such disadvantages as the noise of the districts’ heavy truck traffic” [13], enticing many to yearn for a life that resembled that of the artists who had built an existence in the sprawling spaces.

By 1973, the atmosphere in SoHo had fundamentally changed, transforming the neighborhood from an enclave of artists' studios into a fast-paced commercial center. The first floors of former industrial buildings, once havens for creative expression, succumbed to the pervasive influence of retail stores, solidifying the neighborhood's commercial metamorphosis. With rents often surpassing \$25,000 a month, Greene Street, in New York's SoHo neighborhood, can already boast stores run by the likes of Dior, Versace, Loewe, and Acne Studios [14]. This change was not without consequences, as SoHo has been plagued by escalating rents since the early 1970s. In 1969 a 3,600-square-foot building sold for around \$10,000, and in 1974 those prices jumped to anywhere from \$25,000 to \$45,000. That means within only one year, the prices of living in SoHo went up from 150%, being the lesser, and to 350% being the greater [15].

SoHo today is a captivating destination that draws visitors with its mix of stores, history and diverse culinary offerings. The commercial pulse stretches across Broadway from West to Sixth Avenue and from Houston Street to Canal Street. Broadway, the neighborhood's bustling thoroughfare, is home to global brands alongside charming boutiques. This juxtaposition creates a shopping experience that appeals to a wide variety of tastes and epitomizes SoHo's appeal through the seamless fusion of upscale retail and local boutique charm. According to 2015 American Community Survey data and a breakdown of the distribution of artists in New York City, the study found that there were 56,268 artists living in New York in 2015, an all-time high and an increase of more than 17% from 2000. However, in neighborhoods such as Greenwich Village, Chelsea and the Lower East Side, the number of artists declined dramatically over the course of 15 years [16].

3. Analysis of the two-sides of gentrification

Accordingly, from the transformation of different stages in SoHo, challenges arise as rising property values displace lower-income residents, jeopardizing housing affordability and contributing to social inequality. While gentrification can attract investments in green infrastructure, it may also lead to increased environmental footprints. Balancing economic growth with environmental sustainability becomes crucial. Additionally, cultural and social changes may enhance public spaces but can erode community cohesion. To sum up, these outcomes disobey the principle of sustainable urban development from two aspects. Firstly, as the definition of sustainable development first appeared in 1980 in the "World Conservation Program" developed by the International Union for Conservation of Nature (IUCN) with the support of the World Wildlife Fund (WWF) [17]. A representative view is that sustainable development is based on the coordination and common development of society, population, resources and the environment, and its purpose is to meet the needs of the present generation without posing a threat to the development of future generations, with the balanced and lasting development of the present and all generations as the central task. As the influx of new residents during gentrification may alter the cultural fabric of a community, leading to the loss of historical and cultural heritage, which negatively influences the ability of future generations to connect with their community's history and identity. Secondly, gentrification can be seen as conflicting with several United Nations Sustainable Development Goals (SDGs) due to its potential negative impacts on social, economic, and environmental dimensions. For instance, gentrification can exacerbate existing social inequalities by displacing marginalized communities and fostering a divide between affluent and lower-income residents, conflicting with SDG 10-Reduced Inequality. In addition, gentrification increases consumption, as wealthier residents often have higher consumption patterns and demand for new infrastructure, potentially impacting the local price level, contributing to the conflict with SDG 12-Responsible Consumption and Production [18].

Gentrification is a global phenomenon that is spreading beyond North American metropolitan areas to thriving cities around the world, particularly in rapidly developing middle-income countries (MICs) such as China and India. The Puxi area of Shanghai is a good example of this. As the origin of China's commercial center and an early pioneer in urban regeneration, Shanghai faced challenges due to modern urban expansion and dwindling land ownership. To counteract this, the city adopted a "zero growth" approach to urban planning and turned away from the traditional model of "new development". Shanghai's urban renewal, exemplified by the transformation of the Shikumen construction site into Shanghai Xintiandi, has led to pronounced gentrification effects. Xintiandi, once a residential area, is now the epitome of modern leisure living with luxury brands and boutiques. During construction, property prices rose from 7,000 to 20,000 yuan/square meter [19]. This upscale development forced the original residents to move to the outskirts of the city, creating impoverished areas. At the same time, the government enforced segregation and separated the upscale neighborhoods from the open ones, resulting in social stratification and blurred city boundaries.

4. Conclusion

Looking back from the early stages of gentrification, the exodus of local industries and businesses from SoHo was triggered by the proposal for urban regeneration, which was exacerbated by historical factors. The transition from the Industrial Revolution to the post-World War II period led to a decline in demand for large manufacturing operations such as the textile industry, resulting in a transformation of neighborhoods. In the ensuing phase of gentrification, many artists and long-established residents were pushed out of the neighborhood, leading to fears about the erosion of the neighborhood's special character. This phenomenon can be linked to more general trends of globalization and burgeoning tourism. The increasing connectivity and mobility of cities are attracting

international investment and encouraging the development of high-end real estate tailored to a global elite. As a result, property values are rising, tourist-friendly amenities are increasing, and sometimes residents are being displaced as a result of these changes.

In essence, the gentrification process in SoHo serves as a microcosm of the complex dynamics reshaping urban environments worldwide. It highlights the balance of economic development with the preservation of local character, fostering inclusive growth that benefits both new and established communities. In summary, understanding gentrification within this broader context is essential for shaping sustainable urban futures that prioritize the diverse needs of residents while embracing the inevitable transformations brought about by global forces.

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The Implementation and Implications of Sustainable Development Goals at City Scale and Sustainable Urban Development Path

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Abstract: Cities were products of human social development, but the environmental pollution problems brought by high-density buildings and high-density populations in cities had become increasingly serious. The 17 Sustainable Development Goals proposed by the United Nations in 2015 were closely related to urban sustainable development issues. Based on it, this article analyzed the impact of SDGs and related theories on urban sustainable development and possible development directions. Starting from the impact of SDGs on urban sustainable development, elaborated on their impact on already implemented urban sustainable projects and relevant theories. It concluded that the future development of sustainable cities should be based on existing cities, with different focuses on developed and developing countries, but both require the protection of historical value landscapes and the greening of existing facilities. By explaining the theories and practical cases related to SDGs and sustainable cities, hoping to provide a reference and guidance for the path of urban sustainable development.

Keywords: Sustainable Development Goals, City, Sustainable construction

1. Introduction

City is an important unit of living in the current human community. Since the first Industrial Revolution started in Britain in the 1760s, urbanization has begun its process. At present, more than 55% of the global population belongs to urban population, and more than 70% of global greenhouse gas emissions come from urban areas [1]. With the continuous expansion of urban population, urban pollution levels are also rising rapidly, and sustainable development has become a problem that must be solved. The concept of "Sustainable Development" can be traced back to the report "Our Common Future" issued by the United Nations World Commission on Environment and Development in 1987, which defined sustainable development as "Development that meets the needs of the present generation without jeopardizing the ability of future generations to meet their own needs". Based on this definition, the United Nations adopted 17 Sustainable Development Goals, or SDGs, in 2015. Among the 17 Sustainable Development Goals, up to 65% of the content depends on urban action [2], with Goal 11 explicitly identifying "Building sustainable cities and communities" as a key component of urban sustainable development that promotes social inclusion, economic well-being and environmental quality in cities without compromising their ability to grow in the future [3-6].

This paper analyzes relevant theories and ongoing sustainability attempt cases, and explores how SDGs exert their influence on sustainable transformation at the local urban scale, demonstrate the development path of sustainable urban development or sustainable transformation in the future, and provide a theoretical model for realizing SDGs at the urban scale that can be referred to.

2. Sustainable urban form

The basic form of most modern cities generally presents the characteristics of high density, radial distribution, obvious functional zoning, developed road network, green space and public space. This has shaped the commonality of modern cities: long traffic distances and extremely high space crowding. This does not seem so "sustainable".

On the basis of such a city, "New Urbanism" is derived, and "New Urbanism" breaks the single in traditional urban planning a functional, low-density and car-dependent, while advocating compact, mixed-use and pedestrian-friendly urban design [7], putting more emphasis on humanity and sustainability, advocating urban compact and core diversification, encouraging public transport and walking, aiming to create more socially cohesive and sustainable communities [8].

Sustainable cities are cities that meet the needs of existing and future residents through efficient resource use and environmental protection [7]. The form of sustainable cities in the future can be summarized into four types. Compact cities, The eco-city, Neotraditional development and Urban containment [9]. They have their characteristics and have certain commonalities, corresponding to different sustainable urban forms that may appear in the future.

Under the current urban scale, "15-Minute City" and "Three-Dimensional Ground" are relatively widely used concepts to achieve preliminary sustainable cities.

The concept of "15-Minute City" was first proposed by French urban planner Carlos Moreno in 2016. Promote a sustainable city or community where people can walk, cycle or use public transport within 15 minutes to reach facilities and services that meet their daily needs [10].

Another idea is the "Three-Dimensional Ground", an extension of the three-dimensional transport concept proposed by Professor Colin Buchanan in the UK in 1963, also includes the development of transportation elements such as cars, walking, and public transportation, which break through the two-dimensional space dominated by the surface and extend to the air and underground [11-12]. This is the beginning of the trivialization of urban transportation elements. The urban elements accommodated by the three-dimensional ground include traffic, social public activity and natural ecology. That is, taking the ground as the center to build a three-dimensional structure of ground, underground and air traffic, society and nature, which is especially suitable for the sustainable construction of large-scale developed cities with crowded space, such as Wujiaochang in Shanghai, China [13].

In the form of a sustainable city, people are willing to use sustainable transportation modes, which saves a lot of time, and the city can also reduce the horizontal ground occupation area, and turn to sustainable transformation and other planning, so that the urban ground system is diversified and sustainable.

In Oxford, UK, sustainable development has a community-scale practice, which is called Low Traffic Neighborhoods. Its official website defines it as a "15-Minute City" attempt which was proposed in 2020 to set up barriers on some roads in the community, prohibit other vehicles except emergency vehicles, public vehicles, and bicycles from entering, create a 15-minute life circle environment in the community to promote sustainable transportation mode, and achieve local community ground diversity in the road environment. It is obvious that the sustainability of infrastructure is not limited to the transport sector, starting in April 2020, China began to set strict limits on the construction of high-rise buildings above 500 meters in cities, taking the first step to

reduce the vertical height of the urban core, which is also the SDGs in the impact of infrastructure on cities.

In addition, resource recycling and clean energy in the SDGs are also important factors affecting the sustainable development of cities. Also in Oxford, there is another attempt to promote zero emissions, the Zero Emission Zone. The trial, which began in February 2022, will allow vehicles to enter the zone only if they meet emissions standards, while others will be denied access or will have to pay a fee - often high. In Amsterdam, the Netherlands, the city government proposed the "Amsterdam Energy Accord 2020", which aims to achieve 20% of the city's total electricity consumption from renewable energy sources, encourage the construction of sustainable buildings with renewable or recycled materials, and encourage waste separation and recycling. Promote water conservation and recycling, and encourage walking, cycling, and public transportation.

3. Implications

At present, people can see that the basic form of the city they live in is an urban form with a clear core, tall buildings and developed roads, which has a significant impact on the living habits of the urban population. The traffic time problem is one of the most widely discussed basic problems in large cities at present. Longer traffic distances and time will bring more pollutant discharge, which will pollute the atmospheric environment.

In both developing and developed countries. In recent years, the popularity of "New Urbanism" has made sustainable transformation begin to be carried out, but mostly by adding green space and other ways, and cannot produce enough effect.

In Oxford, UK, 50% of nitrogen oxide emissions come from transport. Under the LTN model, the community environment is improved, the health and safety of students, the elderly and children are taken care of, and the quality of life is partially improved. Within the ZEZ, the problems of emissions, noise and traffic are solved. This shows that the goal of sustainable cities and communities is achievable. It also demonstrates the effectiveness of the "15-Minute City" and the "Three-Dimensional Ground".

But for people who need to use cars, this increases their driving time and has a greater environmental impact. From the perspective of the city, increased sustainability within the community leads to environmental pollution outside the community, which does not actually have an effect, but instead produces "Pollution Transfer". "Pollution Transfer" means that a region moves its original pollution sources such as factories, industrial facilities, and high-density roads to surrounding areas through planning or policies, to reduce the pollution level in the local area to achieve sustainable standards. In simple terms, the sustainable transformation of a community, a region or a city is achieved by moving its pollution sources to surrounding areas, which does not meet the requirements of the SDGs, in which the SDG-17 explicitly mentions Partnerships for the Goals. The construction of a "Three-Dimensional Ground" should also prevent the misunderstanding of the expansion of transportation facilities, and ignore the natural and social parts of sustainable development.

Amsterdam in the Netherlands, one of the first cities in Europe to realize the importance of sustainable cities, has been exploring the path of sustainable transformation since the 1980s. In 2021, Amsterdam will already get more than 50% of its energy from renewable clean sources. By 2023, Amsterdam will have 100% public and green transport coverage, 40% green space coverage, and 400 kilometers of bicycle lanes, thus initially achieving the sustainable transformation of the city.

4. Development path

In view of the rapid development of global urban construction and the relatively high level of urbanization in most regions, the influence of SDGs on the urban scale does not mean to start from

scratch and completely build new cities and urban agglomerations according to its standards, but in most cases, SDGs should be regarded as a theoretical guide. Sustainable transformation under the guidance of SDGs should be carried out according to the different situations and development levels of different cities in different regions, and sustainable development at the urban scale should be finally realized. The following will be elaborated from the two aspects of cities in developed countries and developing countries.

4.1. Developed countries

Developed countries usually have a higher level of urbanization, that is, a higher level of urban construction, more perfect urban facilities, and a larger urban population. The Urbanization Rate is the ratio of a country's urban population to its total population. In most developed countries, the urbanization rate is around 80%. This also includes the result of the special territorial factors of Monaco and Canada, but in general, the level of urbanization in developed countries is quite high.

From the perspective of history, cities in some developed countries began their urbanization process in the early days of the Industrial Revolution and the "Age of Discovery", which also created their distinctive characteristics, that is, they have numerous historical buildings, such as London in the United Kingdom, Rome in Italy, Amsterdam in the Netherlands, and Paris in France. These cities all have modern urban areas, but their core areas are often filled with century-old buildings that have high historical value, but are often built without the space and content to support sustainable development.

Therefore, for cities in developed countries, to realize sustainable urban transformation and sustainable development under the guidance of SDGs, the focus should not be on issues such as urban hardware facilities, but should be based on the consideration of historical and cultural protection. The demolition and construction of large-scale buildings should not be carried out, and more attention should be paid to education equality and gender equality mentioned in SDGs. The "software" of climate action, animal and plant protection, the integration of industrial resources, the establishment of uniform standards and regulations, the avoidance of "Pollution Transfer" from an economic and political perspective, the consideration of clean energy and other aspects, and the construction of appropriate, restricted infrastructure where necessary, to achieve sustainable development based on the SDGs and existing developed urban systems, while avoiding further urban sprawl, resulting in waste of resources and environmental pollution damage.

4.2. Developing countries

The United Nations does not have a clear data standard line for developing countries to judge, but from the perspective of urbanization, the urbanization level of developing countries is generally lower than that of developed countries, but the urbanization level of developing countries in different regions is also different. In the process of sustainable development, cities in developing countries need to consider the basic demands of infrastructure construction and economic construction, so the relevant application content of SDGs is not quite the same.

For developing countries, urban construction and expansion as well as economic development is one of their goals. Under the influence of urban scale and SDGs, developing countries need to encourage and popularize the use of affordable and clean energy while furthering urban construction and economic development. This will help developing countries achieve initial sustainable development in the field of transport in the process of urban expansion. When considering investments in public transportation in medium-sized developing cities, a key priority should be to improve existing bus systems [14]. Therefore, in urban infrastructure construction, it is also necessary to consider the factors of sustainable development, through the construction of a three-dimensional

transportation network, and planning "Three-Dimensional Ground" to achieve the unit land in the environment, society and traffic three factors. Similarly, for buildings or areas of high historical value, a relatively modest conservation strategy needs to be considered.

In addition, in terms of industrial facilities, developing more sustainable industries and innovating production methods should be considered, rather than simply further expanding the original environmentally polluting industries, such as using photovoltaic power generation, wind power generation, hydroelectric power generation and other ways to gradually replace the original unsustainable industrial power generation mode of thermal power generation according to their regional characteristics.

In the field of economic development, responsible consumption and production must be primarily ensured, and prevent the waste of resources caused by excessive consumerism and the environmental harm and waste caused by excessive production. At the same time, partnerships can also be carried out in the field of sustainable development according to the scale of cities, which can be in infrastructure, education, health care, resources and economy, to realize functional division of labor and cooperation between regions, and avoid waste and pollution caused by excessive development of different cities and industries.

5. Conclusion

The current urban core construction has been basically formed, and it has a profound impact on the development of the city itself and the lives of the urban population, which states that the impact of SDGs at the local scale is to carry out sustainable construction on the existing basis, that is, different forms of sustainable transformation attempt to achieve resource recycling and energy clean, which is a long-term and complex process. It must be acknowledged that the basic form of modern cities is still far from achieving sustainable development, in both developed and developing countries.

"New Urbanism" is a first step towards sustainable urban development, but more needs to be done. Although there are some practical problems at present, the "15-Minute City" is undoubtedly feasible. The ideal sustainable urban form according to the design concepts of sustainable urban form is that which has a high density and adequate diversity [9], it is an overview of the commonalities of the different types of sustainable cities that may exist, including the contents and concepts of "15-Minute City" and "New Urbanism".

The construction of sustainable cities and the sustainable transformation of existing cities will be a highly flexible process, which requires specific sustainable development planning based on different natural environments, economic levels and infrastructure levels. The sustainable development of urban scale under the guidance of SDGs needs to be selected according to the actual conditions of different cities in different countries. More attention can be focused on non-physical conditions, pay attention to social factors such as equality issues, environmental protection responsibilities, and limit the expansion of disorderly urban infrastructure to achieve sustainable development. For cities in developing countries, it is necessary to take into account the content of sustainable development, innovate the structure and content of industries, and bring their industries closer to the requirements of SDGs while building infrastructure and economic level. At the same time, inter-regional cooperation should be carried out to maximize benefits and sustainable development levels. It is important to note that while the SDGs affect the construction of sustainable development at the city scale. It is also necessary to ensure the needs of different groups, and pay attention to avoid the misunderstanding of "Pollution Transfer" and "Three-Dimensional Traffic Expansion". While challenges remain, the Sustainable Development Goal concept of urban communities provides a strong foundation for people to build a more livable, prosperous and environmentally friendly future [7].

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Sustainable Waste Management in Urban Area

- A Case Study of the Waste Management of the Cities in China

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Abstract: As urbanisation continues to accelerate, the integration of regional waste treatment capacity is becoming increasingly important and challenging nowadays, as economic development imbalances and environmental problems are becoming more prominent. An important component of urban development is the generation and management of municipal solid waste, and due to differences in socio-economic status, China's world-class metropolises such as Shanghai and medium-sized cities such as Xiamen are facing the same problem. This study attempts to explore the possibilities and prospects for sustainable waste management in China's future by comparing Xiamen with Shanghai, using relevant structural models and relevant research data within the city and the region. The introduction of the concept of waste-free cities also provides a greater diversity of options for future programmes. Finding effective strategies based on China's socio-economic and cultural conditions has implications for developing countries such as China in promoting the shift from waste management to a circular economy.

Keywords: Municipal waste management, sustainable management, technological innovation, policy advice, social participation

1. Introduction

China, the world's largest developing country, has experienced dozens of years of rapid urban change and high-speed development, and urban waste has increased dramatically. Sanitation and management, the critical material supply system for cities, are becoming the focus of sustainable development [1]. The two main strategies for sanitation management are landfill and incineration, with a strong trend for the latter, which will account for 62.0 percent of the total in 2020 (Figure 1), while the proportion of landfill falls to 33.2 percent over the same period [2]. Landfill, composting, and incineration are the three standard waste disposal methods in domestic cities; improper treatment also accounts for a certain proportion.

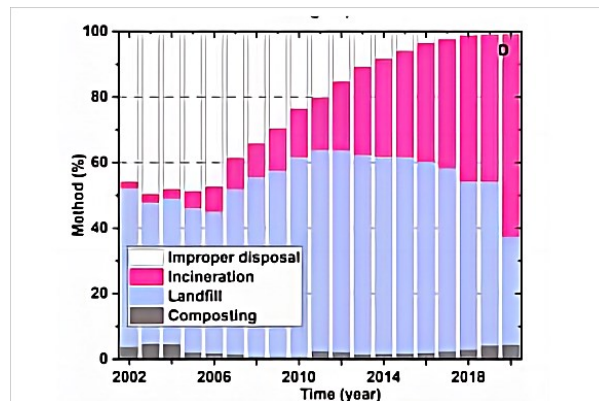


Figure 1: Proportion of MSW incinerated, landfilled, composted and improperly disposed of in China a from 2002 to 2020[2].

Landfill disposal is The primary solution to domestic waste discharge in most cities. Landfill disposal is a comprehensive solid waste management science and technology that moves away from the traditional simple stacking and filling. Landfill disposal has evolved from simple stacking, filling, and covering to engineered storage that encompasses, screens, and segregates[3].

Municipal waste is combustible and suitable for incineration. Harmful substances and pathogens are effectively eliminated during the high-temperature incineration process, while the heat generated can be used for power generation and heating. Waste incineration produces large quantities of acidic gases and incompletely burned organic components. Hence, the exhaust gas needs to be purified before discharge, and the waste residues must be disposed of safely.

Composting is an artificial fermentation process where microorganisms convert organic matter into fertilizer. It involves anaerobic (gas) and aerobic (gas) composting based on oxygen demand during fermentation. If waste is sorted, composting can be a key energy and resource utilization technique for municipal waste.

The circular economy is critical to sustainable urban development and waste management. Developing countries like ours need to look at socio-economic factors, study the spatial and temporal heterogeneity of waste generation and management, and share valuable insights. Local governments address the challenges of sustainable work management and develop comprehensive public participation strategies to address waste issues.

2. National solid waste generation and disposal status

2.1. Waste generation and classification

Municipal waste includes domestic waste, industrial solid waste, medical waste, drainage treatment sludge, construction waste, etc. 2018 data show that large and medium-sized cities in China produce a large amount of solid waste, such as 1.31 billion tonnes of industrial solid waste, 40.011 million tonnes of industrial hazardous waste, 781,000 tonnes of medical waste, and 201.944 million tonnes of domestic waste. The total volume and variety of these wastes are significant and increasing year by year. Although they are environmentally hazardous, they are also usable [4].

Wastes can be categorised as general and hazardous, and sources are classified as industrial and agricultural solid wastes [5]. Hazardous wastes are dangerous, toxic, etc., and threaten human life. Municipal waste includes domestic, construction, and commercial waste. Industrial solid wastes are mainly metallurgical, mining, light industry, petrochemical, and other wastes; agricultural solid wastes are animal excreta, crop residues, etc. [5].

2.2. Waste Management Infrastructure

Solid waste management in China is led by the environmental protection department and local environmental protection departments, with the construction and sanitation departments dealing with domestic and construction waste and the environmental protection department responsible for assessment and statistics. Industrial solid and hazardous waste is handled by the Environmental Protection Department, which sets lists and standards, and by local governments, which build treatment facilities. Hazardous waste treatment companies must apply for a business licence from the environmental protection department. Multiple departments work together to ensure that waste is handled correctly and effectively utilised to prevent pollution.

2.3. Waste management policies and regulations

China's current management of industrial hazardous waste includes regulations, online monitoring, public participation, and environmental protection supervision, and these measures have achieved significant results in management and disposal, curbing illegal transfers, emissions, and disposal. Enterprises are focusing on standardised storage and disposal, strengthening the concept of the rule of law and investing resources in treatment. Local governments use new media to educate on science and legal awareness, raise public awareness of the hazards of hazardous waste and compliant disposal, establish a sound incentive mechanism for public supervision and reporting, broaden the channels for detecting environmental violations, and increase social participation so that the public becomes the main force in environmental protection supervision[6].

National laws include the Environmental Protection Law of the People's Republic of China etc.; administrative regulations include the Regulations on the Management of Urban Environmental Sanitation, etc.; industry regulations include the Provisions on the Management of Municipal Construction Waste, etc.; and environmental protection standards related to municipal domestic waste include the Standards for Municipal Domestic Waste Landfills, etc[6].

Table 1: Summary of Hazardous Waste Management Policies and Regulations[6].

Release time	Policies and regulations	Outline
2012.12	Technical Specifications for the Collection Storage and Transport of Hazardous Wastes	Establishes technical requirements for the collection, storage and transport of hazardous wastes by hazardous waste generators and operators
2017.05	Thirteenth Five-Year Plan for the Prevention and Control of Hazardous Waste Polluton	Clarify the objectives and tasks of China's hazardous waste polluton prevention and control work in the next five years
2017.09	Guidelines for Environmental Impact Assessment of Hazardous Wastes in Construction Project	To further regulate the evaluation of the environmental impact of construction projects generating hazardous wastes, and to provide guidance to the competent authorities for environmental protection at all levels in carrying out the relevant examination and approval work
2019.10	Hazardous Wastes Landfill Pollution Control Standards	Technical requirements for the selection of hazardous waste landfill sites have been standardised, admission standards

Table 1: (continued).

		for hazardous waste landfills and requirements for the control of hazardous waste landfill wastewater discharges have been tightened.
2019.11	Criteria for the Identification of Hazardous Wastes	Clarification of hazardous waste identification procedures and refinement of the rules for determining hazardous waste after mixing and use for disposal
2020.04	Law on Prevention and Control of Environmental Pollution by Solid Waste	Provide for hazardous waste management, collection, storage, transport and disposal requirements
2020.11	National List of Hazardous Waste	Specification of hazardous waste categories, industrial sources, waste codes and hazard characteristics
2020.12	Pollution Control Standards for Hazardous Waste Incineration	Provides for the siting operation, monitoring and ecoenvironmental protection of hazardous waste incineration facilities in the process of waste storage, compounding and incineration and disposal, as well as for implementation and monitoring

2.4. Analysis of the current status of waste management

China has preliminarily established a regulatory and institutional framework for resource utilisation, and has carried out pilot projects on solid waste resource utilisation in various regions. Despite some progress, it still faces many challenges, such as problems in the institutional system, classification and recycling system, recycling efficiency, normality, and resource utilisation system [7]. There needs to be more top-level design for complete life-cycle analysis, government financial guidance, market incentives, and punitive financial and tax systems [7]. In order to promote solid waste classification and resourcing and its industrial development and to realise the great rejuvenation of the Chinese dream, China needs to solve the above problems as soon as possible.

Table 2: Analysis of the benefits of solid waste resource utilisation in China [7].

Waste category	Name(of a thing)	2020	2030
Urban mine	Output/ $\times 10^8$ t	50	80
	Recycling value of major renewable resources/trillion yuan	0.93	2.14
	Emission reduction of $\text{SO}_2/\times 10^4$ t	120	260
	Employed population/10,000 people	2 000	3 000
Rural waste	Output/ $\times 10^8$ t	54	56
	Total amount of resource utilisation/ $\times 10^8$ tce	8.43	9.93
	Investment stimulate/Trillion Yuan	3.37	3.97
	Emission reduction of $\text{SO}_2/\times 10^8$ t	22.51	26.51
	Emission reduction of $\text{SO}_2/\times 10^4$ t	170	200

Table 2: (continued).

	Employed population/10,000 people	1 475	1 142
Industrial solid waste	Output/ $\times 10^8$ t	35	30
	Comprehensive Utilisation Ratio	70%	80%
	Pulling investment/trillion yuan	1.08	1.35
	Employed population/10,000 people	200	150

3. Examples of sustainable waste management practices

3.1. Waste management cases in Shanghai and Xiamen

3.1.1. "Survey on the Current Status of Recyclables Recovery Patterns and Policies in the Context of "Double Carbon Suggestions: Taking Huangpu District of Shanghai as an Example

Under the background of "double carbon," the current recyclables recovery mode and policy suggestions in Huangpu District, Shanghai [8] are put forward. According to the Guiding Opinions on Accelerating the Establishment of a Green, Low-Carbon and Recycling-based Economic System issued by the State Council, it is required to strengthen the recycling of renewable resources and accelerate the construction of the recycling system of waste materials before the carbon dioxide emission peaks in 2030 and carbon neutrality is achieved in 2060 [8].

3.1.2. Xiamen Waste Management

Solid waste management in Xiamen covers industrial, medical, and domestic waste collection, treatment, and disposal. Socio-economic development has increased waste generation and discharge, and safe disposal is imminent.

3.2. Case Description

3.2.1. Waste Management Strategy for Huangpu District, Shanghai

Huangpu District has accelerated the construction of recyclables points and stations, expanded recycling channels throughout the district, and established four types of service points in residential districts and some commercial complexes. Huangpu District has formulated a policy to guarantee subsidy funds by the district finance, which is included in the annual special fund budget, regarding the standard of Shanghai's domestic waste disposal fee, mainly used to subsidise the market price of enterprises and the classification, recycling, transfer, disposal and other aspects of the reduction of domestic waste and resources to provide financial security [8].

3.2.2. Xiamen City Waste Management Strategy

Xiamen's waste management strategy includes building a waste-free city, upgrading treatment capacity, strengthening medical waste regulation, developing a waste-free Heron Island, and monitoring and evaluation. The strategic goal is to reduce, resource, and harmlessly manage waste and promote sustainable urban development.

3.3. Case Description

3.3.1. Analysis and Discussion of the Shanghai Case

Ten streets in Huangpu District have recycling points and cooperate with enterprises to collect recyclables, including regular scheduling, telephone booking, and integrated mode. Most streets have one recycling transfer station; some have more than one. Five hundred fifty-six service points and 1 district transfer station were built in 2021, and professional companies were commissioned to operate them to improve efficiency [8].

Table 3: Basic situation of construction and recycling of recyclables transfer stations in Huangpu District[8].

Subdistrict	Situation at transit centres			Recyclables recovery
	Quantities	Area/m ²	Design ability/(t/d)	
R	1	150	20.00	Glass, clothing mainly, wood, foam generally not recycled
L	1	150	15.00	Glass mainly, foam, clothing in small quantities
H	1	150	25.00	Paper, glass, plastic mainly, foam secondly, clothing, wood to a lesser extent
W	1	15	0.50	Foam-based, small amounts of glass
N	2	230	9.00	Glass, foam mainly, clothing in small quantities
T	1	200	20.00	About 50 percent glass and the remaining 50 percent
Y	1	100	15.00	Paper, plastic, glass primarily, foam secondarily
D	2	212	4.42	Paper, foam mainly, plastic secondarily, clothing in small quantities
X	1	200	10.00	Glass, paper, plastic mainly, foam, clothing to a lesser extent
B	2	350	8.00	Glass, clothing, foam-based

Residents can send their recyclables to recyclers, smart cabinets, or service points, where they will be collected and transported by two-networked vehicles, sorted, baled, weighed, and then transported to collection and distribution yards, where they will then be statistically counted, managed and monitored, before finally arriving at the recycling centre for processing [8]. A community survey in Huangpu District showed that 64.54% of respondents had a strong awareness of waste classification and could classify it in detail; 28.29% of respondents were aware but did not classify it comprehensively, and a small number did not classify it [8].

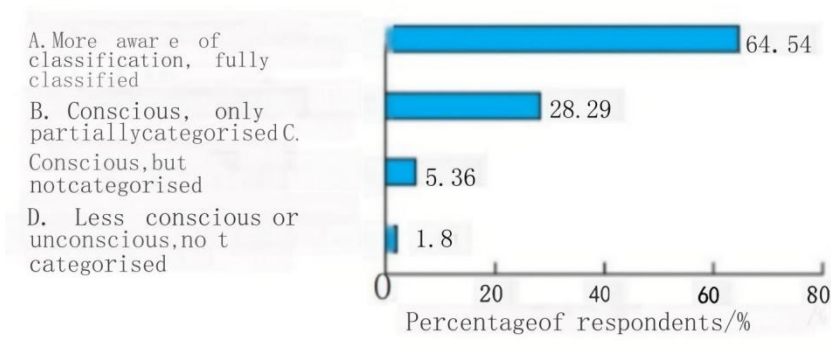


Figure 2: Awareness of Waste Separation among Community Residents in Huangpu District[8].

Figure 3 shows that the main way residents in Huangpu District dispose of recyclables is by separating them and putting them into recycling bins, followed by selling them to individual recyclers and giving them to cleaning and recycling personnel without compensation [8]. However, two years after implementing the Shanghai Municipal Domestic Waste Management Regulations, 35.35% of residents still needed to separate and put out their recyclables according to the regulations. Figure 4 reveals the main reasons for the barriers to sorting, including unclear sorting standards, unreasonable drop-off times, time-consuming and laborious sorting, and inadequate facilities. 57.43% of the respondents needed clarification about the sorting standards, and 48.62% thought the drop-off times were unreasonable, e.g., they missed them because of work [8].

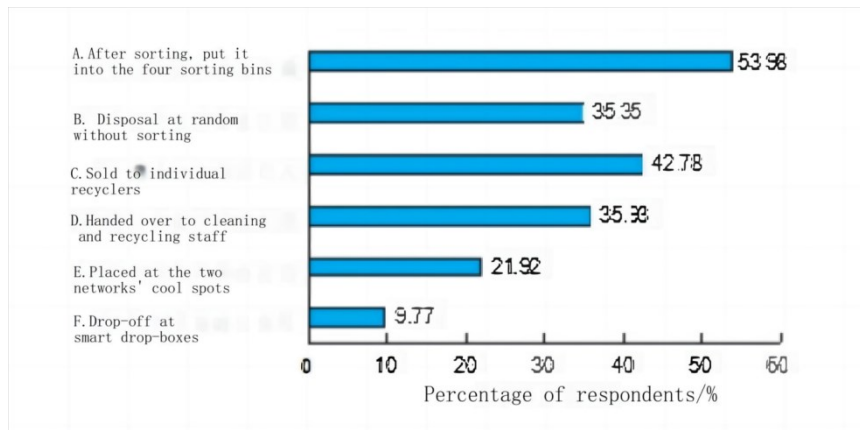


Figure 3: Disposal of recyclables by residents in Huangpu District[8].

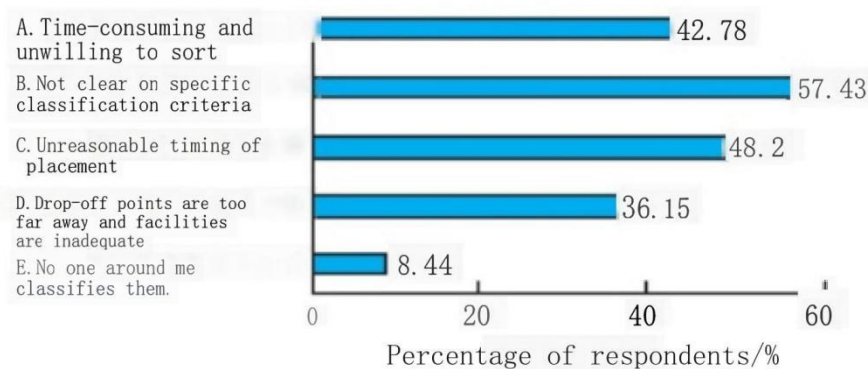


Figure 4: Main reasons cited by community residents in Huangpu District as barriers to sorting recyclables[8].

3.3.2. Analysis and Discussion of the case of Xiamen

Hazardous wastes in Xiamen mainly come from industrial and medical sources, with industrial wastes dominated by waste-to-energy incineration, metal surface treatment, and the manufacture of electrical and electronic equipment [9]. Haicang District is the largest generator of industrial waste, followed by Xiang'an District and Huli District [9]. The amount of medical waste generated in the city is 3,395 tonnes, all handled by Xiamen Oasis Environmental Protection, with a treatment rate of 100%.

However, in Xiamen City, the treatment of solid waste facilities is insufficient, the amount of generation over the years, the existing facilities can not meet the demand, the lack of dedicated disposal landfill, industrial waste accumulation is severe, and even mixed with domestic rubbish, the formation of environmental safety hazards [9]. Solid waste management is weak, compared to water and air pollution, and needs to be paid more attention to; insufficient capacity of the management department, the regulatory system, and the market economy does not adapt. With increased domestic waste, harmless treatment occupies land resources and threatens the ecological environment. Existing technologies have environmental hazards, such as landfill leachate, gas (biogas) generated by the treatment of secondary pollutants [9], waste incineration, hazardous waste, medical waste incineration, secondary pollutants generated by the comprehensive utilisation of waste, the lack of effective countermeasures [9].

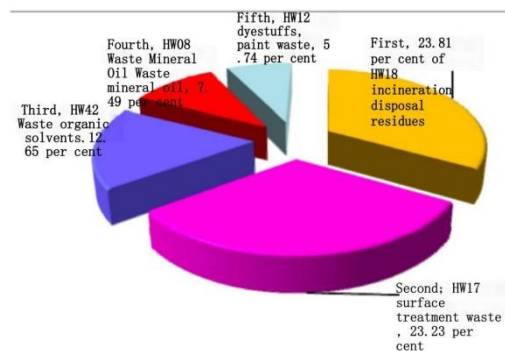


Figure 5: Composition of major industrial hazardous wastes in Xiamen[9].

3.4. Case Comparison

Shanghai's waste management attaches importance to source separation and reduction, with sound policies and regulations and effective treatment and utilisation. However, selecting sites for transfer facilities is challenging, and the facilities could be better. The atmosphere of public participation is intense, but the awareness of waste classification needs to be stronger, and the methods need to be standardised. The utilisation rate of intelligent recycling facilities is low, the management mechanism needs to be more sound, recycling points are few, the time is unreasonable, and the market is chaotic, affecting residents' participation. Low-value recyclables are challenging, market enthusiasm is low, and the recycling network system needs to be fixed.

Xiamen has achieved remarkable results in reducing domestic waste at source, resource utilization, and harmless treatment, with the city's domestic waste resource utilization rate rising from 43.2 percent to 82.27 percent and the harmless treatment rate reaching 100 percent. However, problems such as inadequate infrastructure, limited hazardous waste disposal capacity, and weak enforcement of laws and regulations still require attention and improvement.

4. Sustainable waste management recommendations

"Waste-free city" is an urban development concept that pursues the efficient use of resources and the reduction of waste generation, involving urban planning, infrastructure, production methods, and other aspects to achieve synergistic development of the economy, society, and the environment [10]. This concept originated from the early research and advocacy of environmentally sustainable development and circular economy and is the result of the joint efforts of experts, urban planners, and environmentalists. Globally, including China, more and more cities, organizations, and individuals are promoting the development of "waste-free cities" to achieve a sustainable urban future [10]. The concept is committed to environmental protection, promotes economic development and social progress, lays the foundation for building harmonious and livable cities, and advocates a beautiful vision of harmonious coexistence between human beings and nature.

4.1. Technological innovation

Science, technology, innovation, and development can make waste management and resource use more efficient, environmentally friendly, and sustainable by contributing to the achievement of "waste-free cities"[10]. Innovative science and technology solutions can help transform cities and promote sustainable economic development and environmental protection[10]. Below are the directions for science, technology, and innovation for waste-free cities.

4.1.1. Technological innovation in waste treatment

The realisation of a "waste-free city" requires continuous development and innovation of waste treatment technologies. Scientific and technological progress promotes the development of waste treatment technologies, such as waste classification and recycling, waste treatment and conversion, and waste resourcing [10]. The development of new technologies improves waste treatment efficiency, reduces waste generation, and lowers the environmental impact [10].

4.1.2. Innovation in circular economy models

New technological inventions help the circular economy. Information technology, the Internet of Things, and artificial intelligence enable waste tracking, monitoring, and management, promote waste recycling, and improve resource use efficiency [10]. At the same time, science, technology, and innovation promote sustainable product design and the development of circular economy.

4.2. Policy recommendations

4.2.1. Research and analysis

By collecting and analysing these data, precise analyses can be produced, leading to the formulation of targeted policies and regulations for better waste management and resource use[10].

4.2.2. Setting goals and targets

Setting clear goals and targets is critical to achieving a "waste-free city". Governments should set specific waste reduction and recycling targets and renewable energy and energy transition targets[10]. These targets and indicators should be quantifiable and measurable to monitor progress and assess effectiveness.

4.3. Social participation

Increase community participation and public awareness of environmental protection, motivate citizens to actively participate and take responsibility, and form a common motivation to achieve a "waste-free city". Through publicity and education, to enhance public understanding and awareness of a "waste-free city" and to build a sustainable lifestyle and environmental culture [10]. The following are the directions for developing a "waste-free city" regarding community participation and awareness-raising.

4.3.1. Community education and awareness

Implementing community education and publicity programmes to raise residents' awareness and understanding of a "waste-free city" [10]. To educate and motivate residents to raise their awareness of environmental protection and participate in environmental protection actions by organising training courses on waste separation and resource utilization, organising environmental protection seminars, and showcasing examples of sustainable living.

4.3.2. Community participation mechanisms

Promote community participation in zero-waste urban practices by setting up waste management groups or environmental volunteer organisations to participate in waste separation, recycling and sustainable living. Community meetings are held to collect residents' opinions and suggestions and involve them in waste management decisions [10].

4.4. Directions for the development of "waste-free cities" in terms of economic incentives and market mechanisms

"Waste-free cities" achieve efficient and sustainable development through economic incentives and market mechanisms that motivate residents and enterprises to participate in waste management and resource utilisation [10]. It guides funds to relevant green economy projects and industries and promotes the sustainable development of the urban economy [10]. In this context, "waste-free cities" will welcome new development opportunities and move towards a greener, more environmentally friendly, sustainable future.

4.4.1. Creating economic incentives

Governments can promote the development of waste-free cities through economic incentives. For example, it can implement incremental and differential charging systems for waste disposal and promote waste separation and recycling among residents and enterprises [10]. In addition, governments can incentivise enterprises to invest in innovative waste treatment and resource utilisation technologies through financial subsidies, tax incentives, or rewards.

4.4.2. Development of waste trading markets

The government can stimulate the market value of waste by establishing a trading platform and formulating trading rules to promote waste reuse and recycling and realise enterprises' economic benefits [10].

5. Conclusion

The waste management cases of Shanghai and Xiamen illustrate the cities' initiatives to create waste-free cities. Innovative approaches and collaboration between government, business and the

public have led to waste reduction, resource utilisation and non-hazardous waste. Shanghai emphasises planning and technological innovation, promoting green infrastructure, waste separation and circular economy, and developing innovative waste treatment technologies. Xiamen focuses on cross-sectoral collaboration and public participation, establishing coordination mechanisms, strengthening integrated planning and implementation, raising environmental awareness, and promoting corporate participation in green supply chain management. By combining these approaches, the two cities have reduced waste generation, improved resource efficiency, and contributed to sustainable development goals. Other cities can learn from these experiences.

The limitations of this thesis are mainly in the research methodology, perspective, and literature content. Literature review and case studies were used and lacked empirical evidence. In the future, a combination of quantitative and qualitative methods can be used to analyse urban waste management practices in depth and improve the reliability of the study. Focused on urban waste management and should have covered rural areas. Future research could expand the scope to include rural waste management. Literature citations are limited, and some need to be updated. Future research could increase the number of citations and focus on the latest research findings to improve the value of the paper. There are limitations in the research methodology, perspective and literature content, which could be improved and optimised for future research.

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The Enactment of Sustainable Development Goals at a Local Scale Leads to Various Implications

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Abstract: The hallmark of global sustainable development efforts is the Millennium Development Goals (MDGs) initiative, so the SDGs were proposed after this. Early initiatives highlighted the need for a more comprehensive and globally applicable set of goals, thus laying the groundwork for the SDGs. Among them are sustainability, ecological environment protection and so on. This article explores the local implementation and impact of the United Nations Sustainable Development Goals (SDGs). The main questions are how to effectively implement SDGs policies in different social cultures, and the role of local government and community organizations is carefully analyzed. These are also areas where SDGs can be effectively promoted at the local level through multi-stakeholder collaboration, inclusive policies and innovative approaches. And there are three field examples to prove its effectiveness. For example, sustainable transport and energy management in Barcelona, participatory planning in Kerala and community conservation in Kenya. The significance of the study highlights the key role of local action in achieving the global Sustainable Development Goals, and provides concrete cases for analysis.

Keywords: Sustainable Development Goals (SDGs), local Implementation, Participatory Planning, Community-Led Initiatives, Cross-Cultural Policy Application

1. Introduction

The Sustainable Development Goals (SDGs) were proposed by the United Nations in 2015 to address a range of major global challenges such as climate change and social imbalances, and to achieve a just and sustainable world by 2030. Among them, the local government, as the command of the grassroots administrative departments, plays a key role in realizing these goals. This can be achieved by creating natural security, promoting open well-being and developing sustainable cities. In addition, it is necessary to consider the unique cultural customs of each place and how to implement them. In particular, concerns about resource scarcity and gaps in capacity to fully grasp governance dynamics are also significant. Taking into account these complex factors and effectively coordinating their implementation, the SDGs can be fully implemented and balanced at the local level. This paper analyzes examples of local implementation of SDGs policies, and provides lessons learned on the various ways in which regional challenges and SDGs have been applied, to understand the interpretation and implementation of the SDGs in different contexts.

2. Literature Review

The literature review on localizing the sustainable development Objectives (SDGs) brings into center the centrality of executing these objectives at the nearby level to viably handle worldwide challenges.

In arrange to address sustainability concerns, Moallemi and colleagues stress the importance of an intriguing strategy that combines computational apparatuses with partner interaction. They emphasize the importance of group learning in this circumstance [1].

Fenton and Gustafsson investigate how neighborhood SDGs are molded by multi-level administration. Taking prompts from past ventures like Neighborhood Agenda 21, they advocate for the incorporation of SDGs in local government methodologies, arrangements, and hones [2].

Urban sustainable development objectives are put forth by Klopp and Petretta, who call for a modification of these goals based on comprehensive, straightforward, and local information hones [3]. In parallel, a case considered from southern Australia is displayed by Szetey et al., demonstrating a participative [4].

3. Localizing the SDGs through inclusive practices and policy adaptation

The importance of the local government's strategic plan for the implementation of the SDGs is comprehensively analyzed here. Study how these sectors integrate policies into agendas and development goals. So through this set of approaches, we can gain insight into how the SDGs have been adapted and implemented in different contexts and provide examples and rich experience to inspire other local initiatives.

According to the literature of Moallemi et al, multi-stakeholder partnership activities can achieve the success of localization of SDGs [1]. To do this, a range of sectors, including industry, academia, society and government, need to cooperate. It also emphasizes the value of multidisciplinary innovation and the active participation of all partners. These partnerships facilitate resource sharing and knowledge exchange between society and local government. Therefore, the unified goal of sustainable development strategy between societies is formed.

Szetey et al. proposed the same strategy of top-down participation from the local government to the citizen community [5]. This focuses on empowering local communities and actively involving them in the planning of sustainable development projects, thus fully integrating the SDGs locally. More importantly, it is important to incorporate participatory strategies for civic assembly and inclusive decision-making so that society's citizens develop a sense of ownership and ensure that these measures run smoothly.

More and more studies support the idea that communities should help in reaching Sustainable Development Goals. This shows how vital their involvement is. By being actively involved, local people not only uphold the goals, but they also make reaching sustainable development easier and more related to their communities.

According to the research results of Fenton and Gustafsson, the importance of multi-level governance and the integration of sustainable development Goals into urban strategies are emphasized. The importance of aligning local policies with the SDGs goals was also highlighted [2].

4. Case Studies and Best Practices

Barcelona has adopted a progressive strategic approach to achieving the Sustainable Development Goals, focusing on sustainable transport, social inclusion and renewable energy. Its Urban Mobility Plan (2013-2018) aims to create an efficient and environmentally friendly transport system and is committed to promoting sustainable and accessible transport options [6,7]. In addition to developing the solar energy field, photovoltaic panels are installed on large structures. In Mercabarna, for example, the largest rooftop solar station in the Iberian Peninsula has been formed.

Beyond that, the Urban Resilience strategy focuses on making meaningful improvements to urban infrastructure. These include strengthening school facilities as well as social infrastructure and developing integrated service centers for the elderly with special attention to vulnerable groups.

Kerala's strategy is deeply rooted in local governance, with local governments focused on meeting grassroots needs and improving social well-being adopting a decentralized participatory planning approach. Significant progress has been made in areas such as health care, gender equality and education. An article on the Keraleeyam 2023 website entitled "Decentralized Planning Framework in Kerala: a Blueprint for Inclusive Development" discusses this process of decentralized planning in which more than 1,200 local agencies are involved in the fair and efficient allocation of funds [8].

About 100 community-protected areas have been established in the Kenyan region. These areas are vital for wildlife habitat and promoting tourism, which benefits the country's economy and the environment. This approach therefore reflects the link between community development and environmental protection. The key reason for these efforts is to empower women in leadership and contribute to improving access to education and health care, promoting gender equality and inclusive growth [9].

As a result of these examples, other regions pursuing sustainable development will be able to see how local initiatives can help achieve sustainable, inclusive development on a global scale. Achieving global goals requires local action. Achieving SDGS requires, among other things, the formulation of policies, the implementation of practical strategies, and community engagement.

5. Implications and limitations

Localizing Sustainable Development Goals (SDGs) brings forth distinct opportunities, yet also presents significant challenges. Gaining a thorough understanding of local dynamics and devising effective strategies is key to improving local relevance and impact of sustainability activities. This entails managing intricate problems while maximizing the chance for progress. By tailoring their strategies to local needs and conditions, local actors can considerably contribute to international sustainability initiatives.

5.1. Implications

5.1.1. Economic and Social Implications

Successful integration of the SDGS into local policies will not only boost economic development, but also generate significant social benefits. From an economic point of view, Barcelona can demonstrate that the shift to sustainable energy projects not only reduces dependence on conventional electricity, but also opens up new environmental jobs. Similarly, the emphasis on participatory strategies in Kerala has significantly upgraded its education and healthcare sectors, thereby improving the quality of its workforce. In addition, investing in these key sectors not only improves human resources but also lays a solid foundation for future economic growth. In addition, investing in these key sectors not only improves human resources but also lays a solid foundation for future economic growth.

In addition, from the perspective of social benefits, the implementation of the Sustainable Development Goals (SDGs) has brought profound changes at the social level. The Kenya Community Protection Initiative is a prominent example of a project that has gone beyond environmental gains by empowering women to lead in championing gender equality. So this approach not only promotes biodiversity, but also fosters a more inclusive and equitable community. Involving women in decision-making can enrich the work through different perspectives and improve the effectiveness of the results. So Kenya's example can highlight improved quality of life, reduced disparities, and strengthened community bonds.

5.1.2. Local Innovation and Scaling Up: Advancing SDGs through Community-Led Solutions

Local governments promote creative solutions while integrating the SDGs. Research by Klopp and Petretta shows that collecting local environmental data is critical because it determines the basis for developing innovative solutions to challenges unique to each city [3]. There are also several opportunities for each place to develop new projects and technical capabilities. This approach highlights the potential for local environments to serve as laboratories for SDGs. This is where effective strategies can be tested and then adapted to scale up applications. The iterative process of local innovation and adaptation thus highlights the dynamic form of implementation of the SDGs. It also highlights the potential of local initiatives to influence and shape broader SDGs strategies on a global scale.

5.1.3. Environmental Benefits

Solar power and sustainable transportation initiatives in Barcelona have reduced greenhouse gas emissions significantly. Kerala, on the other hand, has managed its natural resources sustainably through participatory planning. Kerala has adopted a participatory strategy to manage its natural resources. Kenya, on the other hand, is trying to preserve its ecological diversity through local policies. So in these cases, local efforts play a key role in combating climate change and protecting the environment.

5.1.4. Broad and Numerous Goals

There must be a way for Kerala to advance gender equality while simultaneously enhancing education, and Kenya must find a way to balance tourism growth with environmental conservation. Both are vital, but a more sophisticated strategy is needed to promote tourism and protect biodiversity. As a result of the ambitious development agenda of the Sustainable Development Goals, nations with limited resources face difficulties allocating funds. These examples so demonstrate the difficulty in implementing the SDGs and the necessity of resource management and strategic development.

5.2. Limitations

5.2.1. Lack of Binding Nature

The Sustainable Development Goals (SDGs) are voluntary in their national and local governments, relying on commitments between countries rather than binding by law. This leads directly to differences in the level of participation and improvement between countries. For example, Barcelona's urban sustainability efforts depend heavily on state support, highlighting the interplay between local and higher levels of government. Local governance in Kerala exemplifies how proactive local efforts complement national strategic development. Community-driven conservation in Kenya demonstrates the power of grassroots initiatives supported by international cooperation and the initiative of local communities. So these examples show how implementation and success of the SDGs can vary greatly depending on the progress of implementation at the national and local levels.

5.2.2. Overcoming Financial and Technical Hurdles

In addition, Jimenez-Aceituno and the team point out the difficult challenges that local initiatives face in achieving the SDGs [10]. For example, limited funds, information and technical knowledge. The research team suggests adopting creative solutions to overcome these barriers, with a strong emphasis on learning the financial and professional aspects that are capable of supporting SDGs' success. A creative financial strategy and initiatives to increase capacity were also mentioned by the research

team. It is recommended to reduce local entity strategies to help them successfully achieve the SDGs goals. It is therefore important to empower local stakeholders by providing them with the resources and tools they need to achieve the SDGs.

6. Conclusion

The cases of Barcelona, Kerala and Kenya are concrete examples of adapting the SDGs to local contexts, highlighting the issues involved in achieving them and the far-reaching impact of local initiatives. These cases also highlight the importance of value and feasibility in building a fully inclusive future. By valuing local ecological diversity and encouraging community participation, these approaches translate into important behavioral programs and promote sustainable development. In defiance of the realities of challenges such as mandatory resources, innovative problem-solving and a collaborative spirit were found in local governments to help align goals with those of the world. A key factor in the long-term success of the SDGs will be reliable coordination between local government agencies and global initiatives. This collaborative and win-win approach underscores the transformative impact that community activism can have worldwide. So by every community around the world contributing in a local way, people can move towards a more sustainable future.

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Transformative Impact of Green Jobs on Employment Opportunities for Women and Minorities in America

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Abstract: The exigence of conducting this research is the fast-growing threat of climate change in America. Climate change brings changes in American society socially and economically. This paper aims to explore how the development of green jobs impacts employment of women and ethnic minorities in the United States. The paper will utilize an approach that involves analyzing historical data, statistics, and trends to assess how green jobs could affect women and minority groups in the United States. Green jobs can be easily integrated into existing industries and provide the opportunity to improve female and ethnic minority employment in the United States. Women and ethnic minority groups are currently underrepresented in green jobs and other high-income occupations, causing significant wage gaps between them and white men. Through the pursuit in higher education and further advocating of sustainability, women and ethnic minority have the opportunity in the future to thrive in green jobs.

Keywords: Green Job, Employment, Women

1. Introduction

Climate change is a major concern in the 21st century. It has done irreversible damage across the globe. Climate change has brought more frequent and intense drought, heat waves, and storms. Aside from exacerbating natural disasters, the rising sea levels, melting glaciers, and warming oceans caused by climate change directly harm animals by destroying their natural habitats. Climate change also wreaks havoc on people's livelihoods and communities. Climate change has greatly affected America. There were 8648 wildfires in California in 2020. They burned 4,304,379 acres of land, killed 33 people, and destroyed 11,116 structures [1]. In late August 2021, Hurricane Ida hit Port Fourchon, Louisiana with a wind speed of 150 miles per hour. It caused \$75 billion worth of damage and killed 107 people [1]. Natural disasters such as those will only increase in frequency and intensity due to climate change. Climate change will cause shifts in the economy, culture, and health of people in America.

Mitigation strategies are essential in slowing the progress of climate change. The United Nations has established 17 Sustainable Development Goals, aiming to promote sustainability from social, economic, and environmental perspectives worldwide. They are in the 2030 Agenda for Sustainable Development, which aims to promote prosperity while protecting the planet and the environment. The 17 Sustainable Development Goals are No Poverty, Zero Hunger, Good Health and Well-being, Quality Education, Gender Equality, Clean Water and Sanitation, Affordable and Clean Energy,

Decent Work and Economic Growth, Industry, Innovation, and Infrastructure, Reduced Inequality, Sustainable Cities and Communities, Responsible Consumption and Production, Climate Action, Life Below Water, Life on Land, Peace, Justice, and Strong Institutions, and Partnerships for the Goals [2]. They provide a framework for global action to combat climate change and achieve a more sustainable world.

Mitigation efforts are not solely in the realm of global initiatives. People can mitigate on an individual level by reducing greenhouse gas emissions, saving energy, consuming more sustainably, etc. Individual countries can mitigate this by developing a sustainable economy and infrastructure. Green and sustainable job development is a way to mitigate climate change while providing further employment opportunities. This paper will explore the development of green jobs and how it may impact the employment opportunities and justices of women and minority groups in America. The method the paper will use is examining historical data, statistics, and trends to analyze the impact of green jobs on women and minority groups in America.

More importantly, this study derives motivation from the increasing importance of considering the impact of sustainable green jobs development on the employment of women and ethnic minorities in America. This paper is structured as follows. Section 1 will explore the expansion of development of green jobs in the United States and analyze the challenges of implementing nationwide green jobs development. Section 2 will discuss the historic and current trends of female employment in the US, as well as analyzing how women employment could be impacted by green jobs development. Section 3 will discuss the historic and current trends of ethnic minority employment in the US, as well as analyzing how ethnic minorities employment could be impacted by green jobs development.

2. Development of Green Jobs in the United States

Many green jobs emerged in the past decade in reaction to the sustainable movement fueled by the climate crisis. Some of the most popular green jobs include renewable energy specialists, energy efficiency consultants, climate scientists, environmental engineers, sustainable agriculture specialists, foresters, conservationists, green building designers, and climate policy analysts. Green jobs have the potential to mitigate the climate crisis by introducing more sustainable practices while offering new employment opportunities. This section will focus on the development of the emerging green jobs and the benefits of their developments on the environment.

2.1. Challenges and Inconsistencies of Implementing Green Jobs in America

The energy sector contributes to the most greenhouse gas pollution and emission in the US. In 2022, around 33% of the total U.S. energy-related carbon dioxide (CO₂) emissions were attributed to the electric power industry; the electric power sector accounted for roughly 31% of the CO₂ emission [3]. Fortunately, the development of renewable energy could help reduce the environmental pollution created by the energy sector. In addition to reducing pollution, development of renewable energy also drives economic growth, benefiting human development. There are some challenges, however, for the full implementation of renewable energy.

The economic challenges in adopting renewable energy nationwide include high initial costs, prolonged payback periods, limited credit access, and insufficient government financial support. These complications, from upfront investments to slow returns and financial barriers, must be solved to promote widespread adoption of renewable energy. Technical challenges also exist in the full implementation of renewable energy. The limited capacity to design, install, operate, manage, and maintain renewable-based modern energy services restricts the further implementation of renewable energy. The expansion of renewable energy is hindered not just by technological and financial constraints, but also by informational and human resource challenges. The deficit in comprehensive

knowledge concerning renewable energy and energy efficiency obstructs the creation of informed and impactful policies. Moreover, this gap underscores the need for enhanced data dissemination and education in the field, as well as a strategic focus on developing skilled professionals who can navigate and promote the transition to sustainable energy practices.

Aside from the economic, technical, informational and human resource challenges, policy challenges hinder the full implementation of nationwide renewable energy. The concerns for policy challenges for fully implementing renewable energy in the United States include lack of incentives for private sector involvement and inconsistent policies. The main purpose of any business is to make a profit. The main source of energy utilized by companies in the US is natural gas (Figure 1).

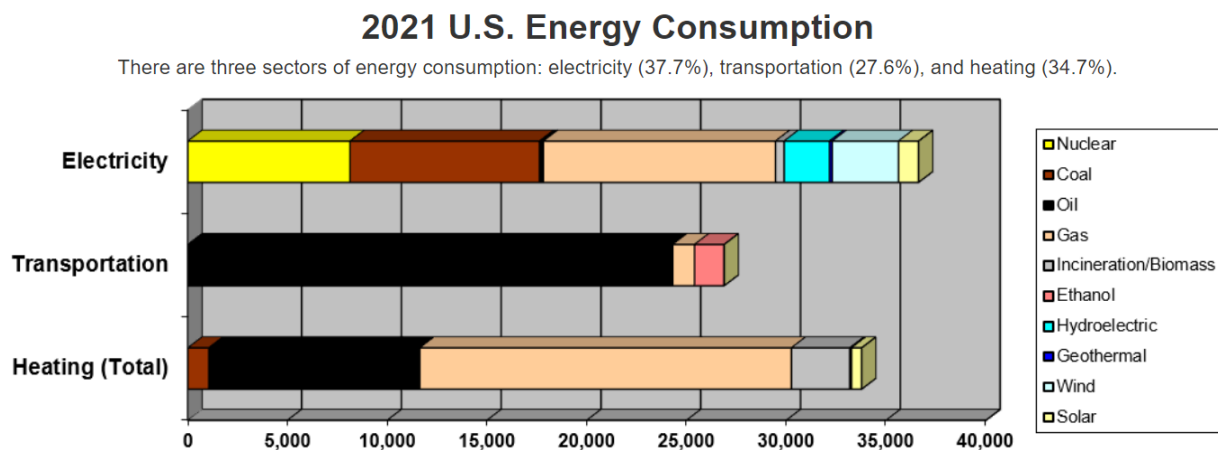


Figure 1: 2021 U.S. Energy Consumption [1]

Burning natural gas results in the formation of nitrogen oxides (NO_x), which then serve as precursors to smog. Additionally, trace amounts of sulfur, mercury, and particulates are produced during the combustion process of natural gas [4]. The combustion of natural gas poses dangers to local communities, and constitutes a noteworthy contributor to global warming, both through direct burning as a fuel and through potential leaks or direct releases into the atmosphere. Smog and other chemicals formed from natural gas combustion are hazardous air pollutants which can lower the air quality of the region, causing detrimental health problems for humans and animals. However, companies continue to use natural gas as the main source of energy because natural gas is relatively inexpensive and more environmentally friendly compared to other energy sources used such as oil and coal.

Although using natural gas is less damaging to the environment than other traditional energy sources, it still has a negative impact on the environment. In order to reduce the damage brought by burning natural gas, further development of renewable energy and energy efficiency provide crucial and more affordable solutions against pollution by diversifying the electricity source away from gas. Carbon pricing methods are currently used in the US to encourage companies to reduce their carbon footprint [5]. Although carbon pricing methods such as carbon taxation and carbon cap and trade programs help reduce pollution in the US, it is not a long-term solution to climate change. They are not implemented consistently in the US. Despite its inconsistencies, carbon policies encourage the formation of green jobs in the renewable energy sector by penalizing companies' carbon emission, thus encouraging them to seek alternative energy sources to reduce emissions.

2.2. Career opportunities in Renewable Energy Fields

There are many career opportunities created by renewable energy. Some available careers in the renewable energy field are solar and wind.

The solar energy industry has expanded rapidly ever since 2008. The growth has led to the generation of numerous new jobs within the industry, with over 208,000 people currently employed, with expectations of further substantial future expansion [6]. There are multiple options for solar energy jobs, ranging from manufacturing, system design, project development, to installation and operations. The different difficulty levels of the solar energy jobs also make the career more approachable and easily enterable. Some of the most popular solar energy related jobs are solar panel installer, solar energy technician, solar system sales representative, solar project manager, solar engineer, solar maintenance technician, solar electrician, solar designer, solar researcher, and solar consultant [7]. It is not difficult to integrate into the solar energy industry as it incorporates people from various professional backgrounds, ranging from scientists to marketers.

Wind energy is another fast-growing green industry. In 2021, wind power constituted 32% of the growth in the US. energy capacity, supporting 120,000 Americans and generating sufficient energy to supply 40 million homes in the country [8]. The wind market reports for 2021 reveal that the continued growth of domestic wind power is emerging as a vital contributor to clean and cost-effective energy generation. This aligns with President Biden's objectives of achieving 100% clean electricity by 2035 and establishing a net-zero economy by 2050 [8]. The wind energy industry offers jobs to people with varying degrees of education, from bachelor's degrees to PHD. Common types of wind energy careers include project development, component manufacturing, construction, operations, education training, and research. Some green jobs centered wind farm developers, project managers specializing in wind energy, wind resource analysts, electrical engineers focused on wind energy, environmental specialists in the field, wind energy analysts, operation and maintenance (O&M) technicians, construction managers in wind energy, grid integration engineers, health and safety officers within the wind energy sector, quality control inspectors, and community relations managers for wind energy projects.

There are more green jobs development outside of the renewable energy sector. Some examples of them are environmental engineers, recycling plant workers, sustainable architects, organic farmers, conservation scientists, water quality analysts, green building inspectors, environmental educators, sustainable transportation planners, wildlife biologists, climate analysts, sustainable forestry managers, waste management specialists, green chemistry researchers, and eco-friendly product designers. They are diverse and all come from different backgrounds, which makes workers integrate easily into the green workforce.

3. Impacts of Green Jobs Development on Women in America

Equal wage and employment opportunities for women gained significant momentum in the 1960s. The Equal Pay Act of 1963 (EPA) passed in June 1963 spearheaded the civil rights legislation centered around employment discrimination [9]. It protected both men and women who perform equal work in the same establishment from wage discrimination due to different sex. Through the various civil rights developments and women's rights movement since then, women's opportunity at fair employment and equal wages have increased substantially [9]. However, wage gaps still exist for women in the US. This section will explore the history of employment for women in the US, current employment for women in the US, and how the development of green jobs could impact the employment of women in the US.

3.1. History of Female Employment in America

American women first entered the workforce in the 1800s due to the Industrial Revolution. One of the earlier examples of women entering the workforce is Lowell, Massachusetts. Francis Cabot Lowell, a wealthy Boston merchant, wanted to establish an entire community involved in textile production [10]. He chose to hire young women to work in the mills because young women could not form a permanent working class since they would leave in a few years to become wives and mothers, and women were less expensive and easier to control. Although they could earn money through their labor, the women were strictly controlled by their employers. Aside from doing their daily tasks in the mills, those women also had to comply with social expectations of being gentle women who were eligible for marriages [10].

Lowell's community ended in the mid 1800s as the price of textiles decreased. In order to keep making profits, Lowell decided to cut labor costs by mandating workers to manage more machines. The working conditions in the mills worsened: people were going deaf due to the loud noises of the machines and the rate of lung diseases rose because of the lack of ventilation in the mills. In response to the inhumane working conditions, the Lowell women formed the Lowell Female Labor Reform Association, which fought against the long working days and unhealthy working environment [10]. Although women were treated unfairly in the mills, Lowell's community pioneered employment of women in America.

Women's rights in the US took a big step forward in 1919. The 19th amendment was passed that year and it gave legal suffrage rights to American women. The advancement in women's political rights also provided women more opportunities in the workforce. Before then, most women remained home and only poor or unmarried young women worked outside the home. However, from the 1930s to the mid-1970s, the economic involvement of women saw a continual increase; more married women were joining the American workforce. Even with increasing participation of women in the American workforce, they were still expected to have temporary careers and secondary earners that supported their husbands. In the 1970s, Figure 2 shows that around half of the single women and 40% of the married women in the US were involved in the labor force [10].

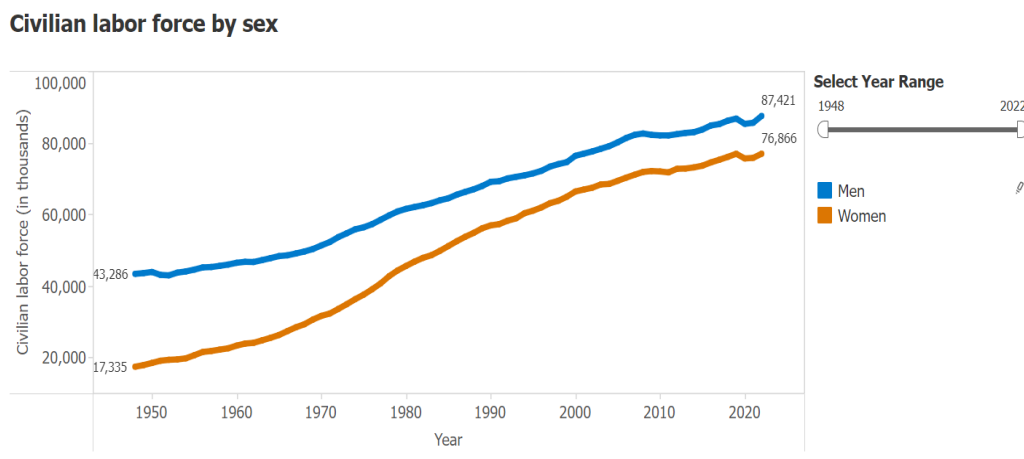


Figure 2: Civilian labor force by sex [10]

By the late 1990s, more women sought after higher education which opened more employment opportunities for them. Women began going into previous male dominated fields such as doctors, lawyers, managers, and professors. The wage gap between male and female in the job was a major concern. In Figure 3 women on average only made around 70% of what men made in the same professions in 1990 [10].

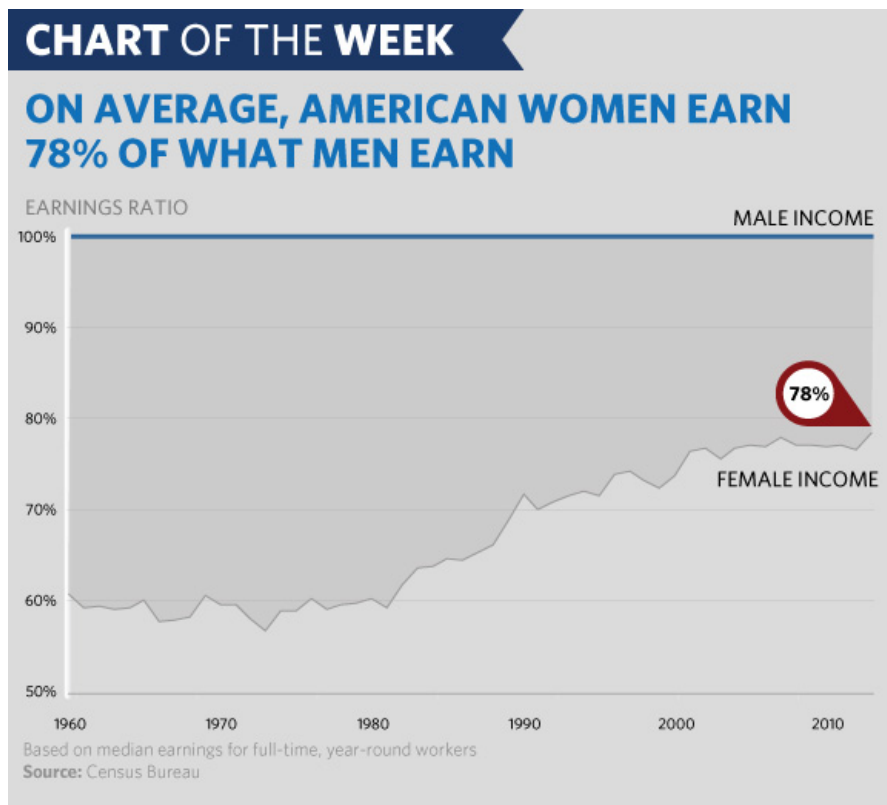


Figure 3: ON AVERAGE, AMERICAN WOMEN EARN 78% OF WHAT MEN EARN [10]

3.2. Current Trends in Female Employment in America

Most women in the US today work full time. Around 75% of prime age women are employed and 84% of the employed women work full time [11]. Overall employment rate in the US was negatively impacted during the COVID pandemic but steadily rose up to pre pandemic levels in late 2022 due to the American Rescue Plan and other fiscal policies in reaction to the pandemic. After the pandemic, there was improvement in the employment in women with minor children due to the reopening of schools and childcare services. The proportion of working mothers has risen significantly. Regardless of their youngest child's age, employment to population ratios were higher at the end of 2022 compared to the pre-pandemic levels in 2019. Overall, employment for women in the modern labor market is far more positive than before.

Despite the improvement of employment for women in the US, there still exists a wage gap between women and men in the same industries. The wage gap worsens with age. Female workers from the age 16 to 24 have average weekly earnings 8% lower than the average weekly earnings of their male counterparts [11]. Female prime age workers, 25 to 54, earn 16% less than male workers. For women who age from 55 to 64, they earn 22% less than men at the same age [11]. Even worse, women who are older than 65 years old earn 27% less than men [11] (Figure 4).

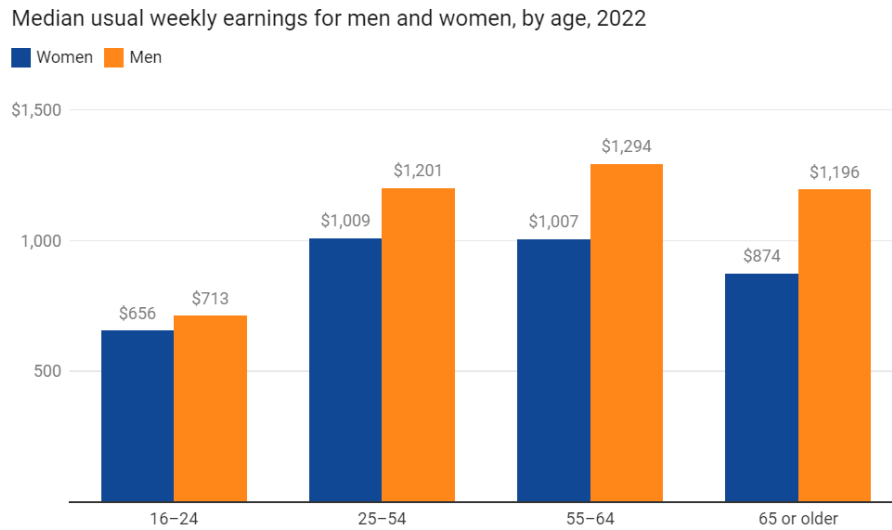


Figure 4: Median usual weekly earnings for men and women, by age, 2022 [11]

Women with lower education suffer even more and experience greater occupational segregation, where a particular demographic group is disproportionately represented in a certain job category, could be due to systematic historical exclusion. On the other hand, employment of women with four-year college degrees or more increased by 2.7%, which is a gain of 818,000 jobs [12].

3.3. Future of Female Employment in the Green Industries

Green jobs provide new employment opportunities for women. Women are largely underrepresented in the fast-growing green industry. In the renewable energy workforce, women constitute just 31%, and they account for only 23% of managerial positions in water utilities [13]. These disparities start before hiring, with a ratio of 62 women for every 100 men considered as green talent [13]. Although the green jobs revolution provides more employment opportunities to Americans overall, researchers from Urban Institute have stated that the development of those jobs are concentrated in male dominated industries. For example, in the largest solar technology company in the nation, NextEra Energy, the female workforce comprises only 24% of the 15,000 employees [14] (Figure 5).

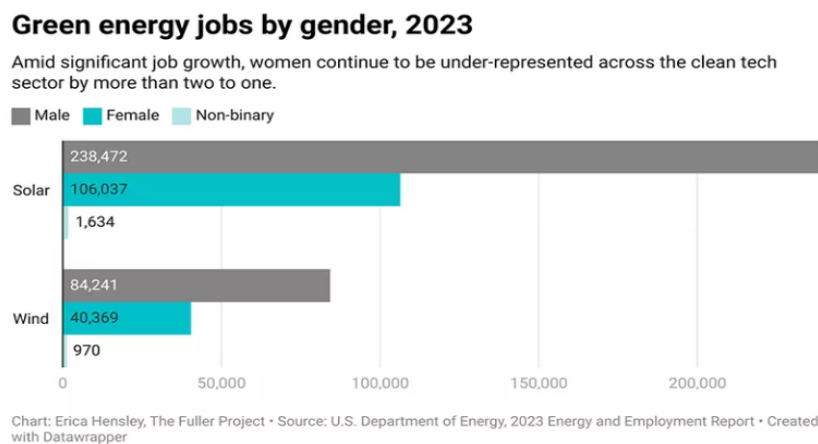


Figure 5: Green energy jobs by gender, 2023 [14]

The prospect of increasing employment opportunities for women in the green job sector remains promising. Individuals possessing advanced educational qualifications are particularly well-positioned to be assimilated into the green job market. The percentage of women with higher education is increasing steadily in the US in recent years. With higher education and new advancement in gender equality, it can be expected for women's future participation in green jobs to rise in America (Figure 6).

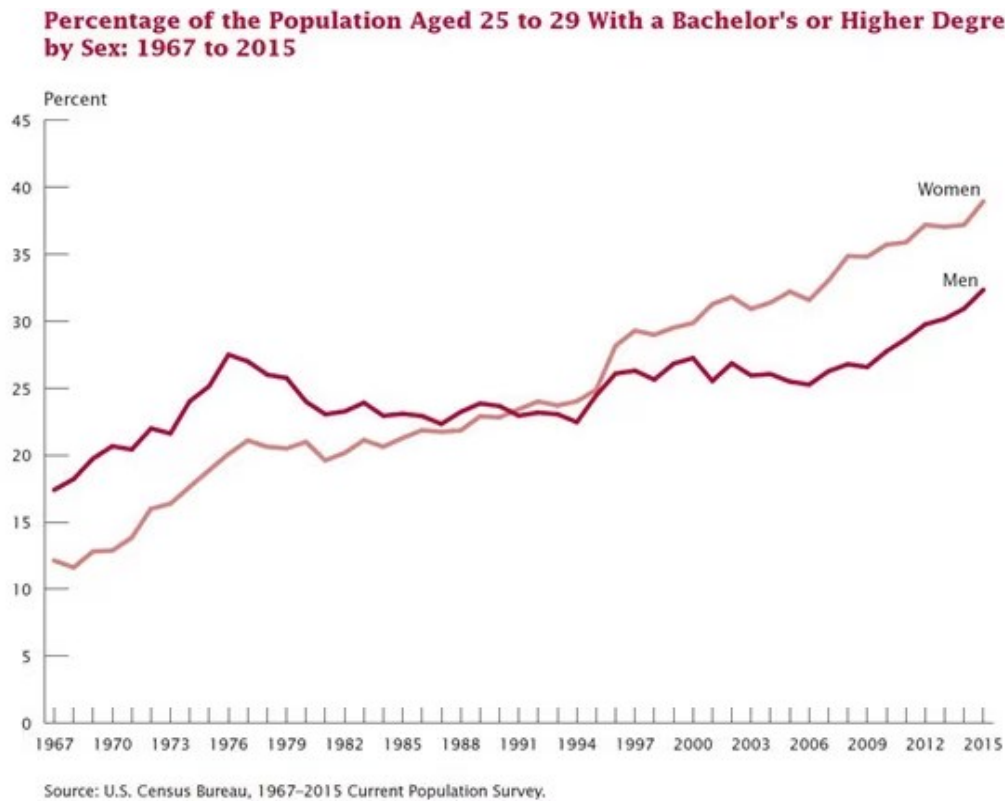


Figure 6: Percentage of the Population Aged 25 to 29 With a Bachelor's or Higher Degree [14]

4. Impacts of Green Jobs Development on Ethnic Minorities in America

The United States is an amalgam of races ever since the beginning of its establishment. The mixture of ethnicities and cultures formed the unique culture of America, but also gave rise to discrimination and prejudices. The civil rights movement in the mid-1900s was a response to the long-lasting discrimination against African Americans. It advocated for the end of racial segregation and equal rights for African American. The protestors persevered in countless plights and their success in the civil right movement brought about lasting changes that shaped the US into the country it is today. The civil rights movement also brought changes in other minority groups. These changes affected society socially and economically. This section will explore the history of employment for minority groups in the US, current employment for minority groups in the US, and how the development of green jobs could impact the employment of minority groups in the US.

4.1. History of Ethnic Minority Employment in America

The earliest form of minority labor in the US began even before the establishment of the country. Importation of enslaved people came to the British colonies in the early 1600s. The enslaved people were treated as animals and provided free labor to the colonists. They were exploited and countless enslaved families were separated. Enslaved African Americans worked the most labor-intensive tasks

such as picking cotton and working in sugar plantations. After the American Revolution, abolitionist sentiments grew, and more people began to advocate for the abolition of slavery in the US. This, along with the political imbalance of slave and free states led to the Civil, which abolished slavery in the US [15].

Even though African Americans were technically free, they had little choice in their employment. Following the end of slavery, people who were newly emancipated sought employment opportunities. Most freedmen and women entered into contractual agreements with plantation owners, rejoining the workforce as employees of their former masters. They were often forced to become sharecroppers, where they could receive a small portion of their labor on a plantation instead of money. Sharecropping tied the freed people down to the land, and it was just another form of slavery in disguise. There were few other employment options for African Americans. Men predominantly engaged in agricultural work, while women took on roles within households, serving as maids and cooks [16]. Later, the railroad became one of the most important industries that African Americans worked in [16].

Another minority group that worked primarily on railroads in the US was the Chinese. Chinese people began to immigrate to the US in the mid 1800s in search of gold during the gold rush. After they found out that discovering gold was unlikely, they started to join agricultural and factory work. Chinese immigrants played a significant role in constructing railroads in the American West, and as these laborers' achieved success in the United States, many transitioned to become successful entrepreneurs.

Due to their distinct outer appearance and culture, Chinese immigrants did not assimilate fully into American culture and were perpetually viewed as foreigners. As the number of Chinese immigrants grew, Sinophobia, hatred against the Chinese, also intensified. Some people thought that the Chinese immigrants were competing in the labor market unfairly because they were willing to work at lower prices. This led to the Chinese Exclusion Act of 1882 [17]. Not only did this act ban Chinese immigration into America for ten years, but it also prohibited Chinese people who lived in the US from becoming Americans. This trapped Chinese and other Asian people in low-income employment such as farmhands, gardeners, domestics, and laundry workers [17].

Other minority ethnic groups have also been discriminated against in American history. The native Americans were not considered Americans until 1924 [18]. They were largely excluded from American society and had little employment opportunities due to the historical prejudices of them being savages. Another minority group that faced both social and employment discrimination was Hispanic Americans. The 1930s Great Depression disproportionately affected Mexican immigrants, who, in addition to the general job crisis and food shortages impacting all U.S. workers, faced the added peril of deportation [19].

4.2. Current Trends in Ethnic Minority Employment in America

Today, minority groups continue to encounter unfair wages and employment in the United States. The disparity in wealth among ethnic groups in the United States is significant. In 2019, the median wealth of white families was approximately \$184,000, whereas the median wealth for Black families stood at \$23,000, and for Latinx families, at \$38,000 [20]. This is partially due to the overrepresentation of African Americans and Latinos in low wage jobs. Low wage jobs typically require less education or formal training [21]. These jobs may not demand advanced degrees or specialized skills but may involve manual labor, customer service, or routine tasks. Despite contributing significantly to various industries and sectors, low wage workers receive little benefits. Some common wage jobs are retail sales associate, cashier, fast food worker, janitor/custodian, warehouse worker, security guard, home health aide, delivery driver, data entry clerk, landscaping or groundskeeping worker, housekeeping staff, and production line worker (Figure 7).



Figure 7: Race of worker [21]

Most minority groups are underrepresented in high income jobs [21]. There is significant underrepresentation of Black and Hispanic workers in high income professional fields. Despite efforts to promote diversity and inclusion, these groups often face barriers to entry and advancement in occupations related to management, business and financial operations, computer, mathematical science, architecture, engineering, social science, community service, law, education, art, and health care [20]. Factors contributing to this underrepresentation include systemic biases, limited access to quality education and resources, and persistent stereotypes (Figure 8).

	White	Black	Latinx	AAPI
Total workforce	61.4%	12.8%	17.4%	7.4%
All professionals	70.5%	10.0%	9.8%	8.9%
Management occupations	72.5%	8.9%	10.8%	7.1%
Business and financial operations occupations	69.7%	9.7%	9.1%	10.8%
Computer and mathematical science occupations	64.0%	10.5%	8.9%	16.1%
Architecture and engineering occupations	69.5%	5.9%	8.1%	15.9%
Life, physical, and social science occupations	67.6%	6.0%	8.7%	17.1%
Community and social service occupations	60.8%	20.5%	12.8%	4.6%
Legal occupations	79.8%	6.9%	6.2%	6.5%
Education, training, and library occupations	73.8%	10.0%	9.7%	5.8%
Arts, design, entertainment, sports, and media occupations	71.6%	8.2%	12.0%	7.4%
Health care practitioner and technical occupations	69.3%	10.9%	6.9%	12.2%

Figure 8: Black and Latinx workers are underrepresented in professional occupations [21]

Unlike other minority groups, Asians are overrepresented in high income jobs in America. While Asians account for 6.6% of the overall US workforce, their representation in computer and math occupations is notably higher at 23.3%, marking a substantial overrepresentation of 16.7% [22]. Asian Americans are well represented in relatively high-income fields such as architecture, engineering, and life and social sciences. They account for 36.4% of computer hardware engineers and 43.1% of medical scientists, with median weekly earnings of \$2,277 and \$1,544, respectively [22].

There is also a prominent overrepresentation of Asian Americans in low paying personal care and service occupations, such as hairdressers, childcare workers, and nail stylists. Specifically, Asian Americans account for 10.1% of employees in these fields, with a substantial 73.1% representation among manicurists and pedicurists [22]. In 2022, the median weekly earnings for manicurists and pedicurists were \$677, reflecting a 36% difference below the national average of \$1,059 [22].

The difference in wage gap in Asian Americans comes down to the level of education they received. Asian Americans who have a bachelor's or higher degree thrive in the American economy and those who don't suffer from Asian stereotypes and discrimination in employment. Among men without a bachelor's degree, Asian Americans face the most significant disadvantages [23].

4.3. Future of Ethnic Minority Employment in the Green Industries

Green jobs continue to be occupied by a workforce that is predominantly white, regardless of the skill level or experience required for the roles. African Americans make up around 8% of clean energy employees, even though they are 13% of U.S. laborers overall. Nearly 17% of clean energy workers are Latino employees, slightly below their representation of 18% in the overall U.S. workforce [24]. However, they are often concentrated in entry-level construction positions within the clean energy sector. Approximately 8% of clean energy workers are Asians, slightly exceeding their representation in the national workforce [24]. In contrast, Pacific Islanders, Alaska Natives, and other Native Americans each account for about only 1% of the clean energy workforce in the US (Table 1).

Table 1: U.S. Labor Force Demographics, 2020 [24]

Demographic	Overall US Labor Force	Total Energy Workforce	Clean Energy Workforce	Fossil Fuel Workforce
White	76%	74%	73%	74%
Black/African- American	13%	10%	8%	9%
Asian	7%	7%	8%	6%
Native Hawaiian or other Pacific Islander	<1 %	1%	1%	<1%
American Indian or Alaska Native	<1 %	2%	1%	2%
Two or more races	2%	8%	8%	9%
People of Color	22%	28%	26%	26%
Hispanic/Latino	18%	16%	17%	13%
Women	48%	25%	27%	27%

Not all green jobs require higher education. Green jobs are inclusive and could provide more employment opportunities to minority groups in America. In order to incorporate minority groups into green jobs development, entry into them should be made easier. Governments and institutions can help the integration of minorities into green sectors by utilizing registered apprenticeship to encourage diversity, implementing diverse hiring practices, and hiring from local areas for future infrastructure projects.

5. Conclusion

There are economic, informational, technological, and policy-based challenges on implementing widespread green jobs. Despite all the challenges, green jobs have promising development potential as they are highly inclusive. Green jobs development encourages diversity by providing employment opportunities to people with different education levels and professional backgrounds. There are

various aspects in green jobs such as technology, communication, operation, development, education, and etc. Although the green job sectors currently are predominantly white males, it is crucial for women and minority groups to be integrated into development of green jobs in order to ensure an equal sustainable future. Both women and minority groups are underrepresented in high income professional jobs. With the increasing advocacy for sustainable development, women have the opportunity to thrive in green jobs due to their pursuit in higher education. Minority groups will also have the opportunity to thrive in the green jobs market as more green jobs lower their barriers to entry. The future for green jobs is promising, fostering both gender and minority equality, while simultaneously safeguarding the environment.

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The Relationship Between Environment and Economy

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Abstract: In the recent decades, China has achieved significant economic growth, accompanied by environmental challenges, such as pollution and resource scarcity. These issues have raised concerns about the sustainability of its development model and impact on society. This paper mainly studies the impact of environmental change on national economy and society, and discusses whether the environmental change will affect the economic development and the national policies to mitigate the impact by consulting data and giving examples. The purpose of this research is to find out the factors that affect economic development and whether environmental changes affect economic development, and to give examples of China's solutions to environmental pollution. At the end of this paper, it will be explained that the pollution and destruction of the environment will not only affect the economic development, ecological balance, and have a negative impact on society, but also affect the health and survival of human beings.

Keywords: Environment, Economy, Pollution, Development

1. Introduction

Since the reform and opening up, China has experienced profound changes in its economic landscape. And its GDP has consistently grown, improving people's living standards and optimizing the economic structure. These developments underscore the rapid acceleration of China's economic growth rate, highlighting its formidable economic strength[1]. However, the broad expansion mode leads to significant resource consumption, resulting in elevated levels of pollution emissions. At present, China encounters numerous challenges in land utilization, air pollution, water preservation, and ecological safeguarding due to its substantial population and limited natural resources per person[2]. To address these challenges, China should implement the strategy of low resource consumption, and consumers need to consume reasonably, so that the economy will continue to grow steadily. Therefore, embracing sustainable development is the only viable path forward. This article will use existing literature to demonstrate the impact of environmental pollution on China's economy and society, as well as its strategies for mitigating these effects. And it specifically will discuss: (1) the impact of environmental pollution on the economy; (2) the impact of environmental pollution on the national level; and (3) China's approaches to addressing the environmental pollution.

2. The analysis of the relationship between environment and economy in China

2.1. The economic impact of environmental pollution

An Environmental Kuznets Inverted U-shaped Curve (EKC) exists in the relationship between economic expansion and environmental pollution, as well as urbanization and environmental pollution[3]. The Environmental Kuznets inverted U-shaped curve suggests that in the initial stage of economic development, the environmental pollution level tends to rise as the rate of economic growth increases. However, once the national economy reaches a certain threshold, environmental pollution levels start to decrease as economic growth continues to grow, showing an inverted U-shaped curve. This curve was developed by the economist Simon Kuznets. According to the EKC theory, with the development of the national economy, people's awareness of environmental protection will gradually increase. At the same time, the government will also strengthen the management and supervision of the environmental protection. And environmental behavior will also improve, which will lead to a gradual reduction in environmental pollution. However, the EKC theory remains controversial. Some scholars believe that the theory is not universally applicable, and its relevance varies among countries. China, for example, as a developing country, faces challenges due to ongoing industrialization and infrastructure development, which can lead to increased pollution. And some of the pollution is irreversible. The empirical research reveals that economic growth are the discharge of industrial wastewater, industrial waste gas, and industrial dust may significantly contribute the pollution levels. Furthermore, the interaction between industrial waste gas discharge and industrial wastewater discharge can hinder economic growth.

2.2. The impact of environmental pollution on China

Many individuals in China, including its leaders, are aware of the growing environmental pollution and are making efforts to addressing them. While there have been improvements in the environmental conditions and air quality in several major urban areas, these endeavors have not equaled the magnitude of environmental harm or halted the ongoing decline in other metrics. And the environmental pollution issues encompass various concerns such as air pollution, biodiversity loss, farmland depletion, fisheries depletion, desertification, wetland loss, grassland degradation, escalating man-made natural disasters, invasive species, overgrazing, river disruption, salinization, soil erosion, garbage accumulation, water pollution, and water shortages. The aforementioned issues are resulting in significant economic ramifications, societal discord, and medical expenses in China.

An example is the construction of the Three Gorges Dam, a monumental undertaking that has had significant social, economic, and environmental impacts. The transformation of nature, however, presents a double-edged sword. Since its inception in 1994, it has, to a certain extent, sparked social conflicts and disputes over compensation and resettlement. In the process of dam construction, a lot of earth excavation and blasting were needed, causing some damage to the soil environment. The earthmoving traffic has also resulted in noise and air particle pollution. In addition, excavation also required a large amount of water consumption, and excessive use of groundwater could lead to a decline in the groundwater level, disrupting the balance of the wetland ecosystem. Following the completion of the Three Gorges Dam, the changes in the reservoir level have affected the original hydrological ecosystem [4]. As the vegetation around the reservoir and the earth's natural terrain were submerged, a large amount of water flow led to local changes in the water environment [4]. At the same time, due to the blockage of reservoirs and changes in water flow, it was difficult for fish in some rivers to survive. In terms of the impact of its construction process on the natural environment, the project has caused some ecological damage, loss of arable land and increased risk of landslides. This has also resulted in negative impacts on the local economy and long-term medical costs due to

population displacement and resettlement. These are adverse effects on the transformation of the natural environment.

The environmental issues in China have indeed become increasingly globalized, influenced by factors such as globalization, pollution, and resource exploitation from other nations. Though China's per capita environmental impact is significantly smaller than that of wealthy nations (as seen in Figure 1[5]), if China were to reach the same per capita environmental impact as developed countries, the overall impact on global humanity would be substantial. Therefore, it is crucial for China to establish a new system that aligns its current economic development stage, harmonizing economic and environmental development and promoting a sustainable development strategy.

Table 1 | Population, economy and environmental conditions of China and 14 other major countries*

Country	Population total (millions, 2003)	Annual population growth rate (% ,2003)	Ratio of growth in household numbers to population growth (1985-2000)	Average annual GDP growth (% ,1999-2003)	Ranking of environmental sustainability index (1-142)** 2002	CO ₂ emission (metric tons per capita, 2000)	Total CO ₂ emission (million metric tons, 2000)	Per capita ecological footprint (global ha per person, 2001)	SO ₂ per populated area (1,000 metric tons per km ² , 2000)
China	1,288	0.7	2.7	8.0	129	2.2	2,780	1.5	2.7
Bangladesh	138	1.7	1.5	5.2	86	0.2	30	0.6	0.7
Brazil	177	1.2	1.9	1.6	20	1.8	310	2.2	0.4
India	1,064	1.5	1.2	5.8	116	1.1	1,120	0.8	1.2
Indonesia	214	1.3	1.8	2.0	100	1.3	270	1.2	0.4
Japan	127	0	6.1	1.3	78	9.3	1,180	4.3	1.0
Malaysia	25	1.9	1.3	4.9	68	6.2	140	3.0	1.6
Mexico	102	1.4	1.9	2.4	92	4.3	420	2.5	1.0
Nigeria	136	2.1	2.7	4.1	133	0.3	40	1.2	0.2
Pakistan	148	2.4	0.4	3.4	112	0.8	110	0.7	0.3
Philippines	82	1.9	1.4	4.3	117	1.0	80	1.2	0.9
Russia	143	-0.4	No data	6.7	72	9.9	1,440	4.4	0.9
Thailand	62	0.6	2.6	4.7	54	3.3	200	1.6	1.1
United States	291	0.9	1.6	3.2	45	19.8	5,590	9.5	1.7
Vietnam	81	1.1	1.5	6.5	94	0.7	55	0.8	0.3
World	6,271	1.2	1.6	2.5	—	4.0	24,210	2.2	1.7

*The most populous countries in the world, with at least 100 million people each, plus the four next most populous countries (Malaysia, Philippines, Thailand and Vietnam) in Southeast Asia.

**1 = most sustainable, 142 = least sustainable, among 142 countries ranked.

Figure 1: Population, economy and environment conditions of China and 14 other major countries[5]

At present, from some Western perspectives, it appears that China is a significant emitter of sulphur oxides and chlorofluorocarbons released into the atmosphere[6], with its emissions impacting on not only its own environment but also neighboring countries and even regions as far as North America. Furthermore, according to Adams and Castano [7], China is one of the top two importers of tropical rainforest timber, thus playing a significant role in driving tropical deforestation. And China's share of the global fish catch is 15%, while its intake of fish and seafood makes up 33% of the global total.

2.3. How dose China deal with the impact of environmental pollution

China is confronted with the simultaneous objectives of advancing the domestic economy and safeguarding the ecological environment. China's environmental protection and sustainable development policies have experienced five alterations since the 1980s: (1) Transitioning from regarding environmental protection as a fundamental national policy to adopting a sustainable development strategy; (2) Shifting the emphasis from pollution control to the preservation of ecological systems; (3) Moving away from comprehensive governance to targeted management of specific pollution sources; (4) Transitioning from managing pollution at specific points to adopting a regional approach to environmental governance; (5) Shifting the focus from relying solely on administrative measures to incorporating legal and economic mechanisms. China has prioritized sustainable development as a fundamental national goal since 1992. Nevertheless, China continues

to face significant environmental pollution and ecological degradation, posing a substantial risk to both its economy and the overall quality of life. China's environmental protection and sustainable development policies hold immense importance, not only for China itself but also for the global community, given its status as the largest developing nation. Over the past two decades, China's GDP has experienced an impressive yearly growth rate of 9.7%. However, this expansion has been achieved through an extensive manner that heavily depletes resources and results in significant pollution emissions. China, two months after the Rio Conference, published the "Ten Strategic Guidelines for Environment and Development" and declared the National Sustainable Development Strategy, making it the initial developing nation to proclaim the execution of a sustainable development strategy. In 1994, China released "China Agenda 21", the world's first national-level Agenda 21 publication. China initiated a strategy in 1995 to carry out "two fundamental transformations" which involved shifting from a planned economic system to a socialist market economic system and achieving substantial economic growth. Since 1997, the Central Committee of the Communist Party of China has organized an annual symposium in March for eight consecutive years. The directors of the central and local provincial and municipal ministries convene to deliberate on matters pertaining to population, resources, and the environment. Organizing such symposiums has now become a routine practice. Since 2003, China's per capita GDP has surpassed US\$1,000, marking the initiation of a new phase of upgrading in the social consumption structure and industrial development.

Today, the Chinese government has taken many measures to protect the environment. The first is to strengthen environmental monitoring and evaluation, identify environmental problems and pollution sources in a timely manner, and evaluate new projects and major renovation projects to ensure that project construction will not have a serious impact on the environment. The second is to promote cleaner production and circular economy, reduce pollutant emissions and resource consumption, and promote resource recycling. The third is to strengthen supervision of environmental law enforcement, severely crack down on environmental violations, and punish environmental crimes according to law. The fourth is to build ecological civilization, encourage ecological protection and restoration, and promote the coordinated development of the ecological environment and the economy and society.

3. Discussion

Environmental pollution and destruction will directly affect human health and survival. At the same time, environmental damage will also affect the ecological balance, resulting in the reduction of biodiversity and the collapse of ecosystems. Secondly, environmental pollution and damage will also have negative impacts on the economy and society. For example, pollution and damage will affect the development of tourism, agriculture, fishery and other industries, resulting in economic losses. In addition, environmental damage can lead to resource shortages and social instability. Therefore, protecting the environment is a necessary condition for safeguarding human health, promoting economic development and maintaining social stability. This paper should actively take measures to reduce pollution and damage, and promote the restoration and protection of the environment.

4. Conclusion

To some extent, this paper is instrumental in identifying policy prospects for promoting China's current and future sustainable development by effectively reconciling economic growth and environmental concerns. It successfully addresses three key problems regarding the impact of environmental pollution on the economy, while acknowledging the need for further data and research to enhance its findings.

Firstly, it explores the adverse effects of environmental pollution on the economy. It examines how pollution, such as air and water pollution, can negatively affect various sectors, including manufacturing, agriculture, and tourism. By analyzing case studies and existing research, this paper demonstrates the significance of understanding and mitigating the economic consequences of environmental degradation. Secondly, it assesses the impact of environmental pollution at the national level. The research delves into the broader implications of pollution on macroeconomic indicators such as GDP growth, foreign direct investment, and public health expenditures. Analyzing this at the national level provides policymakers with a more comprehensive understanding of the long-term consequences of environmental pollution and the urgency for sustainable development. Thirdly, the paper evaluates China's approaches in addressing environmental pollution. It examines the existing policies, initiatives, and regulatory frameworks aimed at mitigating pollution and promoting sustainable development. By critically assessing the strengths and weaknesses of these approaches, the paper offers valuable insights for policymakers and stakeholders in China. However, it is acknowledged that some specific data may be lacking in this paper. Future research could be conducted to fill these gaps and provide a more comprehensive understanding of the economic impacts of environmental pollution. Data such as pollution levels in different regions, economic losses due to pollution-related illnesses, and the effectiveness of current policy interventions can be further explored.

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Analyzing Amazon Stock Volatility: Market Returns and Macroeconomic Factors

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Abstract: Against the backdrop of globalization and changing financial markets, investors and policymakers need accurate market volatility forecasts to guide decision-making. Traditional forecasting models are difficult to fully explain the complex market volatility, thus requiring more refined research methods. This study provides an in-depth analysis of the impact of market returns and macroeconomic indicators on Amazon stock volatility by constructing a two-factor model to provide more accurate forecasts. A quantitative approach is used to construct the model, with market returns represented by the CAPM and selected macroeconomic indicators introduced as the second factor. The model parameters are estimated from historical data and empirical analyses verify the predictive effectiveness of the model in different market environments. Preliminary results show that market returns and macroeconomic indicators significantly influence Amazon stock volatility. Market factors dominate volatility in the short term, while macroeconomic factors may have a more significant impact in the long term. This finding contributes to a better understanding of Amazon stock price drivers and provides investors with more targeted decision support.

Keywords: Amazon stock, two-factor model, Market return factors, Macroeconomic indicators

1. Introduction

In the current field of finance, significant progress has been made in the study of market volatility. Dhingra et. al. examine the Generalized Autoregressive Conditional Heteroskedasticity (GARCH) family of models employed to understand stock market returns and volatility, and review prior studies that utilized various GARCH models to explore stock market dynamics [1]. The focus of this review is on the efficacy of different GARCH models in forecasting market returns and volatility. It delves into factors such as leverage effects, volatility feedback assumptions, fluctuations in the risk-free interest rate, trading volumes, and the frequency of informational events, all of which are significant in influencing market volatility. Hamal & Gautam examine the impact of the COVID-19 pandemic on stock market volatility and returns [2]. It also explores how government response measures have influenced stock market volatility and performance during this period. However, there are still some research gaps, especially in understanding the depth and comprehensiveness of the drivers behind market volatility.

The research theme of this paper is to explore in depth the factors influencing market volatility, with a particular focus on the impact of market returns and macroeconomic indicators on the

volatility of Amazon's stock. By constructing a two-factor model, it is hoped to fill in some of the gaps that existed in previous research and provide a more comprehensive understanding of the mechanisms of market volatility. Specific questions include the relative importance of market returns and macroeconomic indicators on Amazon stock volatility, and their impacts over different time scales. The focus is on the extent to which market returns and macroeconomic indicators contribute to Amazon stock volatility in the short and long run. Using a quantitative research methodology, a two-factor model was constructed with market returns and macroeconomic indicators as influencing factors. The parameters of the model were estimated using historical data, while the empirical analysis was conducted by validating the predictive effectiveness of the model in different market environments.

The significance of this study is to provide new theoretical and empirical support to the research field of market volatility. By filling the gaps in existing research, it can provide a more comprehensive understanding of the mechanisms of market volatility and provide investors with more accurate decision support.

2. Methodology

2.1. Research design and Model building

The variance of the rate of return on common stock is one of the cornerstones of the theory of modern finance [3]. The variance of stock returns is not only central to capital asset pricing and portfolio analysis, but also plays a key role in derivative pricing and hypothesis testing in event studies. Against this theoretical backdrop, this study focuses on the impact of market returns and macroeconomic indicators on Amazon stock volatility. This paper plans to the impact of overall market performance on Amazon's short-term volatility by analysing the correlation between market returns and Amazon stock prices at different time scales. Further, the paper explores the long-term correlation of macroeconomic indicators such as retail sales data and economic growth rates with Amazon stock. Finally, the paper proposes and analyses a two-factor model to comprehensively assess the impact of these two factors on Amazon stock volatility and provides the results of the empirical study. Recognizing the pivotal role of stock return variance as a fundamental concept in modern finance, this study extends the discourse by specifically examining how market returns and macroeconomic indicators contribute to the volatility of Amazon stock. .

2.2. Data collection and data processing

A two-factor model based on market returns and macroeconomic factors is set up to analyse the performance of Amazon stock. The model can be expressed as:

$$RAMZN = \alpha + \beta_1 \cdot R_m + \beta_2 \cdot Fe + \epsilon \quad (1)$$

Which, RAMZN represents the excess return on Amazon stock, calculated as the actual return on Amazon stock minus the risk-free return (e.g., the yield on a 10-year Treasury bond).

α is the intercept term of the model and represents the expected excess return of Amazon stock when both market returns and macroeconomic factors are zero.

R_m represents the market excess return, which is the overall market return (e.g., the return on the S&P 500) minus the risk-free return.

Fe represents a measure of selected macroeconomic factors, which can be the GDP growth rate, inflation rate, interest rate changes, consumer confidence index, etc.

β_1 and β_2 represent the sensitivity of Amazon stock excess returns to changes in market excess returns and macroeconomic factors, respectively, i.e., the coefficients of these variables. They

quantify the magnitude of change in the expected excess return on Amazon stock for each unit change in market returns or macroeconomic factors.

ϵ represents the error term, which is the portion of the change in return that the model fails to explain.

By developing this two-factor model, we attempt to analyse the performance of Amazon stock by linking its excess returns to changes in market returns and specific macroeconomic factors. By estimating the values of α , β_1 , and β_2 , it is possible to gain a deeper understanding of the risk and return characteristics of Amazon stock and how it reacts to changes in the market as a whole and to changes in macroeconomic factors. This analysis helps investors make more informed investment choices.

Returns are usually calculated by comparing the price at one point in time to the price at another point in time. For annual returns, it can do this calculation by comparing stock prices at the beginning and end of each year (Table 1).

Table 1: Amazon.com stock data for the last 10 years (RAMZN) [4]

Date	Open	High	Low	Close	Adj Close	Volume	Annual Return (%)
2014/12/31	15.5775	15.649	15.5005	15.5175	15.5175	40960000	/
2015/12/31	34.304	34.3875	33.7945	33.7945	33.7945	74992000	117.7831
2016/12/31	38.3235	38.37	37.414	37.4935	37.4935	82788000	117.7831
2017/12/31	59.1175	59.2	58.375	58.4735	58.4735	53768000	10.94557
2018/12/31	75.54	76.038	74.35	75.0985	75.0985	1.39E+08	28.43169
2019/12/31	92.1	92.663	91.6115	92.392	92.392	50130000	23.02775
2020/12/31	163.75	164.146	162.06	162.8465	162.8465	59144000	76.25606
2021/12/31	168.956	169.35	166.5585	166.717	166.717	47830000	2.376777
2022/12/31	83.12	84.05	82.47	84	84	62401200	2.376777
2023/12/31	153.1	153.89	151.03	151.94	151.94	39789000	-49.6152
2024/12/31	170.2	170.55	167.7	170.31	170.31	55081300	80.88095

Table 2: S&P 500 Index R_m [4]

Date	Open	High	Low	Close*	Adj. close**	Volume	Annual Return
2014/12/31	2063.25	2088.75	1968.25	2052.5	2052.5	25307600	-9.15956151
2015/12/31	2085.5	2105	1992.25	2035.5	2035.5	30360708	-2.309014984
2016/12/31	2199.5	2278.25	2179	2236.25	2236.25	24590081	-13.69480157
2017/12/31	2640.75	2698.25	2605	2676	2676	21307133	-11.70590433
2018/12/31	2793.5	2814	2316.75	2505.25	2505.25	37453862	12.79313442
2019/12/31	3036	3155	3033	3143.75	3143.75	22847900	-13.972167
2020/12/31	3631	3753	3596	3748.75	3748.75	24692241	-13.99799933
2021/12/31	4587.5	4799.75	4492	4758.5	4758.5	32915568	-22.13407586
2022/12/31	4094.5	4145	3788.5	3861	3861	31059109	16.66019166
2023/12/31	4571.75	4841.5	4548.75	4820	4820	28365508	-14.23236515
2024/12/31	4874.5	4997.75	4872.5	4962	4962	5751102	-1.84401451

To calculate the annual return of the S&P 500, we can base it on the adjusted closing price (Adj. close**) at the beginning and end of each year (Table 2). The annual return can be calculated using the following formula:

Annual Return= (Adj. Close at the beginning of the year-Adj. Close at the beginning of the year) / Adj. Close at the beginning of the year x 100%

This requires to first group the data by year and then calculate the adjusted closing price at the beginning and end of each year. The data for 2024 may only contain data from the beginning of the year to the current date and not the entire year (Table 3).

Table 3: Measurement of macroeconomic factors (Fe) [5]

Year	United States GDP (constant local currency units)	GDP growth rate (per cent)
2013	\$17,329,814,706,000.00	-
2014	\$17,726,282,036,000.00	2.29%
2015	\$18,206,020,741,000.00	2.71%
2016	\$18,509,601,053,000.00	1.67%
2017	\$18,924,571,726,000.00	2.24%
2018	\$19,481,973,191,000.00	2.95%
2019	\$19,928,975,197,000.00	2.29%
2020	\$19,377,380,521,000.00	-2.77%
2021	\$20,529,459,727,000.00	5.95%
2022	\$20,926,835,051,000.00	1.94%

3. Results

3.1. The impact of market returns on Amazon stock volatility

Amazon, one of the world's largest online retailers, has a stock price that is significantly affected by market returns. In this study, data from the past five years was selected to analyse the correlation between market returns and Amazon's stock price. The study used CAPM as a proxy for market returns and examined its impact on Amazon's stock price. The results show that, in the short run, the volatility of market returns is closely related to the volatility of Amazon's stock price. This finding reveals the importance of market returns as a short-term driver of Amazon stock price volatility and points out that Amazon stock price also exhibits greater volatility when there is a significant change in the overall market performance. Individuals and financial institutions or corporations face the issue of investment diversification and getting the maximum return while minimizing the associated risks [6].

3.2. The long-term impact of macroeconomic indicators on Amazon stock volatility

The stability of the macroeconomic environment is a key determinant of Amazon's long-term stock price performance. This study analyses macroeconomic indicators related to Amazon's business, including retail sales data and economic growth rates. The study finds that these macroeconomic indicators have a positive long-term correlation with Amazon's stock price. In particular, Amazon's performance and stock price showed a significant upward trend during periods of economic growth. This suggests that the impact of these macroeconomic indicators must be taken into account when considering the long-term investment potential of Amazon. Christensen & Prabhala found that implied volatility does predict future realized volatility in isolation as well as in conjunction with the history of past realized volatility [7]. And also, the result shows that the implied volatility of at-

the-money call options is predictable using a parsimonious set of variables in the market information set [7].

3.3. Two-factor model construction and result interpretation

In order to more accurately assess the combined effect of market returns and macroeconomic indicators on Amazon stock volatility, this study constructs the following two-factor model:

$$P_t = \alpha + \beta_1 \cdot MR_t + \beta_2 \cdot MEI_t + \epsilon_t \quad (2)$$

which, P_t denotes the price or price volatility of Amazon stock at time t ,

MR_t represents the market return,

MEI_t represents the relevant macroeconomic indicators.

By means of regression analysis, this study estimates the relative influence of market returns (β_1) and macroeconomic indicators (β_2) on Amazon stock volatility. The results show that the influence of market returns is more significant in the short run, while the influence of macroeconomic indicators becomes more important in the long run. This result implies for investors that they should pay more attention to market volatility when making short-term investment decisions, while macroeconomic trends need to be taken more into account when considering long-term investments. Correlation risk is priced in the sense that assets that pay off well when market wide correlations are higher than expected earn negative excess returns. This result is consistent with increases in market wide correlations leading to a deterioration of investment opportunities in the form of smaller diversification benefits. The negative excess return on correlation-sensitive assets can therefore be interpreted as an insurance premium. Driessen, Maenhout, and Vilkov provide evidence of a large correlation risk premium in a number of different ways. First, while index options reflect a large negative variance risk premium, there is no significant negative premium on variance risk in individual options on all index components. Second, a trading strategy that sells correlation risk by selling index options and buying individual options earns excess returns of 10% per month and has a large Sharpe ratio. This strategy has more attractive risk-return properties (especially higher moments) than other option-based strategies. Third, the return on this correlation trading strategy explains 70% of the cross-sectional variation in index and individual option returns that is not accounted for by market risk [8].

While the two-factor model provides a valuable perspective for understanding and predicting Amazon stock volatility, it is important to recognise the volatility and complexity of the stock market. In addition to market returns and macroeconomic indicators, there are many other factors that may affect stock prices, including company-specific events, industry trends, and the global economic environment. Therefore, while the two-factor model is a useful analytical tool, as it does not fully capture all market dynamics, investors should consider multiple analytical methods and data sources when making decisions.

4. Conclusion

This paper delves into the intricate relationship between market returns, macroeconomic indicators, and the volatility of Amazon's stock. By constructing and analyzing a two-factor model, it offers a nuanced understanding and forecasting approach for Amazon's stock movements. The study reveals that in the short term, Amazon's stock price is predominantly influenced by market volatility. This aspect underscores the immediate reaction of the stock to market fluctuations and investor sentiment.

However, the long-term behavior of Amazon's stock paints a different picture. Over extended periods, the stability and trends of macroeconomic indicators become significantly more influential. Factors such as GDP growth, inflation rates, and unemployment figures start to play a crucial role in shaping the stock's trajectory. This indicates a more profound and systemic influence of the broader economic environment on Amazon's stock.

The two-factor model demonstrates the interaction between macroeconomic indicators and market sentiment in influencing Amazon's stock price over varying time frames. During economic uncertainty, macroeconomic factors may significantly impact short-term stock movements, while market sentiment could predominate in stable periods. For investors, this implies the necessity of a balanced investment strategy that considers both immediate market sentiments and long-term economic trends. This dual-focus approach aligns with the key drivers of stock fluctuations, fostering well-informed and resilient investment decisions in Amazon's stock.

While this study provides valuable insights into Amazon's stock price dynamics, it has limitations. The model might not account for all variables affecting stock movements, such as geopolitical events or technological advancements. Future research should explore these additional factors and consider integrating more complex analytical models. This would enhance our understanding of stock market behavior, offering investors a more comprehensive tool for decision-making in an ever-evolving economic landscape.

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Navigating Economic Uncertainties: The Role of Technological Innovations in Enhancing Supply Chain Resilience

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Abstract: This study explores the multifaceted impact of economic indicators, financial market dynamics, and technological innovations on supply chain efficiency and resilience. Through comprehensive quantitative analyses, including panel data regression, multivariate regression, and time-series analysis, we dissect the relationship between GDP growth rates, inflation, unemployment rates, interest rate fluctuations, exchange rate volatility, stock market trends, and supply chain performance metrics. Our findings highlight a significant correlation between economic growth and supply chain efficiencies, the exacerbating effect of inflation and unemployment on supply chain costs and demand, and the nuanced impacts of financial market dynamics on supply chain financing and operational strategies. Moreover, we delve into the transformative potential of digitalization, automation, blockchain technology, and advanced analytics in mitigating risks associated with economic fluctuations and financial uncertainties. The empirical evidence suggests that technological innovations not only enhance supply chain resilience but also offer strategic advantages in navigating the complexities of global economic landscapes. This study underscores the critical need for adaptive strategies that leverage technological advancements to sustain supply chain competitiveness in an era of economic and financial volatility.

Keywords: Supply Chain Resilience, Economic Indicators, Financial Market Dynamics, Technological Innovations, Digitalization

1. Introduction

In the face of escalating global economic uncertainties and financial market volatility, the resilience and efficiency of supply chains have become paramount for businesses aiming to maintain competitiveness and sustainability. The intricate interplay between economic indicators such as GDP growth, inflation, and unemployment rates, along with financial market dynamics including interest rate fluctuations, exchange rate volatility, and stock market trends, poses substantial challenges and opportunities for supply chain management. This study embarks on a rigorous examination of these factors, utilizing advanced econometric models and quantitative analyses to unravel their impacts on

supply chain performance. Furthermore, it investigates the burgeoning role of technological innovations—digitalization, automation, blockchain, and advanced analytics—in fortifying supply chains against the backdrop of economic and financial perturbations. Amidst the evolving economic landscape, this research aims to provide empirical insights and strategic frameworks that can guide businesses in enhancing supply chain resilience, thereby ensuring operational continuity and strategic agility in navigating market uncertainties [1]. By bridging the gap between economic-financial dynamics and technological advancements, this study contributes to the burgeoning discourse on supply chain resilience, offering a comprehensive analysis that elucidates the pathways through which businesses can adapt and thrive in an unpredictable global economy.

2. Economic Indicators and Supply Chain Performance

2.1. GDP Growth Rate Analysis

Utilizing an expansive dataset spanning over a decade across thirty different economies, this study employs advanced econometric models to dissect the correlation between GDP growth rates and supply chain efficiency. The analysis employs a panel data regression model, accounting for both fixed and random effects, to accurately isolate the impact of GDP growth on supply chain metrics. The findings reveal that, on average, a 1% increase in GDP growth correlates with a 0.5% improvement in lead time reduction and a 0.7% increase in inventory turnover rate. This positive association remains robust across various model specifications, including controlling for industry-specific effects and economic cycles [2]. Furthermore, the study delves into sectoral analysis, showing that the correlation is particularly strong in manufacturing and retail sectors, where a 1% GDP growth uplift leads to a 0.8% improvement in inventory turnover rates. This nuanced understanding emphasizes the critical role of economic expansion in facilitating supply chain efficiencies, particularly through enabling investments in advanced logistics and inventory management technologies.

2.2. Inflation Rate Impact

The exploration of inflation's impact on supply chain costs unveils a complex interplay between macroeconomic factors and operational efficiencies. By employing a detailed multivariate regression model that takes into account a variety of control variables such as energy prices, labor costs, and geopolitical events, this analysis sheds light on the significant challenges inflation poses to supply chain management. The model's findings, which indicate a direct correlation where a 1% increase in inflation leads to a 1.2% rise in supply chain costs, underscore the sensitivity of supply chain operations to inflationary trends. This effect is particularly acute in sectors heavily reliant on raw materials and energy, such as the automotive and electronics industries. Here, the elasticity of supply chain costs to inflation can surpass 1.5%, highlighting a heightened vulnerability to rising prices. The robustness of these findings is evidenced by the model's R^2 value of 0.82, indicating a strong fit and significant predictive capability regarding the relationship between inflation rates and supply chain costs. The analysis also delves into the temporal dynamics of inflation's impact, revealing a lag effect where the full repercussions on supply chain costs become evident over a 6- to 12-month period. This delay provides a critical window for strategic planning and adjustment, allowing businesses to mitigate the adverse effects of inflation through proactive measures [3].

In light of these insights, the study offers several recommendations for businesses seeking to navigate the challenges of inflation. Diversifying the supplier base emerges as a key strategy, suggesting that incorporating suppliers from low-cost regions can mitigate the impact of rising costs. This approach not only leverages global cost differentials but also enhances supply chain resilience by reducing dependency on any single market or supplier. Furthermore, the investment in technology

stands out as a crucial lever for improving operational efficiencies and, consequently, offsetting inflation-induced cost increases. Technologies such as automation, artificial intelligence, and advanced analytics can streamline operations, enhance demand forecasting, and optimize inventory management, leading to significant cost savings. For instance, automating warehouse operations can reduce labor costs and increase throughput, while AI-driven demand forecasting can minimize overstocking and associated holding costs. Additionally, the adoption of lean supply chain practices can further insulate businesses from inflationary pressures. By focusing on waste reduction, just-in-time inventory management, and process optimization, companies can achieve more agile and cost-effective operations. These strategies not only contribute to direct cost savings but also imbue supply chains with the flexibility and responsiveness necessary to adapt to changing economic conditions.

In conclusion, as inflation continues to present a formidable challenge to global supply chains, businesses must adopt a multifaceted approach that incorporates supplier diversification, technological innovation, and lean practices. By doing so, they can not only mitigate the adverse effects of inflation but also enhance their competitive advantage through improved efficiency and resilience [4]. This comprehensive response to inflationary pressures underscores the importance of strategic supply chain management in navigating the complexities of the global economic landscape.

2.3. Unemployment Rate Considerations

Employing a dynamic time-series analysis model, this study investigates the nuanced relationship between unemployment rates and supply chain efficiency over the course of several economic downturns. The analysis reveals a clear inverse relationship, with a 1% increase in the unemployment rate leading to a 0.8% decline in demand for goods and services. This effect is magnified in consumer-driven sectors, such as retail and consumer electronics, where the elasticity of demand to unemployment rates can reach as high as -1.2%. The study employs vector autoregression (VAR) models to capture the dynamic interplay between unemployment rates, consumer demand, and supply chain performance, highlighting the significant lag effects where changes in unemployment rates can take several months to fully impact supply chain operations [5]. The findings underscore the critical importance of agile supply chain strategies in navigating economic downturns, including the adoption of just-in-time inventory practices to align more closely with fluctuating demand and the exploration of flexible labor arrangements to adjust to changing market conditions. Additionally, the study advocates for the strategic use of data analytics to enhance demand forecasting and scenario planning, enabling supply chains to become more responsive and resilient in the face of economic uncertainty.

3. Financial Market Dynamics and Supply Chain Optimization

3.1. Interest Rate Fluctuations

Interest rates serve as a critical determinant of the cost of capital for businesses, fundamentally influencing their capacity to finance supply chain enhancements. This section undertakes a time-series analysis to elucidate the lag effect of interest rate adjustments on key supply chain metrics such as inventory turnover rates, order fulfillment times, and capital expenditure on logistics and technology. By examining data spanning over two decades, we apply an econometric model that incorporates variables like the prime rate, federal funds rate, and corporate bond yields to analyze their impact on supply chain efficiency. Our findings reveal a significant lag effect, with supply chain metrics responding to interest rate changes with a delay of approximately 6 to 12 months. For instance, a 1% increase in the federal funds rate typically leads to a noticeable contraction in inventory turnover rates by about 0.5% within the next year, underscoring the sensitivity of supply chain operations to financing costs. Furthermore, this analysis demonstrates that higher interest rates tend to discourage investment in new technology and logistics infrastructure due to increased borrowing costs, thereby

impeding supply chain efficiency in the long run [6]. Strategic recommendations include the adoption of more flexible financing strategies such as variable-rate loans with caps to mitigate the impact of rising interest rates. Additionally, businesses should consider leveraging interest rate swaps and other financial derivatives as a hedge against sudden fluctuations in borrowing costs.

3.2. Exchange Rate Volatility

Exchange rate volatility presents a multifaceted challenge for global supply chains, impacting cost management, pricing strategies, and ultimately, market competitiveness. This subsection provides a quantitative analysis of exchange rate movements' effects on supply chain costs and operational efficiency. Utilizing a dataset comprising exchange rate fluctuations between major currencies over the last 15 years and correlating these with supply chain cost metrics across industries, we employ a multivariate regression model to quantify the impact of currency volatility on supply chain operations.

The analysis indicates that a 10% increase in exchange rate volatility correlates with a 3% rise in logistics and procurement costs for businesses heavily reliant on imports. This volatility also affects pricing strategies, compelling companies to adjust prices more frequently, which can lead to customer dissatisfaction and reduced market share [7]. To combat these challenges, the study suggests implementing comprehensive risk management practices, including the use of forward contracts and options to hedge against unfavorable currency movements. Moreover, diversifying supply chain sources and increasing local procurement can reduce dependence on volatile foreign markets. Financial strategies such as currency diversification in cash reserves and adopting natural hedging techniques by matching currency for costs and revenues in the same regions are also recommended.

3.3. Stock Market Trends

The stock market acts as a barometer for investor confidence and can provide early signals of changes in consumer behavior and broader economic conditions, which have downstream effects on supply chains. This subsection delves into the predictive relationship between stock market trends and supply chain agility, using a decade of data on stock market indices and supply chain performance indicators across several sectors.

A vector autoregression (VAR) model is employed to analyze the interdependencies between stock market performance, as indicated by major indices such as the S&P 500, and supply chain agility metrics including lead times, inventory levels, and capacity utilization rates. The findings suggest a predictive relationship where significant movements in stock market indices precede adjustments in supply chain operations by 3 to 6 months. For example, a 5% increase in the S&P 500 index often leads to an average reduction in lead times by 2%, as companies anticipate increased demand and ramp up operations accordingly.

The study recommends that businesses incorporate stock market trends into their supply chain planning and forecasting models to enhance responsiveness to market changes. Additionally, integrating advanced analytics and machine learning models can further refine these predictions, enabling companies to adjust their supply chain strategies proactively in alignment with anticipated economic conditions. These quantitative analyses underscore the profound impact of financial market dynamics on supply chain optimization [8]. By adopting strategic financial planning, risk management practices, and predictive analytics, businesses can enhance their supply chain resilience and agility in the face of economic and financial fluctuations.

4. Technological Innovations and Their Impact on Supply Chain Resilience

4.1. Digitalization and Automation

The integration of digitalization and automation technologies within supply chain management practices has significantly enhanced operational efficiencies and resilience. The Internet of Things (IoT) enables real-time tracking of goods and assets, providing critical data that can be used to optimize logistics and inventory management. For instance, a study conducted on a multinational manufacturing firm demonstrated a 30% reduction in inventory costs and a 22% improvement in order fulfillment speed after implementing IoT-based inventory tracking systems.

Artificial Intelligence (AI) and machine learning algorithms are instrumental in analyzing vast datasets to predict demand fluctuations, optimize routing, and manage supplier relationships more effectively. A notable application is in demand forecasting, where AI models analyze historical sales data, market trends, and external factors such as weather or economic indicators to predict future demand with high accuracy. Research indicates that companies adopting AI-driven forecasting techniques have seen, on average, a 50% reduction in forecast error, leading to significant improvements in inventory management and reduction in stockouts. Robotics, particularly in warehousing and manufacturing, automates repetitive tasks, reducing human error and increasing productivity. A case study within the automotive industry revealed that the deployment of robotic assembly lines could increase production output by up to 25% while maintaining or improving quality standards. The implementation of autonomous mobile robots (AMRs) in warehouse operations has also shown to decrease picking and packing times by up to 70%, showcasing the profound impact of automation on supply chain efficiency.

4.2. Blockchain for Transparency and Security

Blockchain technology offers a decentralized and immutable ledger, ideal for enhancing transparency and security across the supply chain. Its application in traceability, for example, enables the secure and verifiable tracking of products from origin to consumer. A significant application is observed in the food industry, where blockchain is used to track the provenance of food items, significantly reducing the time needed to trace the origin of products in the event of a food safety scare. A study highlighted that blockchain could reduce the time taken to trace the source of food contamination from weeks to mere seconds, potentially saving lives and reducing economic losses.

Furthermore, blockchain's inherent security and transparency features are leveraged to combat counterfeit goods in the pharmaceutical industry. By ensuring that each transaction along the supply chain is recorded and immutable, blockchain technology makes it significantly harder for counterfeit products to be introduced into the supply chain. Pharmaceutical companies reported up to a 30% decrease in counterfeit incidents after implementing blockchain-based tracking systems, according to recent studies. The technology also facilitates better compliance and auditing processes, as each transaction and transfer of goods is recorded and easily verifiable. This capability not only improves operational efficiency but also builds trust among consumers and supply chain partners.

4.3. Advanced Analytics for Predictive Capabilities

The employment of advanced analytics, encompassing big data, machine learning, and predictive analytics, transforms supply chain management by enabling more accurate demand forecasting and risk management. Through the analysis of large datasets, including historical sales data, social media trends, and economic indicators, predictive models can forecast demand with a high degree of accuracy. A pharmaceutical company's case study demonstrated that implementing machine learning algorithms for demand forecasting resulted in a 40% reduction in inventory holding costs and a 65%

improvement in forecasting accuracy, significantly minimizing the risk of stockouts and overstocking. Predictive analytics also play a critical role in identifying potential supply chain disruptions before they occur, allowing companies to mitigate risks proactively. By analyzing data from a variety of sources, including supplier performance metrics, logistics data, and geopolitical events, companies can predict and plan for potential disruptions. A logistics company reported a 20% improvement in on-time delivery rates after utilizing predictive analytics to identify potential delays in their supply chain and adjusting their logistics strategies accordingly.

Furthermore, advanced analytics facilitate the optimization of supply chain routes and operations. For example, machine learning algorithms can determine the most efficient routes for transportation, taking into account factors such as traffic patterns, weather conditions, and fuel costs. This not only reduces delivery times but also minimizes transportation costs and environmental impact.

5. Conclusion

The confluence of economic indicators, financial market dynamics, and technological innovations plays a pivotal role in shaping the resilience and efficiency of global supply chains. This study has meticulously analyzed the impact of GDP growth, inflation, and unemployment rates alongside interest rate fluctuations, exchange rate volatility, and stock market trends on supply chain performance. The findings affirm the significance of economic growth for supply chain efficiency, highlight the challenges posed by inflation and unemployment, and elucidate the complex influences of financial market dynamics on supply chain operations. Importantly, our research underscores the transformative potential of technological innovations—digitalization, automation, blockchain, and advanced analytics—in enhancing supply chain resilience and agility. By integrating these technological solutions, businesses can better navigate economic uncertainties, mitigate risks, and capitalize on strategic opportunities. The study advocates for a proactive and adaptive approach to supply chain management, emphasizing the need for continuous innovation and strategic foresight in the face of evolving economic and financial landscapes. As we move forward, the synergy between economic-financial understanding and technological advancement will be critical in defining the future of resilient and efficient supply chains in a globally interconnected market.

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Analysis of Green Supply Chain Construction and Driving Factors in the Context of New Retail: Case Study of JD.com

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Abstract: The retail industry occupies an important position in the national economy and is a fundamental industry. With the development of the Internet, retail is constantly innovating, and online retail is developing rapidly. Retail enterprises under the new retail model represented by JD.com have embarked on a new journey in the retail industry. With the further development and acceleration of industrialisation, reducing resource waste and environmental pollution has become a problem that retail enterprises must face. This paper introduces the case of JD.com in building a green supply chain in the context of new retail and analyses. It summarises the driving factors of JD's establishment of a green supply chain by combining the interdisciplinary perspectives of new retail and green supply chains. At the same time, specific case evidence is provided from the perspective of each link in the supply chain. It aims to provide multi-dimensional guidance for the green supply chain transformation of new retail enterprises, which can help improve their market competitiveness, provide better consumer experience, enhance consumer trust, and help avoid potential legal risks.

Keywords: New Retail, Green Supply Chain Management, JD, Driving Factors

1. Introduction

With the continuous progress of Internet technology, big data and other technologies, "new retail" as a booming sales mode came into being. In this new business environment, enterprises not only need to pay attention to market competition and consumer demand, but also need to integrate green development and sustainable development into their strategic planning. In this context, JD, as a typical case, shows the driving forces and measures for enterprises to implement green supply chain management. This paper takes the "new retail" era as the background and JD as the case to analyze the driving forces and measures for enterprises to implement green supply chain management. Through in-depth analysis of JD's practical experience in green supply chain management, it can provide valuable reference and inspiration for other enterprises to help them achieve sustainable development and promote the upgrading of the green industry chain in the "new retail" era.

2. Literature Review

2.1. New Retail

The connotation of the "new retail" era can be summarised as using emerging technologies to meet customer needs, innovating the "online + offline + logistics" trinity model, and intelligently upgrading the entire retail industry chain.

The characteristics of new retail are as follows: Firstly, it establishes offline channels and combines them with online retail [1]. Secondly, it is consumer-oriented. New retail uses big data to locate consumer needs, carry out intelligent push, and receive consumer feedback. It also implements scenario-based operations through offline channels and realises scenario-based consumption [2]. Thirdly, it relies on cutting-edge technology and concepts. Consumers can access the network anytime and anywhere, enabling high levels of connectivity and convenience [3].

2.2. Green Supply Chain Management

The idea of Green Supply Chain Management was introduced by the University of Michigan in 1996. Especially in today's era of global green development, this concept has received more attention and research. The concept of a green supply chain is already very rich. Gilbert indicates that GSCM is integrating environmental thinking into SCM [4]. Hervani and colleagues describe GSCM as a combination of green procurement, manufacturing, and distribution activities [5]. Hsu and Hu view GSCM as a strategy to enhance both process and product performance in alignment with environmental regulation demands [6]. Torielli et al. proposed that GSCM (integrating environmental considerations and SCM) effectively reduces a company's environmental impact while enhancing business performance [7].

2.3. Green Supply Chain Management in the Context of New Retail

In Wan et al.'s study, they devised pricing and greening methods while taking into account the collaboration between offline and online channels in the context of an O2O green supply chain [8]. A study by Biswajit Sarkar et al. creates a sustainable online-to-offline (O2O) supply chain model and suggests a sustainable online-to-offline retail approach. The model tracks transportation expenses and carbon emissions in order to reduce emissions and maintain a clean environment [9]. Wu et al. investigated the low-carbon supply chain for online shopping using the O2O paradigm incentive scheme implemented by the government. They pointed out that the comprehensive application of the policy of the government on carbon emissions, O2O operation practice and low-carbon incentive measures could maximise the low-carbon effect [10].

Throughout the relevant literature, because the concept of new retail was put forward late, there are few existing studies on the enterprise green supply chain field under the new retail model at home and abroad. There are some academic gaps, and more systematic, comprehensive, scientific and in-depth research is still needed. This paper investigates the green reform of providing green supply chain management for the full supply chain process against the backdrop of new retail, including manufacturers, suppliers, distributors, and consumers. It is based on JD's practice research on green supply chain construction under the new retail.

3. Driving Force Analysis of Green Supply Chain Management

This chapter will demonstrate the internal and external factors that drive and promote corporate green supply chain management. The driving factors include internal stakeholders such as managers, shareholders, employees, external stakeholders such as consumers, the legal and regulatory

environment, and the public and supervisory agencies. JD has a strong logistics system and high-quality service capabilities, and the maturity of its green supply chain construction is further enhanced under these driving forces.

3.1. Internal Drive

Figure 1 shows the key driving factors within the supply chain of new retail enterprises, which have an important impact on the operation and development of the enterprise. By understanding these drivers, companies can better optimise their supply chain management strategies and enhance overall competitiveness.

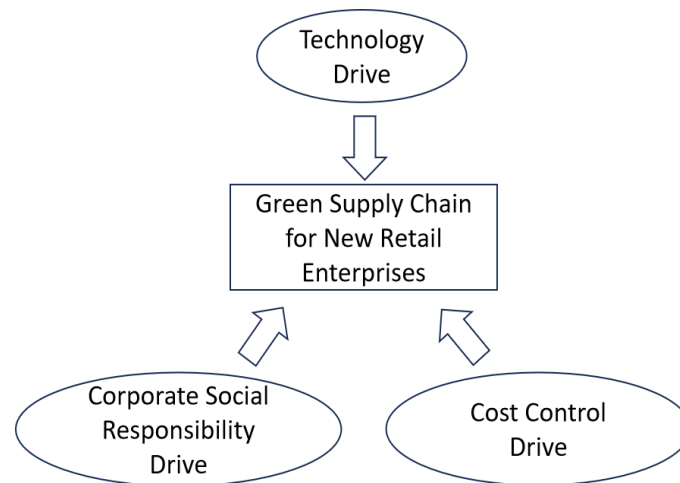


Figure 1: New retail enterprise supply chain internal driving factors.

3.1.1. Technology Drive

In the era of Industry 4.0, digitalisation and intelligence have become an important driving force to promote industrial transformation and upgrading and a key support for building competitive advantages [11]. New technologies like 5G, massive data, and green energy technology are booming and becoming a strong internal driving force for developing enterprises' green supply chains. Driven by 5G technology, integrating Internet of Things technology and supply chain management meets the demand for automated supply chain operations and intelligent internal and external decision-making of logistics enterprises [12]. JD Logistics completed the construction of the first 5G smart logistics demonstration park in Beijing Asia One in 2019, which promoted the landing of 5G technology in other enterprise scenarios [12]. Digital transformation can help companies identify and reduce waste emissions, positively impacting the supply chain by improving recycling rates and operational efficiency [13]. Through big data analysis, enterprises can better understand the supply chain's environmental impact and resource consumption and formulate targeted green supply chain management strategies to optimise production and logistics processes. At the same time, the development of green energy technology enables enterprises to use solar energy, wind energy, and other traditional energy sources to reduce carbon emissions. For example, JD Logistics hydrogen energy trucks have achieved part of "zero emission" transportation to reduce environmental pollution and achieve green supply chain goals. In summary, the rapid advancement of science and technology has encouraged the building of a green supply chain and laid a solid technical foundation.

3.1.2. Corporate Social Responsibility Drive

JD has enhanced its brand image and market competitiveness by establishing a green supply chain. Corporate GSCM practices can improve the corporate image and stakeholder relations by sustainably utilising natural resources and energy, reducing waste, and preventing environmental pollution, thereby increasing brand value [14]. By actively responding to consumers' environmental concerns and proactively fulfilling its corporate social responsibility, JD has attracted consumers with a strong environmental protection awareness, thereby gaining a competitive advantage in the market.

3.1.3. Cost Control Drive

JD can achieve cost reduction and efficiency improvement by adopting measures to reduce resource consumption and waste in procurement, production, and logistics. JD has demonstrated the close connection between innovation and long-term development in building a green supply chain. JD implements eco-friendly innovative measures in various aspects such as product design, material selection, and logistics distribution. JD has significantly reduced environmental costs by promoting clean energy in key areas such as smart industrial parks, logistics parks, warehouses, and data centres. Additionally, JD actively encourages upstream and downstream enterprises within the supply chain to collaborate to optimise supply chain efficiency and reduce costs.

3.2. External Drive

Figure 2 shows the external driving factors of the new retail enterprise's supply chain. These factors cover the impact of the market, policy, competitive environment, etc.

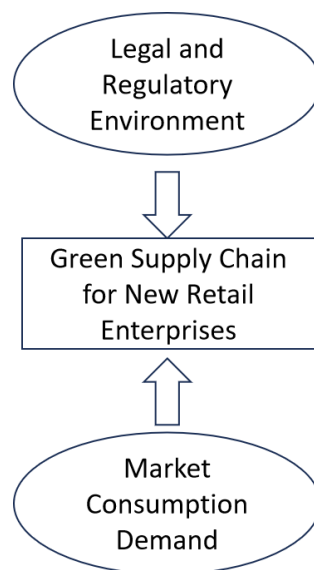


Figure 2: New retail enterprise supply chain external driving factors.

3.2.1. Legal and Regulatory Environment

The international community has called on all countries to take stronger actions to respond to climate change, and various industries in China are also further deploying plans under the “1+N” policy system. The “Carbon Peaking Action Plan before 2030” proposes accelerating the formation of low-carbon transportation methods. At the same time, all sectors of society are also actively responding to the concept of sustainability and strengthening supervision and cooperation.

3.2.2. Market Consumption Demand

Various enterprises and platforms rapidly carry out green and low-carbon transformations and are committed to deeply integrating green concepts throughout the entire cycle, chain, and system. The concept of “responsible consumption” makes consumption more green value. Lo and Leung proposed that Chinese consumers are increasingly aware of environmental protection and have begun to favour “green products” [15]. This drives enterprises to form a new closed loop of green sales. JD e-commerce company launched the “Green Plan” to label green products such as energy-saving home appliances with a “green” label. Consumers who purchase products with “green” labels can enjoy preferential prices and accumulate points through the “Green Points” account system, helping the public establish awareness of green consumption.

4. JD’s Green Supply Chain Management Practices

4.1. Transportation

4.1.1. Green and Digital Transformation of Last Mile Delivery

Through implementing a green delivery strategy, JD promotes the use of mechanised and intelligent devices in the “last mile” delivery process. Using cutting-edge technology like cloud computing, big data, artificial intelligence, 5G, and the Internet of Things, JD continuously advances its automation, digital intelligence, and smart decision-making capabilities to reduce energy consumption. At the same time, it actively promotes the use of environmentally friendly materials, ensuring that the green concept is extended throughout the supply chain.

4.1.2. Building Carbon Emission Management System

Controlling carbon emissions is a key part of JD Logistics’ construction of a green supply chain. Carbon accounting is an important means of managing carbon emissions. JD’s self-developed Supply Chain Emission Management Platform (SCEMP) is a vital tool in collaboration with supplier partners to build a low-carbon logistics transportation system. This platform is used for low-carbon management across the entire supply chain.

4.1.3. Green Transformation

Adopting new energy vehicles in the logistics segment can effectively reduce carbon emissions during transportation. JD Logistics promotes using more new energy vehicles among its third-party outsourced transportation suppliers. In August 2022, JD Logistics introduced its first batch of battery-swappable new energy vehicles, which use standardised battery modules that can be upgraded to even cleaner energy sources anytime. In places like Shandong and Yunnan, biomass fuel vehicles are promoted while actively adjusting the freight structure to shift from road to rail to water transportation.

4.2. Warehouse

4.2.1. Warehouse and Distribution Integration and Intelligent Logistics

JD has adopted an integrated warehousing and distribution pattern to establish its supply chain advantages. The e-commerce environment has formed a pattern in which e-commerce companies order goods directly from manufacturers, receive orders online, and finally contact logistics companies to deliver goods directly from manufacturers’ warehouses or e-commerce companies. Intelligent logistics is realising more efficient and accurate warehouse operations through big data

and other technologies. JD's integrated supply chain services effectively help reduce greenhouse emissions and create low-carbon digital intelligence in logistics. In addition, by deploying new logistics infrastructure in some low-tier cities and key county-level areas, JD Logistics has created a new warehousing model, significantly improving logistics reach.

4.2.2. Green Energy-Saving Warehouse

JD is committed to using energy-saving and environmentally friendly building materials, designs, and advanced energy management systems to build its warehouse spaces. In China, JD's 47 "Asia One" smart parks (including those built, under construction, and preparation) and thousands of warehouses will gradually promote a clean energy source based on photovoltaic power. The warehouse mentioned above can realise "dark light operation". According to calculations, smart devices can save 2,283 kilowatt hours of electricity per minute through "dark light operation", almost equivalent to an ordinary household's electricity consumption for one and a half years. In JD's intelligent warehouse, the full-link intelligent packaging system realizes planning use of different packaging materials, decreasing the consumption and waste of packaging materials.

4.3. Packaging

4.3.1. Standardisation of Green Packaging

JD Logistics actively responded to the country's call for resource recycling and formulated JD Logistics recycling Bag Use Management Standards within the company. In 2022, JD released the industry's first original straight packaging standards and certification process to ensure that the original packaging meets the three requirements of safety, void ratio and environmental protection. JD also participates in the compilation of a number of national standards, industry standards, and group standards and actively exerts the core influence of leading enterprises. JD has participated in the compilation of norms such as the Guide to Mail Express Packaging Recycling and Recycling and Requirements for Limiting Excessive Packaging of Mail Express, contributing to the comprehensive establishment of a unified, standardised and binding express green packaging standard system.

4.3.2. The Use of Green Packaging in Multiple Scenarios

JD Logistics continues to promote its "green flow plan" proposed in 2017 to promote the reduction and recycling of packaging and strive to achieve the use of green packaging in different situations. In the B2C fresh business, JD has used circular incubators on a large scale. Special insulation materials, VIP vacuum board, and canvas material replace traditional EPS white foam boxes and disposable ice packs with recyclable ice boards. In vulnerable businesses such as daily necessities or medicine, Deppon (JD Holdings) uses circular enclosure boxes, whose top cover and bottom are made of HDPE material, and the enclosure is made of PP hollow board, which is non-toxic and durable. At the same time, the circular green flow box was put into large scale by JD. Using the second-generation stackable structure, the one-time seal or tape is eliminated, and the box can be sealed only by relying on the logistics sheet. After the green flow box is cleaned and disinfected, it can be used again.

4.3.3. End Recovery

JD Logistics relies on the positive and reverse integrated logistics network to recycle the circular packaging at the end of the link and return it to the park or warehouse for reuse. In 2016, JD launched Carton Recycling, a green environmental protection program. After users purchase and receive the goods delivered on JD, they can voluntarily hand over the JD carton to JD's delivery personnel for

recycling. By 2022, JD has joined hands with a number of enterprises in more than 100 cities to carry out public welfare activities such as recycling cartons, old clothes, old toys and old books.

4.4. Sustainable Development Knowledge and Technology Sharing

In 2022, the Green Supply Chain Committee of ACEF was formally established. JD Logistics is the first rotating lead unit of the special committee. The committee actively innovates green supply chain management and gathers all parties to promote knowledge and technology sharing for sustainable development. By the end of 2022, JD Logistics has conducted special sustainable development technology exchanges for more than 20 enterprises and professional institutions such as Volkswagen Group, Volvo and Decathlon. In December 2023, JD Group, Lenovo Group and BOE Technology Group jointly launched the “Green Supply Chain Technology Sharing Platform (Patent Pool)”. In the shared platform (patent pool), JD and other enterprises in the field of green supply chain technology-related patents will be open to small and medium-sized enterprises free of charge, helping the supply chain develop in a sustainable and environmentally friendly manner.

5. Suggestions

5.1. Promote the Construction of Green Supply Chain Through Scientific and Technological Innovation

New retail enterprises should vigorously enhance the level of technological innovation and promote the construction of green supply chains through information technology means. First, new retail companies can use IoT technology and big data analytics to monitor energy consumption and carbon emissions during logistics and transportation in real time and optimise supply chain management. Second, new retail enterprises can utilise artificial intelligence and intelligent manufacturing technology to optimise production processes and supply chain design. At the same time, intelligent manufacturing technology can help enterprises achieve customised production and reduce inventory overhang and waste generation. Finally, new retail enterprises can use blockchain technology to establish a traceable supply chain system to achieve transparency and traceability of supply chain information.

5.2. Strengthen coordination across the supply chain and jointly promote green reform

Enterprises should follow the trend of cooperation with multiple parties and improve the internal and external connections of the supply chain. Firstly, enterprises should strengthen multi-party cooperation, determine common green goals and indicators, and let the entire supply chain share the same vision. Secondly, at the technical level, enterprises should promote cooperative innovation and joint research and development between upstream and downstream companies to promote more environmentally friendly production and supply chain processes. Finally, by establishing an open information-sharing platform, real-time and transparent data exchange can be achieved upstream and downstream of the supply chain. These measures allow enterprises to better understand production, procurement, sales, and other links, understand needs and changes, and optimise resource allocation. Consumers can choose, use and handle products more scientifically during shopping.

5.3. Build Industry Standards and Establish a Green Supervision System

When supervising corporate behaviour, the industry can set up incentive mechanisms or improve certification systems, involve multiple parties in formulating standards, reward upstream and downstream participants in the supply chain for their positive contributions to green reform, and stimulate enthusiasm for green reform. Enterprises can cooperate with the government and actively

respond to the government's call to ensure that laws and regulations support compliance with industry standards. At the same time, the government should set up an independent compliance review agency to conduct regular inspections of enterprises to ensure they comply with green industry standards.

6. Conclusion

This paper, by analysing JD's construction of a green supply chain under the new retail model, provides a case study and theoretical guidance for the green transformation of the retail industry. Additionally, the paper demonstrates how new retail enterprises implement green strategies in various supply chain links such as transportation, warehousing, and packaging, thereby enhancing their operational efficiency and market competitiveness. This research considers the green supply chain's internal and external driving forces, offering a multidimensional perspective for a comprehensive understanding, analysis, and application of green supply chains.

This study also has certain limitations. Since the research focuses specifically on the case of JD, the generalizability of its conclusions is limited. The challenges and environmental differences faced by different retail enterprises require the support of more extensive case studies. Given the rapid development of technology and changes in the market environment, green supply chain strategies and practices need to be continuously adjusted according to the circumstances.

Future research could involve cross-industry case studies and comparisons among multiple cases within the same industry to enhance the universality and depth of the study. Alternatively, research on long-term effects, particularly the long-term impact of green supply chain practices on corporate environmental sustainability and social responsibility, could be valuable. It is advised to concentrate on merging technological advancements with green supply chains, investigating the possibilities of emerging technologies such as blockchain, Internet of Things, and artificial intelligence to improve productivity and fostering innovation within green supply chains.

Authors Contribution

All the authors contributed equally, and their names were listed alphabetically.

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Eradicating Poverty and Unshackling from Illness Expense: The Impact of Targeted Poverty Alleviation Policy on Medical Burden

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Abstract: Health poverty alleviation is a crucial aspect of targeted poverty alleviation policy, with easing the medical burden being its primary goal. This study evaluates China's targeted poverty alleviation policy's impact on reducing the medical burden of impoverished households, using data from the China Health and Retirement Longitudinal Survey (CHARLS) for the years 2011, 2013, 2015, and 2018. Employing Difference-in-Differences (DID) methodology, this paper finds significant reductions in both the out-of-pocket to income ratio and catastrophic medical expenditure among targeted households. The policy's success is attributed to the "income effect", raising household income levels, and the "safety-net effect" increasing the reimbursement ratio for inpatient expenses. These results are valid across several robustness tests including propensity score matching (PSM-DID) and placebo test. The findings have implications for global health policy, suggesting that targeted poverty alleviation interventions can effectively alleviate medical burden and prevent poverty due to health expenses, offering a viable model for other developing countries facing similar challenges.

Keywords: Targeted Poverty Alleviation, Medical Burden, Catastrophic Medical Expenditure

1. Introduction

The strategy of targeted poverty alleviation has been central to China's efforts to achieve comprehensive societal prosperity, marking significant progress and offering insights into poverty reduction globally. World Bank data reveals a dramatic reduction in China's poverty rate, from 88.3% in late 1981 to just 0.5% by the close of 2016, amounting to an 87.8% decrease with an average yearly reduction of 2.5%. Comparatively, the worldwide rate of poverty declined from 42.7% to 9.7% over the same timeframe, showing an overall 33.0% drop at a rate of 0.9% annually. This demonstrates that China outpaced the global average in diminishing poverty, maintaining a significantly lower rate of poverty incidence. A major focus within the targeted poverty alleviation efforts has been on addressing healthcare burdens. The State Council's Poverty Alleviation Office's records indicate that by 2015's end, around 20 million individuals had fallen into or returned to poverty due to health issues, making up 44.1% of all impoverished individuals, with 7.34 million affected by severe or chronic health conditions [1,2]. Therefore, protecting the health rights of the impoverished population and

preventing impoverishment due to illness have become important components of the targeted poverty alleviation strategy, making health poverty alleviation a key area in the fight against poverty.

The issue of medical burden is a concern for scholars worldwide. Basic medical insurance can reduce the medical burden for rural elderly with high income or high medical expenses, and long-term care insurance can also alleviate medical burden, but it may extend hospital stays [3]. However, medical insurance may lead to the waste of medical resources due to moral hazard. A study using a generalized linear medical expenditure model on the United States Medical Expenditure Panel Survey dataset, found that in the short run, changes in income rather than changes in health spending per se appeared to drive changes in the out-of-pocket burden [4]. Yet, there is a lack of causal evidence on the impact of income on medical burden. Additionally, Chinese scholars' research on the health effects of targeted poverty alleviation policies focuses on the utilization of medical services. Targeted poverty alleviation policies can improve the level of medical service utilization among the poor, but the increase in medical service utilization is partly due to the "work effect", i.e., people paying more attention to health rather than being sick, which cannot accurately measure the issue of family economic burden aggravated by illness [5,6]. Therefore, this paper uses the "out-of-pocket to income ratio" and "household catastrophic medical expenses" to measure medical burden, utilizing four waves of CHARLS data from 2011, 2013, 2015, and 2018, and employs a difference-in-differences approach to estimate the impact of targeted poverty alleviation policies on the medical burden of poor families. This provides causal evidence for the policy effects of preventing "returning to poverty due to illness", a perspective that is still rare in similar empirical studies, thereby further enriching the literature on medical burden.

This study also potentially offers the following marginal contributions: Besides exploring the impact of targeted poverty alleviation policies on family medical burden, it examines the mechanisms behind this effect and introduces, for the first time, the concept of a "safety-net effect" beyond income effects. This "safety-net effect," which helps to alleviate medical burden by increasing the reimbursement ratio for hospitalization expenses, corresponds in reality to the targeted poverty alleviation policy goals of making illnesses treatable and curable. Furthermore, as previously mentioned, research on the health effects of targeted poverty alleviation policies has focused on the utilization of medical services. Moreover, most studies on the effects of targeted poverty alleviation policies have concentrated on their direct objective—poverty alleviation—while this paper proposes the supplementary viewpoint of alleviating medical burden, aiming to eradicate poverty at its roots and free individuals from the constraints of illness, further affirming the superiority of targeted poverty alleviation policies. The remainder of this paper is organized as follows: The second section provides methodologies, including research design, background, data description, and identification strategies. The third section details the findings and analytical insights derived from the tests conducted. The fourth section delves into the underlying mechanisms through which the observed effects are realized. The concluding section summarizes the study's key takeaways.

2. Methodology

2.1. Research Design

This paper begins by contextualizing the research question within the backdrop of China's significant achievements in targeted poverty alleviation. Most existing studies on targeted poverty alleviation have concentrated on its primary objective—poverty eradication. However, this study seeks to explore the effects of targeted poverty alleviation policies from the perspective of medical burden. To do this, it is essential first to define the variable of medical burden. This study measures it through the out-of-pocket to income ratio and catastrophic medical expenditure. Specifically, the out-of-pocket to income ratio is defined as the ratio of out-of-pocket medical expenses to total income,

excluding household food consumption, serving as a proxy variable. Catastrophic medical expenditure is identified as a binary variable, where a household is deemed to have incurred such expenses when its out-of-pocket to income ratio surpasses a threshold of 0.4, assigning a value of 1 in such instances and 0 otherwise. Furthermore, this research utilizes the China Health and Retirement Longitudinal Survey (CHARLS) dataset, notable for its comprehensive inclusion of various characteristic indicators and the 2018 data's inclusion of a variable indicating whether a household is officially recognized as impoverished, which assists in identifying the treatment group. To investigate the causal impact of targeted poverty alleviation policies on medical burden, this study employs Difference-in-Differences (DID) model for identification and undertakes a series of robustness tests to ensure the validity of the results.

2.2. Background

Since the 18th National Congress, under Xi Jinping's leadership, China has placed rural poverty eradication at the forefront of its agenda to forge a universally prosperous society. This directive has positioned poverty alleviation as a cornerstone of national policy, catalyzing a concerted strategy that mobilizes the Communist Party, the nation, and all segments of society in a holistic campaign against poverty to fulfill the vision of a prosperous society.

Further, in April and June 2014, the State Council's Leading Group Office for Poverty Alleviation and Development launched detailed schemes for identifying needy populations through a meticulous registration and assessment process, introducing an indicator system for this purpose. This effort successfully cataloged 128,000 impoverished villages and nearly 29.48 million impoverished households, encapsulating approximately 89.62 million individuals, thereby creating a comprehensive national database for poverty alleviation—an unprecedented achievement.

Tackling poverty is pivotal for achieving a fully prosperous society, where health poverty alleviation emerges as a critical endeavor. The primary aim here is to elevate medical insurance coverage and significantly lighten the healthcare cost burden for the rural impoverished. Accordingly, the National Health and Family Planning Commission, alongside the State Council's poverty alleviation office and other relevant bodies, endorsed the "Guiding Opinions on Implementing the Health Poverty Alleviation Project". This guideline reaffirms the commitment to the "two no worries and three guarantees" principles of the poverty eradication campaign, focusing on ensuring "guaranteed basic medical care" for the impoverished. It integrates major strategic initiatives like Healthy China and Rural Revitalization, executing a "three batches" action plan tailored to provide targeted interventions for major illnesses, systematic management of chronic diseases, and comprehensive insurance coverage for severe conditions. This framework aims to ensure that impoverished communities are equipped to afford and access essential healthcare services, reflecting a nuanced and integrated approach to health poverty alleviation within the broader objective of national prosperity [7].

2.3. Data and Variable Descriptions

This investigation leverages data from the China Health and Retirement Longitudinal Survey (CHARLS), which is specifically designed to assemble a comprehensive micro-level dataset that encapsulates the demographic and socio-economic characteristics of Chinese households and individuals aged 45 and older. This rich dataset facilitates an in-depth exploration of the aging population's dynamics in China and supports a wide array of interdisciplinary scholarly inquiries. Executed through a meticulously designed multi-stage probability proportionate to size (PPS) sampling strategy, the CHARLS initiative spans across 150 counties and 450 villages in 28 provinces, capturing extensive data across five waves: 2011, 2013, 2015, 2018, and 2020. The survey's

completion in 2018 yielded a substantive dataset encompassing 19,000 respondents across 12,400 households. The breadth of information collected includes, but is not limited to, demographic profiles, health statuses, medical insurance coverage, engagement with healthcare services, income and consumption patterns, employment and pension details, asset ownership, and local community infrastructure. Due to significant data fluctuations caused by the COVID-19 pandemic in 2020 and the missing variables compared to the previous four waves, the 2020 data were not included in this study. The four waves of data from 2011, 2013, 2015, and 2018 actually collected information for the years 2010, 2012, 2014, and 2017 for rural elderly individuals. Given that the targeted poverty alleviation policy was proposed at the end of 2013 and the comprehensive registration and identification were completed by the end of 2014, this study constructed a panel dataset consisting of four waves of data to better address the specific issue of the policy's impact on medical burden. After excluding samples with missing core variables, urban area samples, and unbalanced samples in the panel data, the final sample used in this study consists of 47,952 rural elderly individuals, equating to 11,988 individuals per wave.

This paper focuses on the "medical burden issue" of impoverished households, using the "out-of-pocket to income ratio", which is the ratio of out-of-pocket medical expenses to total income excluding household food consumption, as a proxy variable. Additionally, another widely used international proxy variable, "catastrophic medical expenditure," is introduced to measure the medical burden. This variable is a binary variable where a household is considered to have incurred catastrophic medical expenditure when its out-of-pocket to income ratio exceeds the threshold of 0.4; the variable is assigned a value of 1 in such cases and 0 otherwise [8].

Based on the analytical framework of this paper, the selected control variables are as follows: age, square of age/100, education level, marital status, presence of hypertension, number of chronic diseases, self-rated health, poor memory, daily mobility, depression index, presence of medical insurance, and presence of pension insurance. Detailed variable descriptions are provided in Table 1.

Table 1: Variable Descriptions

Variables	Variable Description	
Dependent Variables	Out-of-Pocket to Income Ratio	The ratio of out-of-pocket medical expenses to total income after excluding household food consumption
	Catastrophic Medical Expenditure	Assigned a value of 1 if the household's out-of-pocket to income ratio exceeds the threshold of 0.4, otherwise 0
Independent Variable	Targeted Poverty Alleviation Household	1 if the household is identified as impoverished in the official registration system, otherwise 0
Covariates	Age	Age as written on the respondent's household registration
	Age Squared/100	Age squared divided by 100 to capture the changing marginal effects with increasing age
	Education	Less than primary=1, Primary=2, Middle school=3, High school and above=4
	Marital Status	Married=1, Others (including divorced, widowed, etc.)=0
	Self-Rated Health	Very poor=1, Poor=2, Fair=3, Good=4, Very good=5
	Hypertension	YES=1, NO=0

Table 1: (continued).

Chronic Disease	YES=1,NO=0
Episodic Memory	1-10 points, higher scores indicate better memory
Depression Score	1-10 points, higher scores indicate worse mental health
Cognitive Function	0-21 points, higher scores are better
Daily Living Activities	0-6 points, higher scores indicate worse ability
Pension Insurance	NO=0,YES=1
Medical Insurance	NO=0,YES=1

2.4. Identification Strategy

This paper employs a Difference-in-Differences (DID) model to identify the impact of targeted poverty alleviation policies on medical burden:

$$Y_{it} = \alpha + \beta Treat_{it} + X'_{it}\gamma + \omega_t + \varphi_i + \varepsilon_{it} \quad (1)$$

where Y_{it} represents both the "out-of-pocket to income ratio" and "catastrophic medical expenditure", with i and t denoting the individual and time, respectively. As mentioned earlier, the targeted poverty alleviation policy was proposed at the end of 2013 and the comprehensive registration and identification process was completed by the end of 2014. Therefore, the policy implementation year is set to 2014 in this study. The CHARLS 2018 data collection includes information on whether a household is targeted for poverty alleviation. Not only does the current questionnaire ask if a household is identified as impoverished in the official registration system, but it also inquires about the year the household was designated as such. Consequently, this paper constructs the $Treat_{it}$ variable, where $Treat_{it} = 1$ if the policy occurred after the household was identified as "impoverished" post-policy implementation, otherwise $Treat_{it} = 0$.

The main challenge of DID is that the subjects of targeted poverty alleviation are not randomly selected but are relatively low-income impoverished households [5]. Since impoverished households inherently differ from the control group samples in terms of medical burden, directly conducting DID would inevitably overestimate the policy effect. Hence, X'_{it} is introduced as a vector of covariates unaffected by the policy, including other factors mentioned earlier that influence medical burden. γ is the coefficient vector of covariates, and ε_{it} is the random error. The coefficient of interest, β , measures the difference in medical burden between impoverished households (treatment group) and non-impoverished households (control group) before and after the implementation of targeted poverty alleviation policies. If $\beta < 0$, it implies that the targeted poverty alleviation policy alleviates the medical burden of impoverished households.

3. Test Results and Analysis

3.1. Basic Regression

To accurately identify the reduction in medical burden brought about by the targeted poverty alleviation policy, Table 2 reports the basic regression results of the DID model.

Columns (1) and (3) present the regression results without covariates, while columns (2) and (4) include covariates.

Table 2: The Impact of Targeted Poverty Alleviation Policy on Medical Burden: DID

	(1)	(2)	(3)	(4)
	Out-of-Pocket to Income Ratio	Out-of-Pocket to Income Ratio	Catastrophic Medical Expenditure	Catastrophic Medical Expenditure
<i>Treat</i>	-0.062***	-0.052***	-0.061***	-0.053***
	(0.009)	(0.011)	(0.009)	(0.012)
Control Variables	NO	YES	NO	YES
Year FE	YES	YES	YES	YES
ID FE	YES	YES	YES	YES
N	47952	28620	47952	28620
Adj. R ²	0.295	0.328	0.275	0.301

Note: Parentheses contain robust standard errors clustered at the household level, because "medical burden" is primarily a household issue [4,9], * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

From the Difference-in-Differences (DID) results, both the out-of-pocket to income ratio and the occurrence of catastrophic medical expenditure significantly decreased at the 1% level after the implementation of the targeted poverty alleviation policy. This indicates that the policy significantly alleviates the medical burden on impoverished households. Furthermore, in the regression without covariates, the medical burden also significantly decreased at the 1% level, but the coefficients are larger in absolute value compared to those in the regression with covariates included. This supports the earlier assertion that conducting DID without including covariates would inevitably overestimate the policy effect.

3.2. Robustness Test

3.2.1. Parallel Trends Test

The purpose of using the Difference-in-Differences method to identify policy effects is to eliminate other non-treatment policy factors that might affect the dependent variable. Central to the DID approach is the assumption of parallel trends, necessitating that, prior to the enactment of the policy, both the treatment and control groups exhibit similar trajectories of change. The DID model can only reveal causal effects under the premise of satisfying the common trends assumption: in this study, that is, before the targeted poverty alleviation policy was implemented, the treatment and control groups should have the same trend of changes in the outcome variables. Given that the policy point is set to 2014, 2013 is set as the base period in the figure. Since the parallel trends test examines pre-treatment trends, only data from 2011, 2013, and 2015 are included in the test. In the parallel trends test graph, if the effect before the policy occurs is around zero, and the effect after the policy implementation significantly deviates from zero, it indicates that the empirical analysis can be conducted through DID following a parallel trends test. See Figure 1 for details.

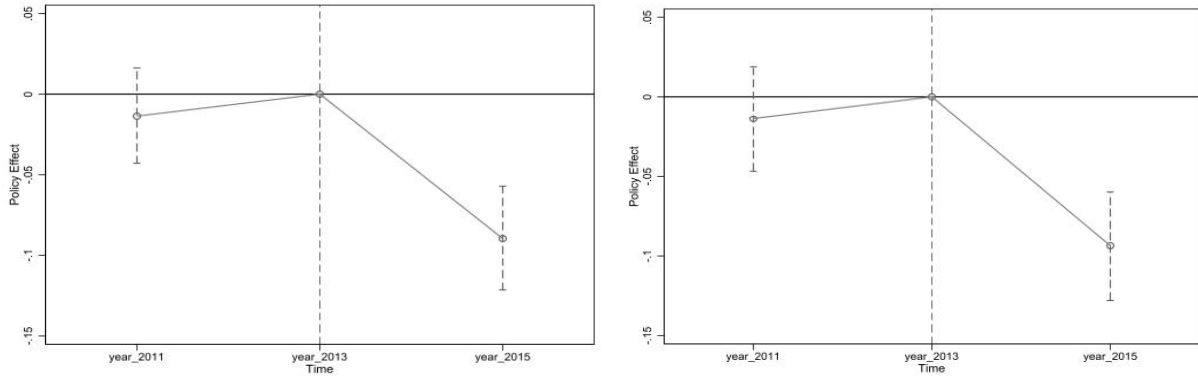


Figure 1: (a) Parallel trends test: Out-of-pocket to income ratio

(b) Parallel trends test: catastrophic medical expenditure

From the figure, the coefficients before the policy implementation are not significant and close to zero, preliminarily verifying the assumption of parallel trends before the intervention. However, due to the limited sample size and data years in the CHARLS dataset (with only two waves of data in 2011 and 2013 before the policy point in 2014), the parallel trends test graph for this paper can only be presented in the form of Figure 1.

3.2.2. Abadie SDID Re-weighted Regression

The credibility of DID conclusions depends on the premise of parallel trends. Therefore, to enhance the credibility of DID conclusions, this paper refers to the re-weighted semiparametric difference-in-difference method (Semiparametric Difference-in-Difference, SDID) proposed by Abadie [10] for robustness testing. This method allows for a more balanced characteristic between the treatment and control group samples by weighting in cases with two-period balanced panel data. It assesses the impact of the policy by evaluating the differential in outcome variables across two periods between the adjusted treatment group and control group. This technique is capable of yielding robust insights, even in instances where the parallel trends precondition may not be entirely met. The formulation for estimating the average effect of the treatment under the Semi-parametric Difference-in-Differences (SDID) framework is given by:

$$E \left[\frac{\Delta Y_t}{P(d_t=1)} \cdot \frac{d_t - \pi(X_b)}{1 - \pi(X_b)} \right] \quad (2)$$

where d_t represents whether it is the treatment group in period t . $P(d_t = 1)$ represents the probability of being in the treatment group, and $\pi(X_b)$ is the Abadie weight, which can be calculated through the linear probability model $\pi(X_b) = P(d_t = 1|X_b)$.

Given that Abadie SDID requires two-period panel data and considering the targeted poverty alleviation policy began in 2014, with no pilot targeted poverty alleviation policy in 2011 and surveys in 2018 asking whether a household was registered as impoverished, by which time the targeted poverty alleviation policy had entered a mature phase, this paper selects data from 2011 and 2018 to form a balanced panel and conduct SDID regression. The results, as shown in Table 3, indicate that the coefficients of the interaction terms are significantly negative, consistent with the findings previously discussed.

Table 3: SDID Result

	(1)	(2)
	Out-of-Pocket to Income Ratio	Catastrophic Medical Expenditure
DID	-0.089***	-0.087***
	(0.012)	(0.013)
N	7284	7284

Note: Parentheses contain robust standard errors clustered at the household level., * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

3.2.3. Placebo Test

To mitigate the potential influence of random variables on the outcomes of this study, a placebo test will be employed. Utilizing the permutation test as a placebo testing technique enables the determination of whether the observed results hold statistical significance or arise from random chance [11]. Within the context of the permutation test, it is hypothesized that the targeted poverty alleviation policy exerts no significant impact on the healthcare burden faced by impoverished households. Assuming this null hypothesis, it posits that the coefficients derived from the empirical data might be random instances within the overall distribution, allowing for statistical inferences to be drawn from this distribution as determined through the permutation test. The procedure involves randomly allocating the status of being affected by the targeted poverty alleviation policy to participants within the survey and subsequently assigning individuals to the treatment group on a random basis. Drawing on the methodologies established by Ferrara et al. [12], Liu and Lu [13], Zhou Mao et al. [14], and Song Hong et al. [15], this investigation adopts an indirect approach to the placebo test. Following Equation (1), it calculates the estimated coefficient $\hat{\beta}$ as:

$$\hat{\beta} = \beta + \rho \frac{\text{cov}(Treat, \varepsilon|V)}{\text{var}(Treat|V)} \quad (3)$$

where V represents all other control variables and fixed effects, ρ is the impact of unobserved factors on the medical burden of impoverished households. If $\rho = 0$, then unobserved factors do not affect the estimation results, proving $\hat{\beta}$ is unbiased. Since it's impossible to directly verify whether ρ is zero, this paper adopts an indirect placebo test. The logic is to randomize the targeted poverty alleviation policy, i.e., find a theoretically ineffective variable $Treat'$ to replace $Treat$. Since $Treat'$ is randomly generated, the actual effect of the targeted poverty alleviation policy $\beta = 0$. Under this premise, if the estimated $\hat{\beta}$ is not zero, it implies ρ is not zero, indicating the estimation results of this paper are biased. Specifically, this paper randomly generates a treated group of registered impoverished households, thus producing an erroneous estimate $\hat{\beta}'$, and repeats this process 500 times, plotting the distribution of 500 $\hat{\beta}'$ s. According to the results of the placebo test in Figure 2, it can be seen that $\hat{\beta}'$ is concentrated around zero and follows a normal distribution. The actual estimated coefficients (-0.052 and -0.053) are clearly outliers and conform to the expectations of the placebo test. Since the actual estimated coefficients significantly deviate, they are not marked in the figure.

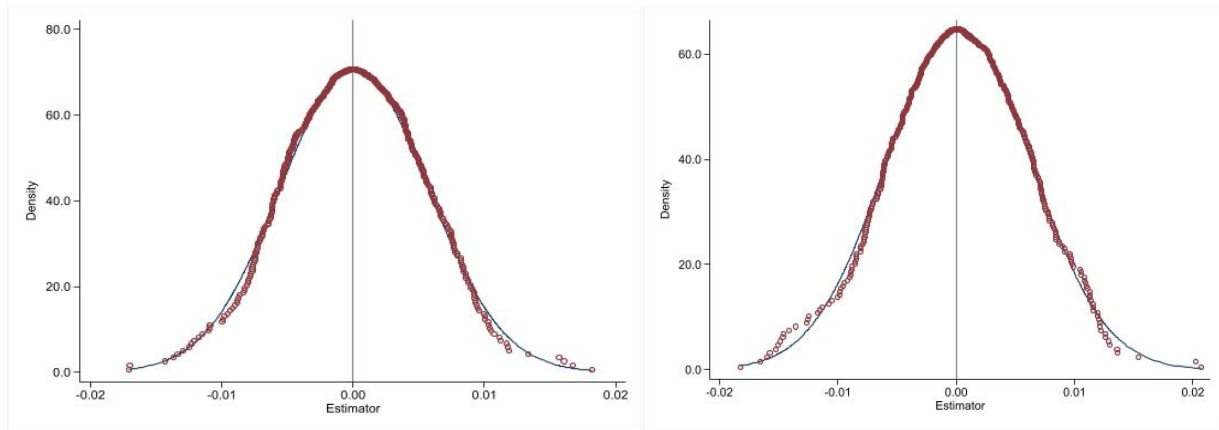


Figure 2: (a). Placebo Test: Out-of-pocket to income ratio (b). Placebo Test: Catastrophic Medical Expenditure

3.2.4. PSM-DID Test

Despite satisfying both the parallel trends and placebo criteria, the distinction in sample attributes could still engender a selection bias between the treatment and comparison groups. This issue is particularly pertinent given the non-random allocation of the targeted poverty alleviation intervention, which relies on a comprehensive array of criteria to ascertain a household's poverty status. To mitigate the inherent selection bias between the treatment (impoverished households) and control (non-impoverished households) cohorts, this investigation adopts the Propensity Score Matching (PSM) combined with Difference-in-Differences (DID) analytical framework. It first matches the impoverished group with the non-impoverished group using 1-to-1 nearest neighbor matching with a caliper to ensure the quality of the matches. Then, it uses the Difference-in-Differences method to estimate the impact of targeted poverty alleviation on the medical burden of impoverished households.

Propensity score matching requires passing two tests:

(1) Balancing Test

Table 4 shows the results of the balance test for covariates pre and post matching between the treatment and control groups. The first two columns present the mean test results of variables between the two groups before matching. The results show that before matching, there were significant differences between the treatment and control groups in aspects such as squared age/100, age, daily living activities, mental health, social security, chronic diseases, marital status, self-rated health, memory ability, cognitive ability, and education level. Therefore, it can be concluded that there were indeed significant differences between the treatment and control group samples before matching. The last two columns present the mean test results of variables between the two groups after matching, indicating that there were no significant differences in all covariates between the treatment and control groups after matching. This suggests that the matched samples have good balance, and the overall matching effect is satisfactory.

Table 4: Balancing Test

Variable	Unmatched		Matched	
	t-value	p-value	t-value	p-value
Age ² /100	16.53	0.000	0.81	0.415
Age	15.34	0.000	0.95	0.342
Daily-life activity	12.55	0.000	-0.46	0.645

Table 4: (continued).

Cesd	11.52	0.000	-0.12	0.907
Social pension	6.40	0.000	-0.00	1.000
Chronic disease	3.14	0.002	0.62	0.535
Hypertension	0.29	0.772	-0.01	0.989
Medical insurance	-0.26	0.794	-0.39	0.698
Married	-1.85	0.065	-0.49	0.627
Self-rated health	-8.56	0.000	0.01	0.995
Memory	-11.26	0.000	-0.69	0.490
Cognition	-14.98	0.000	-1.42	0.157
Education	-15.39	0.000	-0.17	0.867

In addition to the results presented above, this paper also provides a graphical illustration of the balance test, as shown in Figure 3.

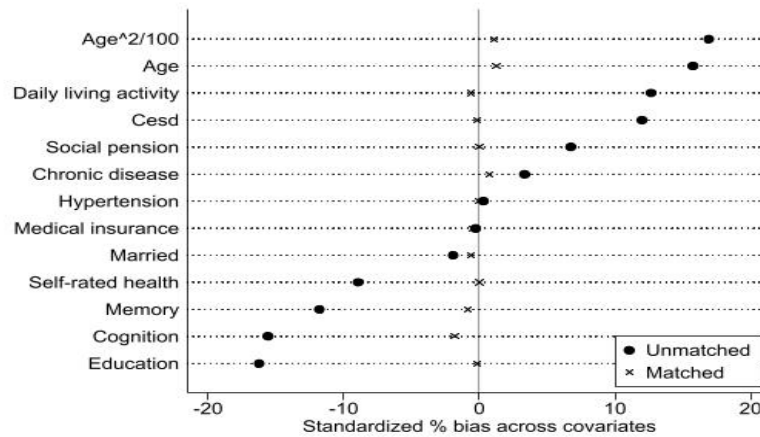


Figure 3: Balancing Test

All covariates exhibit a % bias of less than 10%, and the % bias is significantly lower than before matching. Thus, the balance test is passed.

(2) Common Support Test

Propensity score matching requires meeting the common support assumption, meaning that the propensity scores of the treatment and control groups need to encompass a common range of values. To this end, this study presents a graph of the common range of propensity scores for both the treatment and control groups, as shown in Figure 4:

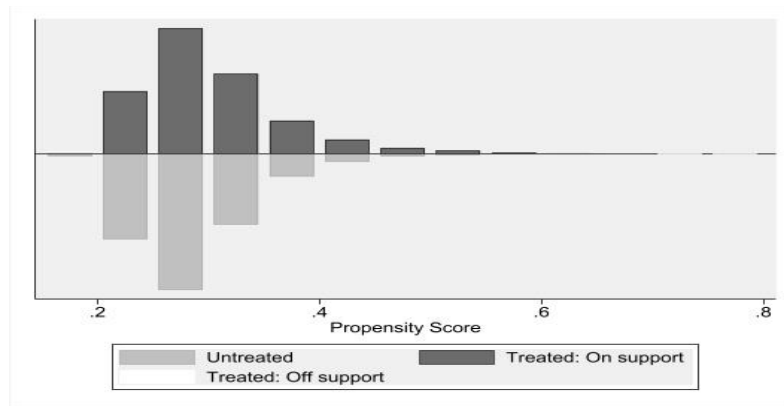


Figure 4: Common Support Test

From this figure, it's evident that the vast majority of samples from both the treatment and control groups fall within the common support range. Samples outside this range tend to have more extreme propensity score values, thus satisfying the common support assumption.

Moreover, this study further examines the common support assumption by comparing the kernel density distribution of propensity scores for the treatment and control groups before and after matching, as shown in Figures 5(a) and 5(b):

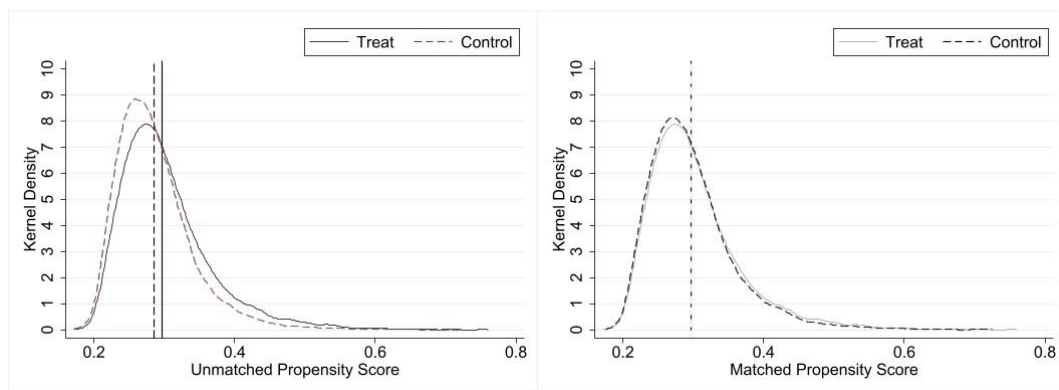


Figure 5: (a) Kernel Density: Unmatched

(b) Kernel Density: Matched

Exactly, the visual evidence from the graphs clearly demonstrates the effectiveness of the matching process. Before matching, there was a noticeable difference between the treatment and control groups, indicating variation in their characteristics. However, after matching, the two groups closely align, nearly overlapping in the kernel density plots. This substantial improvement post-matching confirms that the samples satisfy the common support assumption, ensuring that the treatment and control groups are comparable for the analysis.

(3) PSM-DID Results

Using the samples after propensity score matching (PSM), this study conducts a Difference-in-Differences (DID) analysis, with the targeted poverty alleviation policy as the independent variable and both the out-of-pocket to income ratio and catastrophic medical expenditure as dependent variables. The regression results are as shown in Table 5:

Table 5: The Impact of Targeted Poverty Alleviation Policy on Medical Burden: PSM-DID

	(1)	(2)
	Out-of-Pocket to Income	Catastrophic Medical Expenditure
<i>Treat</i>	-0.059***	-0.06***
	(0.009)	(0.010)
Control Variables	YES	YES
Year FE	YES	YES
ID FE	YES	YES
N	37546	37546
Adj. R ²	0.3285	0.3014

Note: Parentheses contain robust standard errors clustered at the household level., * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

After controlling for covariates, year fixed effects, and individual fixed effects, the impact of the targeted poverty alleviation policy on reducing medical burden for economically disadvantaged families remains markedly significant. Post-policy enactment, there was a notable reduction in the ratio of out-of-pocket healthcare expenses to total income by 5.9%, a figure that holds statistical significance at the 1% level. Similarly, catastrophic health spending saw a 6% decline, also achieving significance at the 1% threshold. When juxtaposed with the pre-match findings presented in Table 2, the post-matching effect of the poverty alleviation initiative on mitigating healthcare expenses is accentuated. This congruence between the propensity score matched Difference-in-Differences analysis outcomes and the initial findings not only underscores the policy's efficacy but also affirms the robustness of the study's core conclusions

4. Mechanism Analysis

4.1. Income Effect

The direct objective of targeted poverty alleviation policies is evidently poverty eradication, with the primary manifestation being an increase in the income levels of impoverished households. Furthermore, based on the definition of medical burden used in this study, an increase in income levels, with out-of-pocket expenses remaining constant, necessarily leads to a decrease in medical burden. Thus, this section replaces the dependent variable with the logarithmic forms of household annual income and per capita annual income to perform a difference-in-differences analysis. This analysis controls for factors that may influence income, such as age, household size, employment status, productive fixed assets, per capita land value, and educational level. The results are as shown in Table 6:

Table 6: Impact of Targeted Poverty Alleviation Policy on Income: DID

	(1)	(2)
	Household Annual Income	Per Capita Annual Income
<i>Treat</i>	0.092**	0.096**
	(0.044)	(0.044)
Control Variables	YES	YES
Year FE	YES	YES
ID FE	YES	YES
N	30261	30261
Adj. R ²	0.4749	0.4469

Note: Parentheses contain robust standard errors clustered at the household level, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

The results indicate that the targeted poverty alleviation policy increased household annual income levels by 8.2% at the 10% significance level and per capita annual income levels by 8.7% at the 5% significance level. This suggests that the targeted poverty alleviation policy effectively raised the overall income levels of impoverished families, providing a fundamental condition for alleviating their medical burden.

4.2. Safety-Net Effect

Following the same logic, this section investigates whether the targeted poverty alleviation policy alleviates medical burden by increasing the reimbursement ratio of out-of-pocket expenses, referred to as the safety-net effect. The logic here is that direct medical costs resulting from seeking medical treatment are a major risk factor for impoverishment [16]. If the targeted poverty alleviation policy intensifies reimbursement efforts and provides a safety net for the medical treatment of impoverished households, it would have a significant impact on easing their medical burden. Due to the limitations of the CHARLS dataset, this study uses the proportion of out-of-pocket expenses as a proxy for the reimbursement ratio, as these two are inversely related. The dependent variables are changed to the ratios of total medical expenses out-of-pocket, outpatient expenses out-of-pocket, and inpatient expenses out-of-pocket. Control variables are added for a DID analysis, with results as shown in Table 7:

Table 7: Impact of Targeted Poverty Alleviation Policy on Reimbursement Ratio: DID

	(1)	(3)	(4)
	Total Expense Out-of-Pocket Ratio	Doctor Visit Out-of-Pocket Ratio	Hospitalization Out-of-Pocket Ratio
<i>Treat</i>	-0.082*	-0.084	-0.245**
	(0.056)	(0.06)	(0.106)
Control Variables	YES	YES	YES
Year FE	YES	YES	YES
ID FE	YES	YES	YES
N	2297	1350	735
Adj. R2	0.1930	0.1556	0.1479

Note: Parentheses contain robust standard errors clustered at the household level, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

The results show that the targeted poverty alleviation policy significantly reduced the total out-of-pocket medical expense ratio, implying that the policy increased the medical expense reimbursement ratio, thereby easing the medical burden on impoverished households. Specifically, the policy did not reduce the outpatient out-of-pocket ratio but significantly lowered the out-of-pocket hospitalization expense ratio, meaning that the targeted poverty alleviation policy primarily eases medical burden by reducing inpatient out-of-pocket expenses. This aligns with logic, as general outpatient visits do not lead to medical burden that could cause impoverishment due to illness. Instead, the significant medical burden mainly arises from hospitalizations for serious illnesses [17]. Therefore, by providing a safety net for serious illnesses among impoverished households, the state can alleviate their medical burden, aligning with the primary objectives of health poverty alleviation.

5. Conclusion

Health poverty alleviation is an integral part of the targeted poverty alleviation strategy, with easing the medical burden on impoverished households being its primary goal. In reality, comprehensively improving the health levels of the impoverished population is a long and arduous process. Given the

limitations of dataset years, the lag in microdata, and the subjectivity of residents' self-assessments, it's challenging to empirically verify whether a policy can enhance health levels. However, the impact on medical burden is immediate. If medical burden is relieved, this provides a fundamental material basis for impoverished households to afford and recover from illnesses, which in turn can have a long-term effect on their health levels.

Therefore, utilizing the CHARLS datasets from 2011, 2013, 2015, and 2018, and based on the quasi-natural experiment of implementing the targeted poverty alleviation policy in China, this paper finds through a difference-in-differences model that the targeted poverty alleviation policy helps alleviate the medical burden on impoverished households. It not only reduces the out-of-pocket to income ratio for impoverished households but also their catastrophic medical expenditure. The empirical results have passed a series of robustness tests. Additionally, this paper confirms that the targeted poverty alleviation policy alleviates the medical burden on impoverished households through both the "income effect" and the "safety-net effect", i.e., by increasing the income level of impoverished households and the reimbursement ratio for hospitalization expenses. These conclusions are crucial for clarifying policy effects and responding to policy goals.

Furthermore, the conclusions of this paper may offer guidance for other developing countries around the world in alleviating the medical burden on their populations. As reported by the World Health Organization in 2017, approximately 800 million individuals globally allocate a minimum of 10% of their household budget to healthcare expenses, pushing nearly 100 million into extreme poverty [18]. China's targeted poverty alleviation policy not only lifted 98.99 million rural impoverished people out of poverty but also significantly alleviated their medical burden, preventing the occurrence of falling back into or being impoverished due to illness. Therefore, other countries grappling with the heavy burden of medical expenses can learn from China's approach, addressing the root causes of poverty to fundamentally solve the issue of medical burden.

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Future Development Analysis Based on the Price Reduction Trend of Tesla

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Abstract: The electric vehicle (EV) market is developing rapidly, while the complexity of the market is growing along with the growing prosperity of the market, continuous technology innovation, and frequent policy adjustments. As a leading pioneer in the electric vehicle market, Tesla's development trends have had a significant impact on the market and other companies in the market. Tesla's price cut may especially affect the brand positioning of other companies in the industry, and they follow its price cut strategy, leading to a price war in the whole market. It urges them to adjust their strategies to maintain their market position and profitability. Therefore, the paper elaborates and focuses on Tesla's financial data from 2021 to 2023 and price reduction strategies, and uses key financial indicators, such as revenue growth, cash flow, and return on investment, to predict the future development trajectory of Tesla. This paper, through Tesla's financial analysis and future trends, provides reference and guidance for investors, markets, or companies seeking to follow suit.

Keywords: Tesla, Pricing strategy, Financial analysis, New energy vehicle

1. Introduction

As global warming and air pollution become increasingly harmful to humanity, and concerns about exhausted petrochemical fuels increase, global attention increasingly is on green-environmental protection and sustainable development, making the new energy market prospects a bright situation. As a leading enterprise in the new energy vehicle industry, Tesla's market performance and future development trends are closely related to the booming development of the whole industry. However, Tesla, which shoulders the responsibility of promoting the development of the new energy vehicle industry, has been constantly lowering product prices in order to cope with market competition and expand market share. Tesla has a profound impact on the market by influencing consumers' purchasing decisions and the competitive awareness of other automakers.

Zhou analyzed the influencing factors behind the pricing strategy of Tesla in 2022, from the theory and empirical aspects, according to the recent financial data of Tesla, market share, and sales of popular models. It can be seen that the price policy of the new energy vehicle industry has a significant impact due to policy factors, cost factors, and market competition factors [1].

Huang et al. analyzed the future of Tesla and believed that Tesla has huge potential, leading to sales growth. The author analyzed the sensitivity of Tesla through four elements and found that it had a trend of rising and then declining. The authors believed that this trend just affects people to buy stocks in the downward trend, thus bringing rise and growth to the future of Tesla's market [2]. Shao

et al. analyzed Tesla's present approach and prospects. The authors argue that increased competition and falling demand for electric vehicles could lead to lower market share. Following an analysis of revenue, profit, and stock price, to diversify its revenue streams going forward, Tesla will need to enter new markets and increase its expenditures in the development of automated public transit [3]. Yan through the analysis of financial ratios, the author proves that Tesla's price reduction strategy is successful. However, if Tesla wants to maintain its market share in China's gradually saturated electric vehicle market, it should maintain its brand independence and step up its research and development efforts. Tesla's pricing strategy reflects that the country's overall electric vehicle industry is about to reach market saturation[4].

Ding and He analyzed financial and corporate strategy to examine Tesla's ongoing challenges and potential future trajectory. Through a rigorous assessment of fundamental research and economic conditions, the authors evaluated the current risks and strategic changes at the company, highlighting the effectiveness of its pricing strategy. However, with the dominant electric vehicle market in China gonna saturated, Tesla's prospects for expanding its market footprint necessitate the preservation of independence and relentless innovation in technology[5]. Wang analyzed Tesla's accounting analysis and performance evaluation segment, employing financial ratios to critically assess Tesla's financial well-being and operational effectiveness in comparison to a select group of competitors. The author disclosed that Tesla exhibits robust financial performance and a dominant market position, driven by substantial investments in capacity expansion to accommodate escalating demand and a relentless focus on innovation to preserve its competitive lead [6]. Zheng analyzed Tesla's financial performance, focusing on profitability, operational effectiveness, solvency, and developmental prowess. Comparative assessments were carried out using the financial statements of industry peers like BYD and SAIC. The author revealed that Tesla's debt repayment strength has consistently escalated, marked by robust profitability, stable net income, increasing gross margin, and a promising market trajectory for electric vehicles, which retains substantial growth potential [7].

Huang conducted a thorough analysis of indicators including revenue, sales volume, earnings, capital composition, and pivotal ratios Tesla's innovative products are adequate to meet the company's capital demands with a rising trend in owner equity, it is poised for a favorable growth trajectory. The author underscores Tesla's robust research and development prowess and its substantial potential to attain its strategic objectives[8]. Lin et al. study employs financial and corporate strategic analysis to examine Tesla's ongoing challenges and potential future trajectory. Through a rigorous assessment of fundamental research and economic conditions, the authors evaluated the current risks and strategic changes at the company, highlighting the effectiveness of its pricing strategy. However, as the dominant electric vehicle market in China nears saturation, Tesla's prospects for expanding its market footprint necessitate the preservation of independence and relentless innovation in technology[9]. Fang analyzed a comprehensive financial analysis of Tesla's reports, focusing on the evaluation of the company's financial stability and operational model by examining its assets, liabilities, and shareholder equity. Through this assessment of Tesla, the author projected its potential future financial outcomes. The author's analysis indicates a positive outlook, forecasting sustained growth in Tesla's car sales and revenue projections for the upcoming years[10].

Therefore, this paper aims to explore the future development trend of Tesla through an analysis of its price reduction trend and financial data. So as to promote the development of a new energy industry and promote the process of global green environmental protection.

2. Tesla's Price Reduction Strategy and Reasons

2.1. Review of The Price Cut

From 2022 to January 2024, Tesla has made several price adjustments, especially with four official price cuts for its popular products, the Model Y and Model 3. Among them, the price of Model Y dropped from 417,900 yuan to 396,900 yuan to 363,900 yuan to 258,900 yuan, while the price of Model 3 dropped from 367,900 yuan to 279,900 yuan to 245,900 yuan to 285,900 yuan. Then, Tesla's capacity has increased rapidly thanks to its Gigafactory in Shanghai, China. However, Tesla's sales are not keeping up with production capacity, and the market is oversupplied, so it has to rely on price cuts to boost sales. On the one hand, Tesla's price reduction strategy is a direct response to the rising Chinese new energy vehicle enterprises, and on the other hand, it shows its competitive awareness and strategy adjustment in the electric vehicle market. In addition, policy incentives have also contributed to Tesla's price reduction strategy, enabling Tesla to adjust its pricing strategy. Furthermore, changes to Tesla's in-car batteries and the integration of the supply chain have reduced its costs, giving it room to cut prices. Tesla has already embarked on its journey to cut prices that aim to boost sales, market share, and factory utilization, and face pressure from slowing global consumer demand.

2.2. Reasons

2.2.1. Competitor

Table 1 illustrates that Tesla dominates the market, especially the sales of Model Y and Model 3 entering the top three global new energy model sales. However, BYD caught up, taking six positions in the top 10, and even Song entered the top three, becoming the only model to surpass Tesla and rank in second place in sales. The presence of several BYD models, including the Song, Qin, Yuan, Dolphin, Seagull, and Han, in the top 10 ranking underscores the competitive dynamics in the new energy vehicle market. Tesla, known for its limited model portfolio driving high-demand products, is confronted with the strategic advantage of BYD's extensive product diversification. In addition, Tesla also faces threats from other Chinese electric-car makers, because the top 10 brands are all Chinese brands except for Tesla. What's more, BYD has attracted some customers who originally preferred Tesla, and has continuously grabbed Tesla's market share. As a result, Tesla can only maintain or boost its market share by cutting prices to boost sales. However, from the global new energy model sales list in 2023, Tesla's price reduction strategy is effective, stabilizing its leading position in sales.

Table 1: Top10 Global Sales of New Energy Model Numbers (2023)

Ranking	Model	Sales (,000)
1	Tesla. Model Y	1,211,6
2	BYD. Song(BEV+PHEV)	636,5
3	Tesla. Model 3	529,3
4	BYD. Qin Plus(BEV+PHEV)	456,3
5	BYD. Yuan Plus EV/Atto 3	419
6	BYD. Dolphin EV	354,6
7	BYD. Seagull EV	254,2
8	SAIC-Wuling. Mini EV	237,9
9	GAC. Aion S	235,9
10	BYD. Han (BEV+PHEV)	228

2.2.2. Policy Incentives

The Inflation Reduction Act of 2022 ("IRA") was enacted on August 16, 2022, allowing eligible Tesla customers to receive tax credits of up to \$7,500 if they buy a qualified electric vehicle in the United States by 2032. That means consumers can get higher subsidies for Tesla's trams, boosting Tesla sales. In addition, before the IRA, American high-net-worth companies, like Tesla, had to pay tax under the Corporate Tax Act (Internal Revenue Code) at a 21% rate. There may even be some additional tax rules and restrictions such as marginal tax rates, even as high as 30% for some interest income. However, the IRA imposes a 15% new corporate replacement minimum tax on companies earning more than \$1 billion. That means Tesla needs to pay much less taxes, giving it more room to adjust the price of its products and attract more consumers at more attractive prices. Moreover, Tesla has signed leases with the State University of New York Foundation and agreements with the Shanghai Municipal Government and Nevada and Storey County, Nevada; receiving grants for manufacturing facilities and most of the construction funds, a \$76 million grant, and specific tax breaks from Nevada, basic tariff energy rate discounts and negotiable tax credits of up to \$195 million respectively. Government tax breaks and donations can directly reduce the tax revenue and production costs that Tesla needs to pay during its operations, so Tesla has more money to offset the impact of price cuts.

2.2.3. Technology and Supply Chain

In terms of supply chain, Tesla has ensured the stability of its raw material supply by signing long-term contracts and vertical integration with battery suppliers such as Ningde and Panasonic. Powerful supply chain management capabilities allow Tesla to reduce procurement costs and thus have more space to cut prices in pricing. At the same time, Tesla has six Gigafactories that can enable economies of scale through mass production. As its electric vehicle production increases, fixed costs (such as plant construction and equipment investment) can be shared and unit costs fall. In terms of manufacturing technology, Tesla began to introduce integrated casting technology in 2020, and dozens of parts produced by stamping and other processes can be integrated into one casting part, which greatly reduces the number of parts and improves the production efficiency of final assembly. Moreover, with the expansion of the scale, the original body cost is also constantly reduced. In addition, Tesla has replaced the interior batteries of some models from ternary lithium to lithium iron phosphate, and it has a certain scale of production capacity, greatly reducing battery costs, so it can maintain profit margins even when prices are reduced.

3. Financial Analysis

3.1. Profitability

Table 2 illustrates that Tesla registered a substantial increase in revenue in 2022, followed by a mild growth trajectory in 2023. What's more, the company's net profit exhibited a significant rise in 2022. Despite implementing a price reduction on its electric vehicles, and even registered a slight increment post the price cut in 2023. This analysis reveals that Tesla's ability to expand sales was accompanied by effective cost management, resulting in a rising profitability trend. Furthermore, Tesla's gross profit margin reached a peak in 2022 but experienced a significant decline in 2023. This drop was attributed to the company's strategic investment in new technology during that year. As competition in the electric vehicle market intensified, Tesla adopted a pricing strategy to safeguard or enhance its market position, which led to lower gross margins. This could potentially pose challenges for Tesla's future financing. Notably, the return on capital employed (ROCE) increased significantly from 2021 to 2023. A high return on capital employed (ROCE) indicates that the company is efficiently

generating substantial profits relative to the capital it utilizes. This indicates a substantial enhancement in the company's capital efficiency, translating to heightened profitability.

Table 2: About the Profitability datum of Tesla.

	2021	2022	2023
Revenue (,000)	\$ 53,823	\$ 81,462	\$ 96,773
Net profit margin	10.49%	15.45%	15.47%
Gross profit margin	25.28%	25.60%	18.25%
ROCE	11.91%	24.13%	25.67%

3.2. Efficiency

Table 3 illustrates that Tesla's asset turnover ratio, which gauges a company's ability to efficiently utilize its assets. In 2021, Tesla's asset turnover rate indicating a recent peak in asset utilization efficiency. This surge, for instance, can be attributed to the December 2022 release of the Tesla Semi, which facilitated effective resource allocation. However, the asset turnover ratio fell slightly in 2023, suggesting a bottleneck in optimizing asset utilization. Reflecting Tesla's strategic investments in production capacity expansion, such as factory construction, which, while not immediately translating to short-term revenue growth, are integral to the company's long-term growth strategy. Moreover, Inventories rose from 2021 to 2023 as competition intensified in the market and Tesla continued to expand its Gigafactory. This may disrupt Tesla's production rhythm, resulting in the production plan being unable to proceed smoothly, and thus affecting Tesla's efficiency.

Table 3: About the Efficiency datum of Tesla.

	2021	2022	2023
Asset Turnover Ratio	0.87	0.99	0.91
Inventory (,000)	\$ 5,757	\$ 12,839	\$ 13,626

3.3. Solvency

Table 4 illustrates that Tesla's current ratio rose sharply from 2021 to 2023, indicating improved solvency. At the same time, although the asset ratio declined from 2021 to 2022, it rose rapidly again from 2022 to 2023, indicating that Tesla's cash liquidity has improved very well, which indirectly proves the improvement of Tesla's solvency.

Table 4: About the Solvency ratios of Tesla.

	2021	2022	2023
Current Ratio	1.38	1.53	1.73
Quick Assets Ratio	1.25	0.91	1.14

3.4. Investment

Table 5 illustrates Tesla's investment ratio, the price-to-earnings (P/E) ratio, which is a widely recognized valuation metric that provides insights into stock price reasonableness. The P/E ratio experienced a significant decline from its peak in 2021, followed by a gradual recovery, as depicted in the chart. Critics often argue that Tesla's stock is overvalued, but people overlook a crucial aspect: market dominance. In 2023, global new energy vehicle sales reached 10,522,000 units, with Tesla's sales accounting for 1,808,000 units or 17.18% of the market, solidifying its position as the industry leader. Moreover, Tesla's manufacturing facilities are capable of meeting the high demand, and

capacity constraints are no longer an issue. Furthermore, Tesla transcends the traditional automotive label, functioning as a technology-driven enterprise that has revolutionized the industry through innovation. Its technological prowess justifies a premium valuation compared to conventional carmakers. Consequently, it can be concluded that Tesla's stock price is not unjustifiably high.

Table 5: About the Investment ratio of Tesla.

Years	2021	2022	2023
P/E ratio	188.37	30.64	52.53

4. Expectation

In the fierce competition in the electric vehicle market, Tesla's price reduction from 2022 to 2024 is not only a direct strategic response to the rise of new energy vehicles in China but also demonstrates its keen insight and strategic flexibility in the industry competition. In the face of BYD's strong rise, Tesla has maintained its market share and attracted more consumers through price adjustments.

Tesla's acceptance of government construction funds and tax incentives, as well as tax credits from the IRA, has reduced production costs and made it able to adjust its pricing strategy. This not only reflects Tesla's keen grasp of policy orientation but also indicates that in the future, Tesla may continue to optimize the cost structure to achieve greater profit space. Secondly, facing the intensified competition in the electric vehicle market in the Chinese market, Tesla needs to further optimize its product line and enhance its brand differentiation. In the Chinese market, Tesla should make full use of its policy advantages to improve its local production and service capabilities to cope with the growing competition.

With the improvement of environmental awareness and policy support, more and more consumers choose to buy electric vehicles in order to travel environmentally friendly, so the electric vehicle market will continue to expand, and Chinese car companies will continue to emerge with innovative technologies to attract consumers to seize the market share. Therefore, China's new energy vehicle market competition will be more intense. Tesla should make full use of its policy advantages to improve its local production and service capabilities to cope with the growing competition.

In the future, Tesla needs to focus on technological innovation and product quality while reducing costs to maintain price competitiveness, so as to improve consumer loyalty. Continued strengthening of relationships with the government and partners will help Tesla stay ahead of the competition. However, as the electric vehicle market matures, Tesla needs to adjust its strategy from a competitive price advantage to a competitive value advantage and lead the electric vehicle companies to cut prices and develop more environmentally friendly electric vehicles, to achieve environmental protection and long-term sustainable development.

5. Conclusion

This paper analyzes the financial data and future development trend of Tesla through its price reduction trend, analyzes the reasons for the price reduction from the aspects of competitors, policy incentives, its own technology and supply chain, and evaluates its profitability, operating efficiency, solvency, and investment value based on its financial reports. At the same time, the competitive situation of Tesla in the tram market is analyzed. Moreover, this study concluded that competition in the electric vehicle market will intensify. According to the financial data of Tesla, its revenue and net profit rate rise with strong profitability; asset utilization efficiency meets bottleneck, inventory management has certain pressure; solvency increases; the growth of market value has certain investment value.

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Research on the Development of Agricultural Products Industrial Chain under the Trend of Live E-Commerce

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Abstract: Based on the background of the rise of live e-commerce after COVID-19, this paper reviews the literature on the internal and external factors of the development of live e-commerce, aiming to study the changes in the industrial chain of agricultural product sales under the trend of live e-commerce. Based on the current status of the industry, the potential problems are found. It is found that the main problems of live broadcast e-commerce still exist in the selection of products. At the same time, the professional quality and logistics of the anchor are also worthy of the attention of enterprises. The study found that live broadcast e-commerce has a strong momentum of development in the future. Due to the changes in the industrial chain brought by live broadcast e-commerce, the realization of the scale effect of the origin can become a strong driving factor for the live broadcast e-commerce of agricultural products. Enterprises' independent contracting of planting or cooperative operation with farmers are all useful measures for sustainable development in the future.

Keywords: Live e-commerce, Agricultural products industry, Industrial chain, Scale effect

1. Introduction

live e-commerce is an emerging supply and marketing method for the integration of Internet development. Live e-commerce of fresh agricultural products is also called "helping farmers" live e-commerce, which is an innovative measure to help the recovery and development of the agricultural economy in the post-epidemic era. Taking the digital economy as the development background, e-commerce live e-commerce can promote the increase of agricultural product sales, enrich the types of agricultural products, and promote the improvement of the upstream and downstream industrial chains of the agricultural economy. Affected by COVID-19, traditional sales channels are blocked, and a large number of agricultural products are unsalable in the hands of farmers, causing economic losses. With the popularity of the 'East online shopping platform', e-commerce live e-commerce has brought lower-cost sales channels for agricultural products. More and more farmers participate in the live e-commerce industry of agricultural products, which has become an endogenous new driving force for the development of the real economy. At the same time, the e-commerce of agricultural products has also had a counterproductive impact on the physical retail industry. By studying the new model of live selling of agricultural products, this paper explores the sustainable development of online and offline integration in the future.

Wang and Wu deeply studied the impact of East's online shopping platform on the sales of agricultural products. Through the analysis of the heterogeneity of fans, the mechanism of the impact on sales is further discussed. It is found that the live account with a large number of fans has a more significant increase in sales under the new live e-commerce mode [1]. Xia analyzed the marketing mode of live e-commerce of agricultural products and pointed out that agricultural products have the inherent attribute of low added value. The combination of live e-commerce sales mode with low cost can form a better sales mode of low profit and high sales and can reduce the intermediate circulation links in the sales process of agricultural products so that farmers can benefit more and customers can buy more affordable products [2]. Cui and Xia used the SWOT model to analyze the development and dilemma of e-commerce live e-commerce of agricultural products. The article points out that this new sales method reduces sales costs, promotes the construction of related infrastructure, and provides more jobs. However, there is still a low degree of standardization of products, unqualified products will harm the interests of consumers [3].

Fu et al. studied the evolution process of a certain brand under the promotion of an e-commerce platform. In different stages of brand development, the government, e-commerce platform, and brand side attach importance to different interests, emphasizing that the development of e-commerce should pay attention to the strategic choices of different game players to protect the healthy development of the economy [4]. Lv found that price concessions, timely after-sales service, and live interaction greatly affect consumers' purchase behavior when investigating consumers' willingness to purchase fresh products provided by e-commerce platforms. Rich product information can enhance customers' perceived usefulness and stimulate consumption. Higher consumer willingness can enhance customer loyalty and promote the long-term effective development of e-commerce platforms [5]. Zhang et al. found that the use of live e-commerce marketing and cold chain logistics can increase the sales of agricultural products and achieve profit growth by constructing a game model of the fresh agricultural products supply chain. Cold chain logistics services can reduce the consumption rate of fresh agricultural products, and consumers can enjoy the 'high quality and high price' of fresh agricultural products [6].

Mittal et al. studied the hedonic motivation and utilitarian motivation of live shopping and found that the characteristics of product information orientation will affect the shopping behavior of viewers, and physical attractiveness and liking streamers will enhance celebrity-related intention and increase sales [7]. Heeks constructed a development model related to E-commerce in the research and proposed that in the development process of e-commerce, we should pay attention to the capacity strand and impact strand, and pay attention to the transformation, strategy, and trajectories of the business model of the enterprise [8].

Zhang used the SWOT model and The Marketing Theory of 4Ps to study the new operation strategy of FRESHIPPO and found that in digital management, Freshippo should integrate online e-commerce and offline physical stores to create a new strategy for e-commerce supplements [9]. Fabri and Márquez based on the e-commerce statistics of Italy and Spain, studied the impact of the development of e-commerce on the traditional retail industry. Although the traditional physical store model will be destroyed, the integration with the e-commerce platform will bring new development vitality in the future [10].

Based on the trend of live broadcast e-commerce of agricultural products sales and the comparison with traditional agricultural operations, this paper aims to study the changes in various sales entities and the changes of the entire industrial chain, and thus analyze the existing deficiencies, to optimize the future development path of live e-commerce of agricultural products.

2. Development Status of Live E-Commerce in the Agricultural Products Industry

2.1. Scale

The scale of live e-commerce for agricultural products in China is immense and continues to grow rapidly. China has emerged as a global leader in live streaming commerce, with platforms like Taobao Live, Douyin (TikTok), and Kuaishou driving the trend. Agricultural products are particularly popular for live-streaming sales due to consumers' increasing demand for fresh, high-quality produce and the desire for transparency in food sourcing. Through the statistics of Douyin live e-commerce(China Financial Times,2023), it is found that from September 2022 to September 2023, Douyin e-commerce helped sell 4.73 billion agricultural products, with an average of 13 million packages containing agricultural products sold throughout the country every day. In one year, the types of agricultural products sold on the platform increased by 188 % year-on-year, the number of rural talents in TikTok e-commerce increased by 105 % year-on-year, and the number of agricultural merchants increased by 83 % year-on-year. There are more than 24,000 agricultural merchants whose annual sales exceed one million yuan. Through live e-commerce, the consumer market of agricultural products is constantly activated, and the live e-commerce of agricultural products will enter a deeper and more comprehensive development chain, constantly driving the development and upgrading of the agricultural products industry.

2.2. Category

The categories of live e-commerce of agricultural products mainly include agricultural products necessary for daily life, products needed for agricultural production (such as pesticides, fertilizers, etc.), agricultural production tools (such as seeds, agricultural equipment, etc.), and the most popular local characteristic agricultural products. Through the introduction and interaction of the anchor in the live e-commerce room, the viewer will be interested in the unique agricultural products of other cities and the desire to buy them, which can promote the development of characteristic agricultural industries in various regions.

2.3. Pattern

Live commerce should be considered based on two parts. The first is live screaming, which involves short video operation and hotspot analysis to guide network traffic. Then it is necessary to complete live e-commerce planning, account operation, and data analysis to find product types that consumers prefer and pay more attention to. The second is to sell goods. Operators select high-quality and low-cost products by analyzing customer preferences and accurately controlling profit indicators. At the same time, we should also pay attention to delivery logistics, after-sales service, and sales management, to improve customer satisfaction. There are three main types of live e-commerce, namely:

Single product live mode. The anchor will introduce the characteristics, functions, and uses of a specific agricultural product, and mention the dog purchase link or coupon code to guide the audience to buy;

Brand live e-commerce mode: This mode is aimed at the whole brand or brand series for live publicity and sales, in the live sales of agricultural products, common is given priority to specific areas, the local characteristics of agricultural products for centralized display and sales.

Theme live mode: This mode is based on a specific theme or scene for live e-commerce, such as holiday promotions, seasonal products, etc. The live e-commerce of agricultural products mainly chooses the seasonality of products as a selling point, increasing the audience's sense of urgency and guiding purchases.

3. Analysis of Changes in the Agricultural Products Industry Chain Under the Trend of Live E-Commerce

An industrial chain refers to the interdependent and interrelated relationship network between all links and participants in an industry. It consists of a series of links such as production, processing, manufacturing, circulation, and sales of raw materials. In traditional agriculture, the industrial process is mainly farmers' planting, production, and processing, transportation companies or farmers spontaneously deliver goods, and agricultural products are delivered to farmers' markets or physical retail malls, waiting for customers to purchase, and customers' payment behavior is completed, and the whole production, supply, and marketing link is over. With the progress of the Internet and the development of the new retail industry, the purchase of goods has broken through the limitation of time and space.

For the development of agriculture, the preservation technology of agricultural products has promoted the progress of warehousing services, coupled with the growth of customers' demand for cross-regional agricultural products, making long-distance and fast logistics possible. Under the trend of live e-commerce, the industrial chain of agricultural products has also changed accordingly. The live e-commerce industry chain consists of the supply side, platform side, and consumers.

The increase in live e-commerce platform links has promoted the development of related live e-commerce service providers, channel platforms, and anchors. In terms of supply, agricultural products with live e-commerce are classified into direct supply mode of origin and processing and sub-storage mode of origin. As long as some agricultural products that require high timeliness, such as fruits, vegetables, or fresh products, are directly displayed in the way of sample live e-commerce in the place of origin, and then picked according to the order quantity of the platform, and then directly processed and packaged by the place of origin and sent directly to the consumer.

The mode of producing area processing and sub-warehousing refers to that after agricultural products are picked, they are directly transported to the partners in different cities through basic processing and packaging, stored in the cold storage warehouse of the partners, and then delivered directly by the "logistics pre-warehouse" nearby. This new mode greatly shortens the interval from placing an order to receiving goods, improves consumers' satisfaction, and helps to improve the repurchase rate. The traditional supply chain model, with farmers, farmers' markets, wholesalers, and retailers as the main body, circulates agricultural products in the form of spontaneous trade, which has the disadvantages of unstable supply, large price fluctuation, uneven quality, and single trading channel.

4. Current Problems and Relevant Suggestions for Live E-Commerce of Agricultural Products

The following are some cases of problems in the process of live e-commerce of agricultural products collected based on the TikTok platform, and corresponding development suggestions are given based on these problems.

Li Jie, the anchor of Rizhao, Shandong Province, began to sell chestnuts live in the autumn of 2022. However, in the process of sorting and packaging chestnuts, only insects or bad ones were picked out, but the size was not distinguished, which would lead to the problem that the weight of a single fruit did not reach the promised size. In the autumn of 2023, Li Jie also intends to classify chestnuts according to large, medium, and small. It is impossible to avoid omissions by manual work, but the bumps of machine screening will cause damage to some chestnuts, which makes it difficult to ensure the instability of commodity quality and standardization. At the same time, because the labor cost cannot be reduced, the price of chestnut may not be accepted by consumers, and consumers may change their target businesses.

The peaches sold on the East Buy complained that they were moldy and hairy. According to the logistics records of the buyers, it took five days for the peaches to be delivered from the place of origin to the customer's receipt. Due to the perishable nature of the peaches themselves, they may not be fresh when they are delivered to the customers. Sun Dongxu, CEO of New Oriental Online, once said that the grasp of quality control and logistics problems are the difficulties of live e-commerce of agricultural products with goods.

In the short video of Vibrato, the live video of the female anchor with black garlic was posted on the hot search as a funny video. Because the anchor is unfamiliar with the actual taste of the promoted product, the performance in the live e-commerce process is not consistent with the description and is even disgusting. This leads to the product itself being rich in value, but because the anchor is unfamiliar with the business in the promotion process, it will mislead customers' understanding of the product and affect their buying behavior.

To sum up, to improve the standardization of live e-commerce of agricultural products, brands or platforms can contract upstream farmers and formulate stricter product standards; or vertically integrate, establish their planting base or farm, and make products that customers care about very much and have high repurchase rate into self-operated products, so that the research and development, production, manufacturing, packaging, logistics, delivery and customer service of self-operated products are more stable and controllable.

To solve the problem of timeliness of agricultural products, it is necessary to strictly control the unit cost of cold chain logistics. When goods form scale effect, cold chain resources can reduce the time of being vacant, build regional centralized warehouses, realize centralized warehousing and joint transportation and distribution, and then share costs and reduce operating expenses.

For the problem of familiarity with the anchor business, it is necessary to improve the professional quality of the hired anchors and strengthen training. For the agricultural products that are broadcast live on the same day, the anchors must be familiar with it in advance. The positioning of the anchor should be more accurate, and the traffic should not be the highest. The customer's recognition and satisfaction with the live e-commerce products are the most important content for the enterprise.

5. Conclusion

By studying the changes in the industrial chain under the live e-commerce of agricultural products, it is found that the number of intermediaries in the new model has become less, showing the characteristics of direct supply from the place of origin or direct supply from the transit warehouse. Because of the timeliness of agricultural products, it has driven the development of the logistics industry. Live e-commerce makes the live broadcast platform and anchor become the core part of sales so that sales and publicity are realized at the same time. At the same time, there are still many problems in the live e-commerce of agricultural products.

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Research on the Social Media Marketing on Beauty Product: Based on Questionnaire Method

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Abstract: With the rapid development of the Internet, network broadcast and product marketing advertisements are gradually integrated into our lives. As the main force of consumption, women's consumption behavior has also become the focus of attention. This paper takes the social platform marketing of beauty products as an example, and conducts a directional analysis of consumer behavior through the research method of questionnaire survey. The survey results show that the main group of online consumption is concentrated in young people. From the perspective of regional distribution, most consumers come from southeast China, that is, the more economically developed areas, and the first-tier cities are mostly. Consumers prefer actual demand and are influenced by Internet celebrities and online comments. The research results of this paper can be used as a reference for cosmetics companies to formulate more targeted marketing strategies, help cosmetics brands to improve sales and performance, and provide references for the direction of social network publicity.

Keywords: Beauty products, Female consumers, Social platform.

1. Introduction

In today's society, social media has a growing influence on people's daily lives. Many individuals have developed a habit of shopping by using social media platforms.

To begin with, women are gradually playing an increasingly important role in society, often possessing multiple identities, including daughters, mothers, and wives. In daily consumption, people will also purchase different types of goods due to their different identities. Female consumers also occupy a place on social networks, and the frequency of online shopping is much higher than that of men. More and more products are being recommended and live streamed on social platforms, and the model is changing. Especially in the beauty industry, many bloggers, to some extent, sell beauty products. What platforms do famous beauty bloggers rely on, and the current situation of using social platforms for beauty products.

In recent years, there has been an increasing amount of research on the consumption structure and marketing strategies of social network platforms. Yan proposed that most female consumers care more about appearance, summarizing several marketing strategies such as establishing a good reputation, pricing products reasonably, strengthening website interface design, adopting various promotional methods, and enhancing shopping satisfaction [1]. Xiao proposed that female consumers pay attention to cost performance, scrutinize product specifications very strictly, and tend to engage in emotional consumption more often. Online shopping platforms should pay more attention to

personalized customization, offline experiences and sales channel diversification [2]. Chen et al. took female consumers in Dongguan as an example and presented four empirical hypotheses. The quality of online word-of-mouth, the characteristics of the communication platform, the credibility of word-of-mouth reviewers, and the perceived value of consumers have a positive and significant impact on consumers' purchase decisions [3]. Li pointed out that high prices can be set for new products and personalized products with the help of the price psychological criteria of female consumers' unique sensitivity and comparison psychology [4]. Shan and Yu conducted a survey and research on female consumption behavior in the context of network broadcast, and found that women have herd consumption behavior and weak awareness of rights protection, which leads to the advocacy that women need to establish a correct concept of consumption [5]. Han found that opinion leaders and word-of-mouth communication have become the main factors affecting consumption, interactive communication in shopping communities enhances user stickiness [6]. Liu pointed out that women's online consumption is prone to addiction, for the reason that the consumption process of online shopping is very simple, which greatly saves labor costs and time costs [7]. Lu pointed out that the network broadcast industry shows a "live +" ecological trend, combined with major industries to build a diversified live broadcast ecosystem, which changes of consumption behavior from timeliness to delay has become another feature of network live broadcast consumption [8]. He pointed out that the brand special live broadcast is to promote the rural consumer groups to intuitively understand the brand characteristics [9]. Liu and Zou pointed out that the essence of live agricultural products economy is mainly manifested as the user's attention economy, body sense economy, and relationship economy [10]. Zhou proposed that female consumption shows the characteristics of equal emphasis on quality and practicality, paying more attention to individuation and differentiation, and more inclined to online consumption channels [11]. Li proposed that modern people are actively using social networking services as a means of information exploration in order to purchase necessary items [12].

Therefore, the analysis of marketing of beauty products in this paper can not only provide reference for beauty companies to understand consumer behavior in practice and adopt better marketing strategies, but also further enrich the research on social platforms in a theoretical sense and provide an important supplement for the research on online consumption structure and marketing of beauty products. This study mainly focuses on the impact of social media on women's consumption behavior in the beauty products.

2. Method

This paper adopts the method of questionnaire survey. A total of 15 questions were designed, including consumers' age range, geographical region, urban development, frequency of using social media, social media platforms most frequently used, attention to online advertising and live broadcasting of beauty products, consumption preferences, and influences by different marketing methods and content.

3. Results

3.1. Basic Information

This survey was conducted through online channels, resulting in 111 responses related to beauty product consumption patterns. The primary respondents were females, constituting 90% of the total participants (figure 1).

Regarding age distribution, individuals aged 18-24 and 35-50 each accounted for 27.93% of respondents, while those aged 25-34 represented 21.62%. Participants over 50 years old comprised 20.72%. While those under 18 being the smallest group, only accounted for 1.8% (figure 2). The

survey primarily targeted economically independent adult women capable of making their own purchasing decisions.

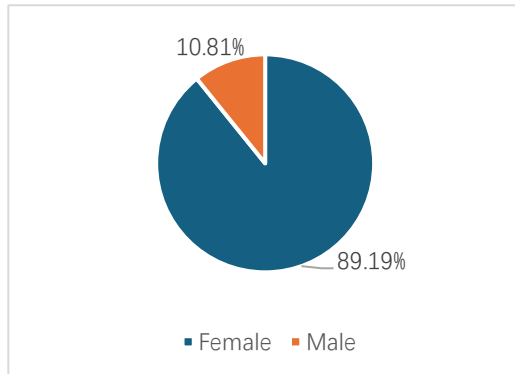


Figure 1: Gender distribution

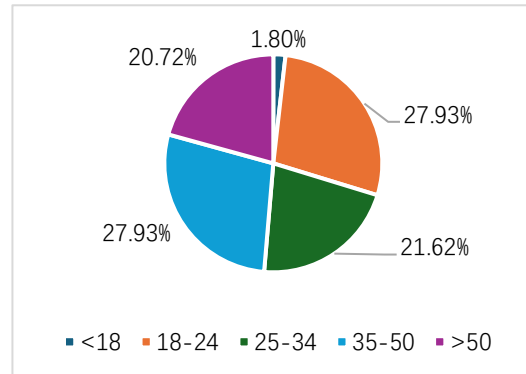


Figure 2: Age distribution

Geographically, respondents from first-tier cities such as Beijing, Shanghai, Guangzhou, and Shenzhen constituted a significant portion at 45.05%. Those from non-first-tier provincial capital cities accounted for 27.93%, followed by other urban areas at 15.32%. Rural participants made up only 1.8%, while an additional 9.09% were located overseas in regions including Britain, Canada, Malaysia, and Singapore (figure 3).

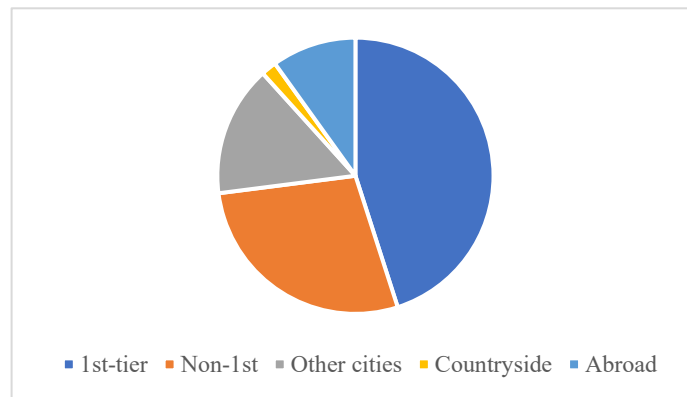


Figure 3: Districts

3.2. Frequency analysis of social platform use

In terms of how much time are spending on social media platforms: 35.14% of the participants reported they spend one to three hours on social medias. 31.53% of the participants spent over three hours. 23.42% of the participants spent 30 minutes to 1 hour. Only 9.91 % of the participants spent less than 30 minutes per day on social medias (figure 4).

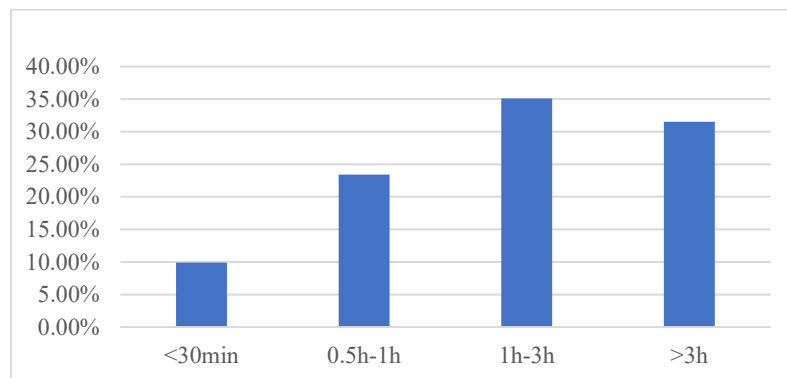


Figure 4: Time distribution

3.3. Preference analysis of online shopping

The most frequently used social media platforms among participants included WeChat, Taobao, JD.com (these two are E-commerce platform), RED (which is similar to Pinterest), Chinese TikTok, Weibo, bilibili (which is similar to YouTube), and international platforms like Instagram, YouTube, and Facebook which are not directly accessible within mainland China. Additionally, Baidu (which is similar to Google), Chinese Quora, these knowledge-sharing applications were utilized by 2.7% of the participants (figure 5).

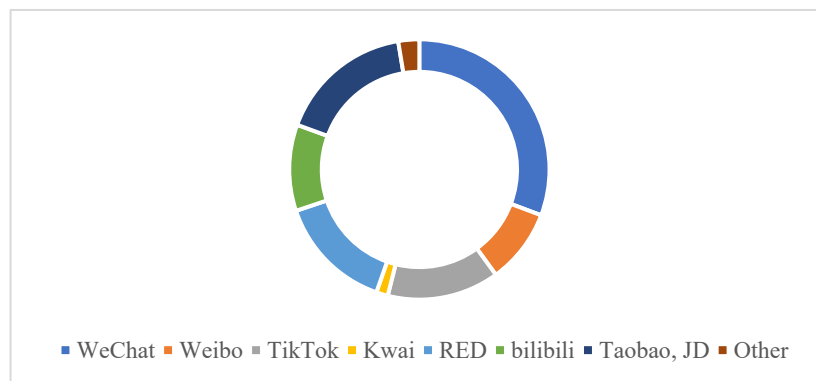


Figure 5: Social platform

Approximately half of respondents indicated that they watch advertisements or live streams featuring beauty products on social media. However, the remaining 49.55 % expressed no interest in doing so.

The majority (58.56%) preferred promotional videos or live broadcasts showcasing products tailored to their specific needs. Furthermore, a substantial proportion valued practical product functionality (20.72%), while 11.71% emphasized engaging advertising narratives and plots. Only 9.01% of the participants thought that whether the appearance of the products is pretty or not is most important when making shopping decisions (figure 6).

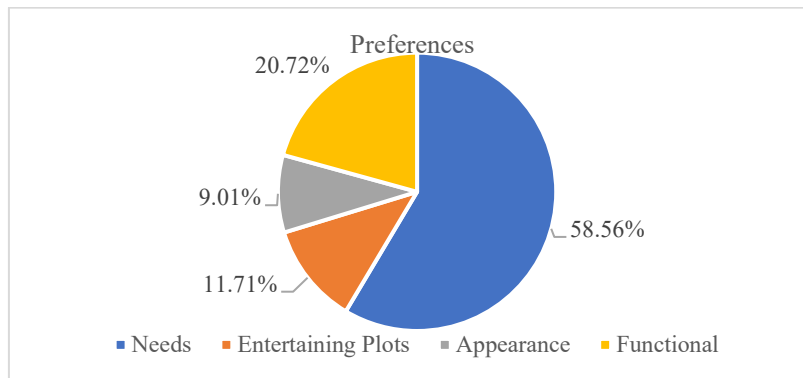


Figure 6: Preferences

When considering celebrity endorsements' impact: Merely 35.14% of the participants stated that they would be more likely to purchase a beauty product if endorsed by influencers or celebrities that they like. In the contrary, a significant 64.86% of the participants indicated that this factor did not affect their purchasing decision-making process. Nevertheless, when the products are endorsed by the influencers or celebrities that participants dislike, most people(exactly 59.46%)will reduce the probability of buying the specific beauty products. This suggests that aversion towards certain public figures has a more pronounced effect on consumer behavior compared to positive associations with celebrities or influencers.

Concerning peer influence: A striking 79.28% expressed reliance upon browsing through customer reviews before making cosmetic purchases via comments sections or similar buyer feedback forums. Conversely, the remaining 20.72% were unaffected by such input.

It can be seen that the Internet platform has many advantages. As an essential part of daily life for modern people, it connects consumers from all over the world. Therefore, beauty products should make good use of the network platform to attract consumers.

3.4. Category analysis of online shopping

As shown in figure 7, beyond beauty products: The majority (73.87%) also expressed interest in clothing advertisements or live streams, followed by 55.86% of the participants have interests in daily necessities and 35.14% of the participants have interests in accessories such as earrings and necklaces. Other categories including electronics (24.32%), decorative items/ toys (19.82%), maternal and infant products (7.21%), as well as health-related items/ investments/ food/ beverages (4.5%).

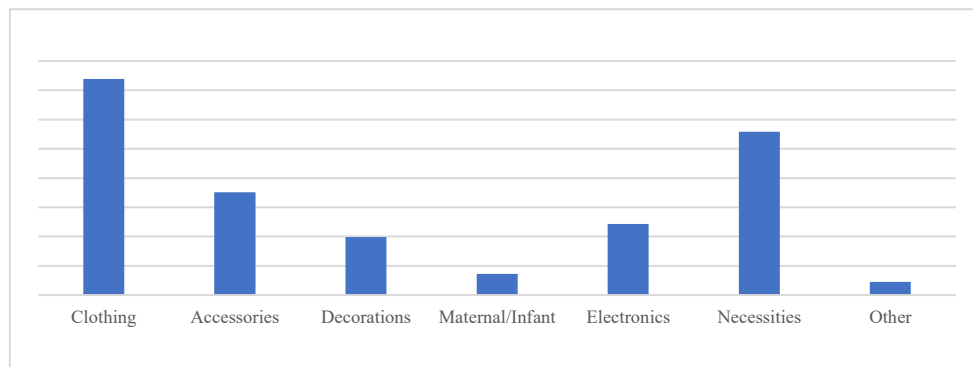


Figure 7: Categories

Additionally, 52.25% of the participants claimed that they have purchased recommended beauty products featured in content delivered via personalized recommendations across various social media channels. However, the remaining 47.75% did not engage in such practices extensively.

In terms of feedback sharing, only 25.23% of the participants have shared their experiences or evaluations regarding beauty products across social media platforms with the vast majority 74.77% opting not to do so. Finally, in terms of planned purchases, during online promotional events (such as Double 11 Shopping Festival and 618 Mid-Year Shopping Festival) 65.77% intended to purchase beauty products on impulse without prior intentions. Those who did not engage in such behavior accounted for 34.23% of participants.

4. Conclusion

Female consumers in all regions watch live broadcasts and advertisements of beauty products on social platforms and make selection and consumption decisions. The effect of live advertising is wide, covering various types of products. Online shopping is most concentrated among young people. They use social platforms frequently in their daily lives and tend to communicate and obtain information with their peers on the Internet. These consumers will make purchases according to their own needs, and most people will not make impulse purchases because of appearance. The more practical the product, the more popular it is. In addition, online shoppers are greatly affected by public opinion and others' evaluations, and are very concerned about Internet celebrities and promotional activities. The supply and demand of product evaluation are not coordinated.

The trend of "She-economy" has led female consumers to become more self-conscious. This also explains why clothing and accessories account for a large proportion of women's consumption structure.

The high frequency use of the Internet has caused modern people to gradually develop a tendency of social fear. Most consumers say that when shopping offline in shopping malls, they are more resistant to accepting shopping guide services. However, in online shopping, non-face-to-face communication makes the communication between consumers and merchants smoother and effective.

Most of the female online shoppers are 9-to-5 office workers or college students, with relatively high education level, busy daily affairs and work, and a faster pace of life. In this context, live broadcasting and online advertising should be more concise, convey the most useful information in the shortest time, and help consumers make consumption decisions the fastest. At the same time, most consumers watch live broadcasts and advertisements in public places such as offices or classrooms, which need to maintain a certain degree of quiet, so live broadcasts and advertisements can add voice recognition subtitles or display important information on the screen. In this way, watchers do not have to turn on the speaker or wear headphones to get effective information.

According to the research of this paper, the following suggestions are put forward for product marketing. In network marketing, it is necessary to strengthen the pertinency of specific groups, use information statistics and big data technology, combined with the search and record function of social platforms, and accurately evaluate the social positioning of the products sold to the crowd and each consumer. The biggest help of social platforms for product sales is to enhance brand awareness, so brands need to summarize their main advantages, match with consumer needs, and meet personalized needs. Practicality is the main concern of online shopping consumers, so social platform merchants should not spend too many resources on product packaging. Good appearance may attract consumers to watch advertisements, but what really makes consumers make a purchase decision is the practical value of the goods placed on the Internet.

Not all products are suitable for online shopping, product types with high quality requirements should choose other sales channels. Such as maternal and infant products and health care products.

Trinkets, for example, which are widely available at low prices and are easily affected by the mood of consumers, are also not suitable for online sales.

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Research on the Investment Value of BYD Based on SWOT, Financial, and Valuation Methods

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Abstract: Against the backdrop of environmental degradation, green energy transformation is a strategic measure to address climate change and promote green development. The new energy vehicle industry is experiencing an unprecedented period of rapid growth. As a leading player in this sector, BYD's development is virtually representative of the Chinese new energy vehicle industry. SWOT analysis, financial analysis, and valuation analysis are crucial criteria for assessing the development status of a company. Through the analysis of profitability, operational capability, and P/E ratio data, the development status, operational capability, market competitiveness, and growth potential of a company can be directly reflected. The results show vertical integration of supply chain and cost advantage is the main strength of BYD, however it has the weakness of excessive dependence on Chinese government subsidies. From the perspective of financial performance, it has great profitability and its operating capacity situation is good. Moreover, the valuation shows it is worth for investment. This provides decision-makers with information and suggestions on enterprise management, investment, and financing, helping investors and managers make rational decisions.

Keywords: BYD Auto, New energy vehicles, Financial analysis, Valuation analysis

1. Introduction

As the global climate and environment deteriorate, the new energy industry, as a key area for accelerating energy conservation and emission reduction, has received strong support from many countries. The "Development Plan for the New Energy Vehicle Industry (2021-2035)" released by the General Office of the State Council of China in November 2020 emphasizes the need to better leverage the government's role in strategic planning, assist the new energy vehicle industry in enhancing technological innovation, shaping new industrial forms, and improving infrastructure. In recent years, the market size of the new energy vehicle industry has seen substantial growth. As a typical representative of the new energy vehicle industry, BYD's sales volume of new energy vehicles has been increasing year by year. In 2023, BYD sold 3,024,417 vehicles, a year-on-year increase of 61%. Simultaneously, BYD's stock price has been consistently rising, garnering significant attention from investors.

New energy enterprises, represented by BYD, have actively responded to the call, utilizing green bond financing for low cost and high efficiency, and have achieved a good reputation [1]. Meanwhile, BYD's engineers specialize in intelligent driving technology and have achieved certain accomplishments, becoming the first automotive enterprise in the country to obtain an L3-level test

license [2]. Under the dual effects of the current economic downturn and subsidy reduction policies, BYD has demonstrated strong resilience and development potential, yet there remain issues of inefficiency. [3] Through analysis of the usage patterns among its electric vehicle users, it is evident that BYD's electric vehicles suffer from significant shortcomings, including poor safety performance and inadequate charging infrastructure. As the market continues to grow and segments emerge, a diversified development strategy for electric vehicles will become the focal point of BYD's future growth [4]. In terms of investment management, the company faces challenges with its fund management systems, necessitating the formulation of appropriate risk prevention and control measures [5].

Regarding investment value, the Ideal Automobile Company needs to optimize its supplier management practices [6] and enhance competitiveness through a combination of strategic cooperation and technological innovation [7]. Tesla Motors needs to increase communication with upstream and downstream enterprises, address product quality issues [8], continue with precise market positioning and innovative marketing strategies, and prioritize consumer demand [9]. Weilai Company should promptly establish a financing risk management system and enhance the management of accounts receivable and inventory [10]. Moreover, small and medium-sized new energy automobile enterprises such as Xiaopeng and Zero Run should implement comprehensive fund management and strengthen financial performance evaluation [11].

Based on existing literature research, this article adopts three methods SWOT analysis, financial analysis, and valuation analysis for analysis. Through these studies, reference can be provided for investor decision-making and enterprise development issues. At the same time, it can also further supplement important research on BYD and investment value-related fields.

2. Method

2.1. SWOT

SWOT analysis was proposed by American scholar Albert S. Humphrey in the 1960s. SWOT is the acronym for Strengths, Weaknesses, Opportunities, Threats, and Strengths refers to the internal strengths and advantageous factors of a company or individual, including unique skills, resources, brand reputation, etc.; Weaknesses refers to the internal weaknesses and shortcomings of a company or individual, which may help achieve goals and gain competitive advantages; Weaknesses refers to the internal weaknesses and shortcomings of a company or individual, which may help achieve goals and gain competitive advantages. Strength refers to the internal advantages and advantageous factors, including unique skills, resources, brand reputation, etc., which can help to achieve goals and achieve competitive advantage; Weaknesses refers to the internal weaknesses and shortcomings of the enterprise or individual, which may hinder the realization of goals or lead to competitive disadvantages, including poor management, shortage of resources, technological backwardness, etc.; Opportunities refers to the external environment. Favorable conditions and opportunities that exist in the external environment, can be used to take advantage of existing strengths and resources, and seize the opportunity to achieve the development and growth of the individual or organization; Threats refer to the disadvantages and potential threats that exist in the external environment, which may pose a threat to the development and survival of the enterprise or individual in terms of various factors. Using SWOT analysis BYD can analyze the strengths, weaknesses, opportunities, and threats of the internal and external environments, which can help it to comprehensively solve its situation, including internal resources and capabilities as well as the influencing factors of the external environment. At the same time, SWOT analysis can also provide an important reference for strategy development. By identifying its strengths and opportunities, it can formulate smarter development strategies; at the

same time, by recognizing its weaknesses and threats, it can take corresponding countermeasures to solve problems and improve competitiveness.

2.2. Financial analysis

Financial analysis is a process of quantitative and qualitative analysis of an enterprise's financial condition, operating performance, and future development trends. By collecting, organizing, analyzing, and interpreting the financial statements and other financial data of an enterprise, financial analysis mainly adopts profitability indicators, operating ability indicators, and solvency indicators to analyze to assess the profitability, solvency, operating efficiency, and growth potential of an enterprise and to provide decision-makers with information and suggestions about the enterprise's business management, investment, and financing.

2.3. Valuation analysis

Valuation analysis refers to the process of determining the reasonable market value or intrinsic value of an enterprise, asset, or investment project through quantitative and qualitative analysis. This analysis is usually based on financial data, market conditions, industry outlook, and other factors, and uses different valuation methods and models, such as the discounted cash flow method, price-earnings ratio method, price-net ratio method, etc., to assess the value of the object being analyzed. Valuation analysis is widely used in scenarios such as investment decisions, asset pricing, M&A transactions, and equity incentives to help investors and business managers make rational decisions.

3. Results and Discussion

3.1. SWOT analysis results

3.1.1. Strengths

This paper analyzes the strengths of BYD and finds three areas of strengths, which include vertical integration and cost analysis, market leadership on a global scale, and leading technological capabilities.

(1) Vertical integration and cost advantage. BYD owns and operates its entire supply chain, reducing the complexity of price increases and negotiations related to external suppliers, to solve problems faster and flexibly adapt to market demand. This vertical integration not only cuts costs but also gives BYD absolute control over quality and consistency, reducing the risk of component defects or production bottlenecks.

(2) Global market leadership. In terms of EV sales in the last quarter of 2023, BYD surpassed Tesla, selling a record 526,000 pure battery vehicles. Market leadership gives BYD brand recognition and prestige. Consumers around the world equate the brand with advanced EV technology and reliability, which increases trust and willingness to buy. This reputation facilitates entry into new markets and attracts potential customers and investors.

(3) Leading technical capabilities. BYD devotes significant resources to internal research and development, with greater control and flexibility in innovation. Numerous R&D centers work with leading academic institutions to foster a progressive culture. BYD's patent portfolio is impressive, especially in battery technology. One of BYD's most important technological achievements is the blade battery, a lithium iron phosphate (LFP) battery with higher safety, longer service life, and higher energy density. This innovation not only reduces production costs but also improves vehicle range and safety, providing consumers with a convincing advantage.

3.1.2. Weaknesses

The three main aspects of its vulnerability analysis are brand image related to the perception of low quality in China, over-reliance on the domestic market, and reliance on government subsidies.

(1) Brand image is related to the perception of low quality in China. The negative image of low cost and low quality associated with the quality of Chinese manufacturing has been deeply rooted in the minds of global consumers. This is a significant barrier to BYD's efforts to establish itself as a premium EV brand, especially in developed markets. This perception could lead to initial skepticism among potential buyers, which could influence purchasing decisions.

(2) Overdependence on the domestic market. the Chinese EV giant derives 70.43% of its revenues from the domestic market in 2021, and its dependence on the domestic market further increases to 78.43% in 2022. The company's over-reliance on the domestic market is a potential weakness. Over-reliance on a single market carries inherent risks. China's domestic economic volatility could severely impact BYD's performance while creating geopolitical vulnerabilities. Tensions between China and other countries could lead to trade barriers or restrictions that could disrupt BYD's supply chain or access to export markets. Overdependence on a single market makes BYD vulnerable to external factors beyond its control.

(3) Dependence on Chinese government subsidies for electric vehicles. From the beginning, government subsidies have played a key role in BYD's success. These financial incentives artificially lowered the cost of electric vehicles. In addition, the subsidies have helped BYD invest heavily in R&D, driving its technological progress and consolidating its leadership position in the domestic market. However, such subsidies to the government are not guaranteed to last forever. Changes in government policies or economic priorities may lead to a reduction or even complete elimination of subsidies which would seriously affect BYD's profitability and competitiveness.

3.1.3. Opportunities

There are three main areas of opportunity: international market expansion, the growing popularity of electric vehicles, and technological advances.

(1) International market expansion. With environmental concerns and policy support, the global EV market is booming, offering lucrative opportunities outside of China's saturated market. By entering new markets, BYD can gain access to millions of potential customers and significantly increase its sales, driving its global market share and brand awareness. In addition, different markets provide insights into different consumer preferences and driving conditions, enabling BYD to customize its products and develop new models that meet the needs of specific regions. In addition, international expansion can diversify BYD's revenue streams and reduce the risk of relying solely on the Chinese market. Geopolitical tensions or an economic downturn within China could have a significant impact on its domestic performance.

(2) Electric cars are increasingly popular. Growing environmental awareness among global consumers has fueled demand for cleaner alternatives like electric cars, creating a huge and expanding market. BYD already has a reputation for innovation and sustainability and is well-positioned to capitalize on this growing demand. BYD's focus on clean energy solutions and its commitment to reducing emissions have resonated with environmentally conscious consumers, boosting its brand image and sales numbers. In addition, the policies of governments around the world are actively promoting the adoption of electric vehicles. The policy has further stimulated consumer demand and encouraged automakers to invest in the development of electric vehicles. With its existing infrastructure and advanced technology, BYD can easily adapt to these policy changes and benefit from the government's efforts to promote the widespread adoption of electric vehicles.

(3) Technology Advancement. Embracing cutting-edge technology provides BYD with a once-in-a-lifetime opportunity to solidify its position as a global leader in the electric vehicle race. Advances in battery technology are the cornerstone of BYD's future growth. Its proprietary blade batteries offer greater safety, longevity, and energy density than traditional lithium-ion batteries. Continued research and development in this area, exploring solid-state batteries and other next-generation solutions, is critical to maintaining a competitive edge and extending range while reducing charging time. Investing in robust battery management systems that optimize performance and lifetime will further improve the efficiency and attractiveness of the overall electric vehicle.

3.1.4. Threats

The main threats are the procurement of key components and the global economic slowdown.

(1) Procurement of key components. Although BYD is vertically integrated and produces batteries and semiconductors in-house, it still relies on external suppliers for key components such as chips, rare earth minerals, and battery materials. Shortages and price volatility in these areas could significantly impact production costs and schedules, potentially derailing BYD's ambitious growth plans. The issue is also affected by several factors. The global chip shortage continues, affecting the global industry, including electric vehicles. Geopolitical tensions, particularly between the United States and China, further complicate the issue and could disrupt access to key minerals and technologies. In addition, the growing global demand for electric vehicles is putting enormous pressure on the limited supply of key materials, pushing up prices and creating bottlenecks.

(2) Global economic slowdown. The global economic slowdown, characterized by reduced consumer spending and business investment, could have a significant impact on BYD's growth trajectory. Consumers facing tighter budgets may delay purchasing luxury items such as electric vehicles, which would directly impact BYD's sales. Companies tightening their belts may delay fleet electrification plans, further dampening demand. The impact of the downturn is not limited to direct sales. Access to capital may become more difficult, which will hinder BYD's investment in R&D, which is critical to maintaining its technological edge. Rising interest rates could increase the debt burden, affecting profitability and limiting expansion plans.

3.2. Financial analysis results

3.2.1. Profitability analysis (benefit analysis)

This paper uses the proportion of accounts receivable in business income to analyze BYD's profitability, as shown in table 1, over the past three years, BYD's proportion of accounts receivable in business income has gradually declined, indicating that the company's business income has gradually become faster and faster, and also reflects the company's strict credit policy; It can be seen that the proportion of accounts receivable in operating income of the company is less than 10% in 2022 and 2023, which proves that the financial situation is better.

Table 1: Proportion of accounts receivable in operating income from 2021-2023

Project	unit:%		
	2021	2022	2023
The proportion of accounts receivable in operating income	17.92	8.85	8.36

3.2.2. Analysis of operating capacity (efficiency analysis)

As shown in figure 1, over the three years, BYD's current assets and part of its non-current assets are financed by current liabilities, and the other part of its non-current assets are financed by non-current liabilities and owner's equity. In other words, that is, short-term assets and some long-term assets are financed by short-term funds, and some other long-term assets are financed by long-term funds. It indicates that BYD belongs to the adventurous asset-liability term structure. It is characterized by the fact that since the cost of short-term funding is usually low and the risk is relatively high, this matching using more short-term funding is a riskier choice, making the company's return and risk higher.

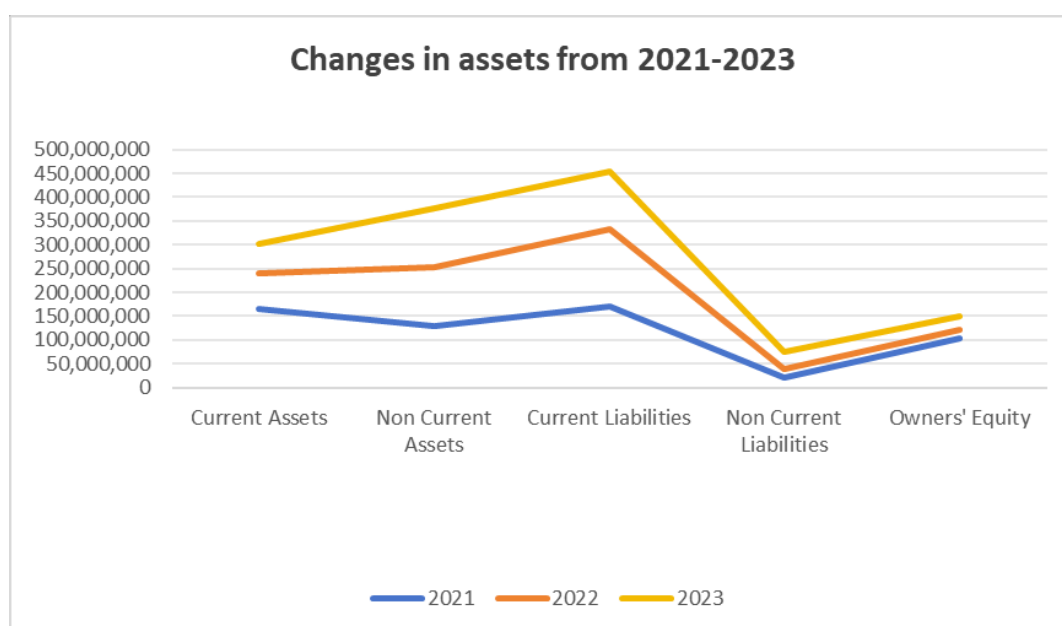


Figure 1: Changes in assets from 2021-2023

3.2.3. Solvency analysis

Short-term solvency analysis

Factors affecting the company's liquidity and short-term solvency include current assets, current liabilities, working capital, and cash flow. This paper mainly analyzes the quick ratio and cash flow.

(i) Quick ratio (acid test ratio)

As shown in table 2, over the past three years, BYD's quick ratio has been declining year by year, and the annual average quick ratio is 0.56, indicating that BYD's short-term solvency is weaker; similar to the current ratio, the company's quick ratio may be artificially manipulated as well, therefore, it should be carefully identified during the analysis, and once manipulation is found to exist, adjustments should be made to recalculate the quick ratio.

Table 2: Proportion of quick ratio from 2021-2023

Project	unit: %		
	2021	2022	2023
Quick Ratio	0.72	0.49	0.47

(ii) Cash flow ratio

As shown in table 3, in the past three years, BYD's cash flow ratio is not high, and first rises and then will be no more than 1. From the point of view of cash flow to current liabilities, BYD's short-term solvency situation is not very satisfactory;

Table 3: Cash flow ratios from 2021-2023

Project	2021	2022	2023
Cash Flow Ratio	0.38	0.42	0.37

unit: %

3.3. Valuation results

In this paper, we use the price-earnings ratio method, price-to-book ratio, and price-to-sales ratio to analyze the valuation of BYD Company. The results are shown in table 4.

Table 4: Analysis results of BYD's P/E ratio, P/B ratio, and P/S ratio on September 30, 2022

2022.9.30	P/E Ratio	P/B Ratio	Sales Ratio
BYD	BYD's P/E ratio is 134.20, the rolling P/E ratio of the automotive industry is 28.91, and the median rolling P/E ratio of Listed Companies in the automotive industry is 41.97. Compared with industry data, BYD's valuation is relatively high. However, because the automobile sector is a traditional industry, the valuation of new energy vehicles can not be evaluated only by the P/E ratio, but also by the future automobile delivery volume. Now BYD is facing a critical period of upgrading, with large fluctuations in profits. It is not known whether it can maintain high growth in sales and double growth in revenue and profits in the future. If its high growth trend is unsustainable, BYD's valuation may be sharply lowered.	As of September 30, 2022, BYD's P/B ratio was 7.59, the automotive industry's P/B ratio was 2.18, and the median P/B ratio of Listed Companies in the automotive industry was 2.27. Compared with industry data, BYD's investment value is relatively low.	BYD's market-to-sales ratio is 2.66. The market-to-sales ratio can be used to determine the value of stocks relative to past performance, but it is difficult to reflect changes in costs. BYD has developed rapidly in recent years, investing a lot of costs in scientific and technological research and development, and judging its valuation only by the market sales rate is somewhat one-sided.

4. Conclusion

In conclusion, this paper uses the methods of SWOT analysis, financial analysis, and financial analysis to analyze the investment value of BYD. The results show that in the SWOT analysis, its main advantages are vertical integration of supply chain and cost advantage, leadership in the new energy market, leading technological capabilities and internal development of resources, weak brand image and low-quality stereotypes in China, excessive dependence on the domestic market and dependence on Chinese government subsidies. The opportunities include the expansion of the international market for new energy, the improvement of the popularity of electric vehicles and technological progress, as well as the threats of key parts procurement and the slowdown of the global economy; From the perspective of financial performance, we can see that its profitability is strong, its financial situation is good, and its operating capacity situation is good. However, due to the risky

choice of short-term capital cooperation, the company's earnings and risks are high. Through the analysis of quick ratio and cash flow ratio, we can see that BYD's short-term solvency is weak; From the valuation analysis, it shows a state of high valuation in the industry as a whole.

The results of this paper have two main implications: the first is to provide investors with a clearer and comprehensive understanding of BYD's financial indicators, operating conditions, and industry environment, to provide corresponding reference for them to make investment decisions; Another enlightenment is that for BYD itself, it can help it look at its problems more objectively and fully, to provide reference and reference for improving and enhancing its ability to cope with challenges and threats and increasing market share in the follow-up operation.

Although BYD has a more comprehensive analysis through SWOT analysis, financial analysis, and valuation analysis, this paper only analyzes from the micro perspective, such as the environment faced by the enterprise itself, and considers less from the macro perspective, such as the trend of the whole economic market, macroeconomic factors and so on. In the follow-up research, it needs to be further expanded.

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The Feasibility of Egypt's Photovoltaic Industry Drawing on China's Successful Experience

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Abstract: This study aims to evaluate the feasibility of Egypt's photovoltaic industry drawing on China's successful experience. Firstly, based on Egypt's national conditions and actual situation, the current situation, development potential, and challenges faced by the Egyptian photovoltaic market were analyzed. Egypt's economic foundation remains less competitive, with outdated electricity infrastructure and long-term dependence on natural gas, posing challenges to its transformation. Egypt is one of the regions with the most concentrated solar energy resources in the world, which gives it the possibility and new opportunities to overtake in the photovoltaic field. Secondly, by analyzing the development process of China's photovoltaic industry, this paper explores China's successful experiences in policy support, market demand, technological level, financial support, and talent cultivation. Compared with China, Egypt's photovoltaic industry is still in an underdeveloped and developing stage, and requires sustained efforts in multiple aspects. This article compares the significant differences in the development of photovoltaic industries between China and Egypt, and analyzes the opportunities and challenges faced by Egypt's photovoltaic industry, as well as the corresponding strategies from three aspects: policy stability, demand activation, and desert photovoltaics. Finally, based on the research results, policy recommendations and development paths are proposed to promote the development of Egypt's photovoltaic industry, to provide reference and inspiration for the sustainable development of Egypt's photovoltaic industry.

Keywords: photovoltaic industry, Egypt, China's experience, comprehensive sustainable energy strategy, desert photovoltaics

1. Introduction

1.1. Background

In terms of power generation capacity, Egypt ranks first in the African continent. Besides, From the perspective of power grid construction, the Egyptian power grid has achieved full coverage, sufficient to meet the electricity needs of every household. Moreover, from the perspective of power generation types, Egypt's electricity supply is mainly based on natural gas power generation. According to Fitch Solutions data, Egypt generated approximately 196.2 TWh of electricity and consumed approximately 161.8 TWh of electricity in 2021, resulting in an oversupply of electricity. In terms of energy structure, natural gas power generation accounted for 77.6% in Egypt in 2021, hydroelectric

power generation accounted for about 6.5%, and renewable energy power generation only accounted for 3.4%.

Egypt is a major producer and consumer of oil and gas in Africa. Since the 1970s, Egypt's natural gas production and consumption have maintained a synchronous growth trend, and exports have been increasing year by year since 2004 [1]. Natural gas is an important industry supporting the Egyptian economy, accounting for over 10% of GDP and a significant source of export earnings. In the fiscal year of 2021-2022, Egypt's natural gas export revenue was 8 billion US dollars, and the natural gas export volume increased 13 times in 8 years. Egypt's liquefied natural gas export growth rate ranked first in the world.

Currently, Egypt is facing a relatively severe debt crisis. As of the end of June 2023, the ratio of Egyptian government debt to GDP has reached 97% [2]. Therefore, Egypt needs to export more natural gas in exchange for more foreign exchange urgently. Moreover, the aging of equipment in Egyptian power plants has led to insufficient power generation capacity. Further, the continuous increase in exports of natural gas to Europe and surrounding countries has reached a considerable extent that caused periodic shortages of natural gas supply to domestic power plants, resulting in frequent power outages in various regions of Egypt during the scorching summer.

In summary, although the overall electricity supply in Egypt has a surplus, the domestic electricity supply is facing structural shortages due to the increased natural gas exports and a single-power energy structure. So, all in all, green energy power generation seems to be an ideal solution. And can ease the burden of electricity.

1.2. Energy Transformation

It is a wise choice for Egypt to build a green and low-carbon new power system with natural gas power generation as its main source, and renewable energy as its supplement energy source. In photovoltaic power generation systems, the cost of components accounts for two-thirds of the total cost, so the cost of components directly affects the comprehensive cost of power generation. The International Energy Agency predicts that by 2025, the world will almost entirely rely on China's supply of key components for the production of photovoltaic panels [3]. After 2009, the production cost of photovoltaic enterprises in China significantly decreased, bringing the era of "one RMB" photovoltaic power generation ahead of schedule. It is also an important turning point for the development of the photovoltaic industry in third-world countries. The preparation of silicon materials and the production of silicon wafers in the upstream end of the photovoltaic industry usually require a large amount of electricity consumption. Therefore, only by reducing the cost of electricity can the production cost of silicon materials and silicon wafers naturally decrease. Thanks to the arduous entrepreneurship of Chinese photovoltaic enterprises, the global photovoltaic cost has decreased by more than 85% in the past decade, making it the most competitive clean energy in the world [4]. To sum up, China's success can provide valuable experiences for Egypt's crisis.

Compared to natural gas power generation, the cost of photovoltaic power generation mainly includes equipment procurement and silicon wafer production, with relatively lower subsequent operation and maintenance costs.

After years of development, the cost of solar photovoltaic power generation has significantly decreased by more than 90%. The cost of photovoltaic power generation has been rapidly decreasing, and in some markets, it has become equally competitive with coal, natural gas, and land sea wind power generation [5].

Bloomberg New Energy Finance data shows that the capital return rate of photovoltaic projects in Egypt is 10-11%, making Egypt one of the countries with the lowest cost of photovoltaic and onshore wind power globally [6]. These researches show that the photovoltaic perspective is bright and may reduce their energy cost, which can ultimately promote their economic development.

1.3. Energy Transformation

The International Renewable Energy Agency predicts that by 2050, renewable energy generation will account for 85% of electricity, with 60% coming from photovoltaic and wind power [7].

Egypt has abundant photovoltaic resources. According to the Global Solar Atlas, the main sunny areas in Egypt have an effective annual sunshine duration of over 2400 hours. Egypt's goal is to achieve a renewable energy share of approximately 42% by 2035, with photovoltaics accounting for 21.3% [8].

The reason why Egypt has launched a comprehensive sustainable energy strategy is to achieve the early replacement of traditional fossil fuels with renewable energy, minimize the proportion of traditional energy such as petroleum and chemical, and maximize the proportion of renewable energy represented by photovoltaics.

2. Changes in Egypt's electricity supply structure over the next five years

2.1. Optimization of Power Energy Structure

Since 2011, Egypt has frequently faced social problems of power supply shortages. After 2014, Egypt gradually increased its special investment in the field of hydropower, which to some extent solved the problem of electricity shortage. However, the problem of excessive reliance on natural gas power generation has become increasingly prominent. Egypt repeatedly proves that the imbalance of the power energy structure directly affects the stability and the sustainability of the power ecosystem.

On June 5, 2012, Egyptian Minister of Electricity and Energy Yonis revealed that the Egyptian power sector has formulated a 15-year plan to vigorously develop solar photovoltaic power generation, intending to increase Egypt's solar photovoltaic power generation capacity to around 20% of total electricity demand by 2027.

Another more specific goal for Egypt is that by 2040, renewable energy generation will account for 60% of Egypt's total electricity generation. According to third-party predictions, The photovoltaic industry in Egypt is accelerating its development, with a planned installed capacity of 43 gigawatts (GW) by 2035 [9].

From 2024 to 2029, Egypt's overall power generation will maintain a slight steady increase, with an expected growth rate in the range of 3% -5%, and natural gas power generation will remain the main form. Nowadays, Egypt has become one of the important sources of natural gas supply to the European continent. In the next five years, Egypt's natural gas exports are expected to continue to maintain a high growth model. With the acceleration of new energy development, Egypt has become the second largest market for new energy development in the African region [10]. Egypt will still utilize natural gas more for exports rather than power generation, to alleviate its debt burden. This paragraph detailly suggests the structure change of Egypt's power energy.

3. The Successful Model of Desert Photovoltaics in Xinjiang Province

3.1. What is desert photovoltaics?

Egypt has a desert area of 950,000 square kilometers. 95% of its land area is desert. The province with the largest desert area in China is Xinjiang, with a desert area of 440,600 square kilometers, accounting for 64% of China's desert area.

Xinjiang, an economically underdeveloped region in China, has achieved commendable results in promoting desert governance, ecological protection, and industrial development through photovoltaic coordination. The development model of desert photovoltaics in Xinjiang is worth Egypt's reference and reference.

Taking Xinjiang's desert photovoltaics as an example, photovoltaic power stations are usually built on the edge of deserts. Vigorously developing desert photovoltaics, utilizing photovoltaic panels to produce green energy through "on board power generation, inter board sheep farming, and under board grass planting", and achieving positive interaction [11]. Nowadays, in the desert areas of Xinjiang, China, solar panels with a height exceeding 2 meters have become the preferred choice for wind protection and sand fixation. Compared to various vegetation typically over 30 centimeters in height, the wind and sand fixation effects of solar panels are improved by at least four times. Based on this, plants such as thorns, sand grass, shuttle, and jujube trees are planted under the solar panels to prevent wind and sand fixation. Poultry is raised under solar panels, and poultry manure naturally becomes a natural fertilizer for wind and sand fixation plants. Using photovoltaic to control sand, planting grass to fix sand, and raising poultry to plant greenery, can effectively control barren deserts. A photovoltaic power station built in the desert can stably transfer considerable electricity to the outside, achieving a dual harvest of social and economic benefits, forming a virtuous cycle of "photovoltaic power generation+ecological agriculture+desert restoration".

3.2. Recommendations

To achieve Desert photovoltaic, planning and construction are the focus, transmission and operation are the key, and talent introduction and training are the core. The construction of desert photovoltaics in Egypt must address these three issues. Otherwise, we will face the dilemma of low operational efficiency and the difficulty in transmitting electricity resources to the outside world.

The focus of desert photovoltaics is to solve the practical problems of where money comes from and how the industry develops. As the most renowned policy bank in China, the China Development Bank has established a market-oriented grid connected photovoltaic power generation project infrastructure fund in Xinjiang. In addition, the National Electronic Development Fund has greatly promoted the development of the photovoltaic industry in Xinjiang, the landing of the photovoltaic industry in Xinjiang and cultivated professional talents with the ability to operate and maintain photovoltaic power stations. Two polysilicon companies in Xinjiang have become one of the world's lowest production cost polysilicon companies [12].

Photovoltaics is a key green energy industry supported by Egypt. Xinjiang is a good model to emulate. It is suggested to build a complete photovoltaic industry chain, to introduce powerful enterprises to build desert photovoltaic industry parks, to form photovoltaic industry clusters with Cairo and Aswan as the core cities, to accelerate the planning, construction, and operation of photovoltaic bases based on the Gobi, desert, and desert. Taking desert photovoltaics as the starting point, to efficiently manage the desert, improve people's long-term livelihoods, promote the economy, and reconstruct Egypt's energy structure.

4. China's Experience and Lessons Learned

4.1. Policy Stable is Essential

The investment return cycle of the photovoltaic industry is about 10 years, and the stability of policies is the main reason for the flourishing development of the photovoltaic industry in China, the United States, and Germany. The instability and discontinuity of policies are the biggest obstacles to the development of the photovoltaic industry in Egypt. The stability of industrial policies in Egypt is poor, especially at the implementation level. Private and corporate photovoltaic power generation policies, photovoltaic power generation subsidy policies, tax relief, preferential electricity purchase, etc. All policies to promote the development of the photovoltaic industry should be consistent and sustainable.

Egypt's policies supporting the development of the photovoltaic industry mainly reflect the provision of cheap land and tax incentives. Egypt's development of the photovoltaic industry requires

a holistic consideration of the four aspects of supply, demand, market, and industry, and the formulation of policies that give enterprises and industries more confidence in the photovoltaic industry. Legislation as a guarantee, policy-driven, and demand-oriented, are inevitable requirements for the development of the photovoltaic industry. The feed-in tariff and the feed-in agreement all need to be confirmed by the rule of law.

Enterprises participating in the construction of desert photovoltaic industrial parks can be given no less than 20% of project cost support and related financing support. The Egyptian government should formulate a five-to-ten-year plan for the development of the photovoltaic industry. Egypt should follow the example of Xinjiang in China, and continue to promote the development and construction of new energy projects based on desert photovoltaics in the deserts and Gobi regions in the northern and southern regions.

4.2. Activating Demand is a Key Priority

In the years before 2010, China's photovoltaic industry faced a paradox, strong local government drive and weak domestic market demand. Relying on external demand and weak domestic demand is a lesson for the development of China's photovoltaic industry. The key to the development of Egypt's photovoltaic industry lies in activating domestic market demand. Egypt's domestic electricity price is on the rise, and increasing subsidies for photovoltaic electricity consumption will help the public and enterprises turn more to clean energy. Implementing tiered electricity prices, the more photovoltaic electricity consumers use, the more subsidies the government will provide. For residential users, a subsidy of 0.5 Egyptian pounds per kilowatt-hour will be given for electricity consumption of 0-200 kilowatt-hours per month, and a subsidy of 0.8 Egyptian pounds per kilowatt-hour will be given for electricity consumption of more than 200 kilowatt-hours per month. For commercial users, a subsidy of 0.7 Egyptian pounds per kilowatt-hour will be given for electricity consumption of 500-1000 kilowatt-hours per month, and a subsidy of 0.8 Egyptian pounds per kilowatt-hour will be given for electricity consumption of 1000-2000 kilowatt-hours per month.

The subsidy policy will last for five years, and the subsidy amount will remain at a 20% increase every year. Residents and businesses using photovoltaics will be granted personal income tax and tax deduction and exemption, while increasing the intensity and breadth of consumer loans and production loans to residents and businesses using photovoltaics. Following the experience of the United States and China, Egypt implemented incentives to support photovoltaic consumption, supported net-metering photovoltaic projects, and avoided the embarrassment of selling electricity at low prices and taking electricity from high-priced grids, so that residents can obtain more real benefits from using photovoltaics.

There are both electricity price subsidies and installation subsidies, which guide ordinary people to join the photovoltaic roof plan and encourage ordinary farmers to build and install photovoltaic power plants. This is a typical subsidy demand-side behavior. The greater benefits of the public joining the photovoltaic roof plan and building and installing photovoltaic power plants are reflected in the savings of daily electricity expenses, and the surplus electricity can be sold to the national power grid to obtain tangible benefits.

4.3. Advocating Industry Integration

The prominent problem of Egypt's photovoltaic industry is "small and scattered, scattered and chaotic". The market share of enterprises above the designated size in Egypt's photovoltaic power generation industry is around 10%. The industry entry threshold is not high, the regional distribution is scattered, the homogenization competition is serious, and the low-price internal consumption is obvious, resulting in poor comprehensive competitiveness of Egypt's photovoltaic industry. Egypt

lacks large-scale and high-quality photovoltaic manufacturing capacity, mainly relying on imported equipment or introducing enterprises to meet the increasing demand for photovoltaics. The photovoltaic industry in Egypt is still in its early stages, There are relatively few local personnel with relevant experience and technology [13].

Industry consolidation is the direction and trend of the development of Egypt's photovoltaic industry. Egypt should adhere to the principle of "market for technology, market for development" in the process of attracting well-known photovoltaic enterprises from China through investment promotion. Small and medium-sized photovoltaic enterprises in Egypt can provide industrial support for Chinese photovoltaic enterprises. Chinese photovoltaic enterprises can provide support for small and medium-sized Egyptian photovoltaic enterprises in technology research and development, skills training, business incubation, manufacturing, etc., expand and enhance the product structure, added value and technological content of small and medium-sized Egyptian photovoltaic enterprises, and promote the integration and overall upgrading of Egypt's photovoltaic industry.

4.4. Embracing Marketization as the Path Forward

The photovoltaic industry is highly competitive, and the marketization of the Egyptian photovoltaic industry is a trend. Due to the particularities of Egypt's economic development, the power industry, including the photovoltaic industry, still belongs to the monopoly nature of administrative dominance, resulting in the strange phenomenon of being both rule makers and industry participants. Opening up to the outside world and liberalizing within the country. To develop the photovoltaic industry, we should allow more private enterprises to participate in it, give them more policy support, and make "government guidance and market leadership" the underlying logic of the development of the Egyptian photovoltaic industry.

5. Conclusion

5.1. Personal observations

In February 2023, I was awarded a full scholarship for the AFS STEM academic camp for middle school students. From July 20th to August 17th, I went to Egypt to participate in the 2023 AFS STEM international cultural exchange program for middle school students and visited BP Egypt in the UK. During Egypt, there were frequent nighttime power outages, which triggered my thoughts on the development of Egypt's electricity supply, especially the photovoltaic industry.

Due to time and space limitations, this article is mainly written in the form of reading literature and conducting online interviews. Due to the lack of detailed data support, this article's estimation of Egypt's photovoltaic power supply for the next 5 years is not precise or precise enough.

5.2. The overall structure

This article reflects on the development of China's photovoltaic industry, which can help Egyptian government departments learn from it in policy formulation and industry promotion. During 2009, China's photovoltaic industry experienced problems such as oversupply, market failure, and government failure due to distorted local government performance views and rapid growth. In 2009, the global financial crisis broke out, and the photovoltaic industry became a key engine driving China's economic growth. In the field of photovoltaics, the Chinese government has introduced strong stimulus measures, and the Chinese Ministry of Finance has stipulated that grid connected photovoltaic power generation projects will be rewarded with 50% of the total system investment in that year [14]. Since 2013, the domestic photovoltaic application market in China has truly started and rapidly exploded [15]. Therefore, it is necessary to confirm the role and effectiveness of the market

and policies in the development of the photovoltaic industry. Policy guidance and market leadership are the feasible strategies to promote the healthy development of the photovoltaic industry.

The future research on the photovoltaic industry will always focus on both demand and supply. Whether to pursue a demand oriented photovoltaic policy or adhere to a supply oriented photovoltaic policy depends on a country's economic development needs. From the experience of the development of photovoltaic industry in various countries, it can be seen that adhering to fully differentiated market competition on the supply side is more effective, while the demand side requires active guidance from subsidy policies that can be implemented and withdrawn.

With the adjustment of energy structure, China is striving to transform from an energy importing country to a clean energy exporting country [16]. Due to a lack of core competitiveness, China's photovoltaic industry suffered an avalanche in 2012. By 2015, China's photovoltaic industry not only had independent technology, but also controlled a huge domestic market [17]. The focus of this article is to analyze the successful practices and lessons learned in China's development of the photovoltaic industry, and based on this, to analyze the opportunities, challenges, and actions of Egypt's development of the photovoltaic industry. To open up to the outside world and to open up domestically, only by opening up to the outside world can Egypt's photovoltaic market continue to grow. Only by opening up domestically can Egypt's photovoltaic demand become increasingly prosperous, thus forming a Pareto optimality. In the photovoltaic field where cooperation between China and African countries is deeply mature, China has accumulated a good reputation [18]. Egypt can emulate and learn from China's approach of "policy guidance, enterprise leadership, and demand being king" in the high-quality development of the photovoltaic industry.

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Revolutionizing Finance: The Comprehensive Impact and Application of Machine Learning

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Abstract: The adoption of ML in finance has great potential to reform financial practices. This paper delves into the pivotal role of machine learning (ML) in revolutionizing the financial domain, including enhancing predictive accuracies, reducing cost, catalyzing financial innovation, and improving customer relationships. By dissecting the advantages, this paper summarizes the application of ML in finance like stock market forecasting, fraud detection, credit risk prediction, portfolio management and asset evaluation. Meanwhile, it also acknowledges existing obstacles such as data quality, transparency of models, and output homogenization. Finally, the paper seeks to provide comprehensive insights into the future landscape shaped by ML technologies in finance.

Keywords: Machine learning, Financial practice, Impact, Application

1. Introduction

The rapid development of technology and widespread use of big data has made machine learning (ML) crucial for innovation and efficiency in the financial sector. As a critical branch of artificial intelligence, ML encompasses the development of algorithms that enable computers to evolve and optimize their performance by learning from past data and experiences [1]. This evolution has notably improved the efficiency and effectiveness of financial transactions and operations, as highlighted by emerging research in the field [2].

Given the dynamic capabilities of ML and its widespread usage, it is crucial to thoroughly investigate its significant impact and diverse application in financial practice. This paper endeavors to examine how ML is reshaping financial services, focusing on enhanced prediction accuracies, cost efficiencies, the promotion of innovation and the improvement of customer relationships. Also, this paper explores application areas of ML in finance including stock market forecasting, fraud detection, credit risk identification, management of portfolios, and asset evaluation. Additionally, the paper navigates through the hurdles faced when incorporating ML into financial methodologies. Finally, the paper aims to shed light on prospective advancements in the application of ML in the finance field.

This analysis aims to offer an in-depth perspective on ML's evolving role in finance to researchers, policymakers, and financial professionals. The intention is to provide valuable insights and foresight, thus enabling well-informed strategic decisions and planning within a rapidly transforming financial domain.

2. Impact of ML on Financial Practices

Having outlined the significance of ML within the financial sector and its rapid technological advancements, this paper now pivots to an in-depth examination of ML's multifaceted impact on finance. The next section examines how ML not only increases the accuracy of analysis but also changes the way financial operations and decisions are made. It sets the foundation for a thorough look at its benefits and roles in the ever-changing finance sector.

2.1. Analytical accuracy enhancement

Linear regression, due to its reliability, is a staple method in the field of economics, extensively employed in numerous studies. However, recent research including that by Hoang and Wiegratz, indicates that ML demonstrates superior performance in terms of forecasting accuracy, particularly in scenarios involving a multitude of variables [3].

The superior accuracy of ML models primarily stems from their exceptional capability to process and analyze high-dimensional data. Cao et al. highlight this in their analysis of stock prices for companies characterized by complex, voluminous, and multifaceted datasets [1]. They found that ML models outperform most human analysts in these contexts. This is largely attributed to the inherent limitations of human cognitive processes, which are typically adept at interpreting data up to three dimensions, thus struggling with the more complex, high-dimensional datasets.

To harness these advantages in data analysis, the ML field employs a structured approach known as feature engineering. This involves techniques such as feature selection, feature extraction, and dimensionality reduction. Through these techniques, ML can transform complicated raw data into a more predictive and manageable format. Vasques points out that this transformation not only diminishes the impact of extraneous information (or "noise") but also significantly bolsters the model's ability to discern and comprehend the key economic indicators driving outcomes [4]. As a result, these methodological advancements in ML lead to marked improvements in forecasting accuracy, underscoring the transformative potential of machine learning in enhancing the precision of economic analyses.

2.2. Cost reduction

On account of the highly regulated nature of the financial industry, financial firms have to devote tremendous resources to ensure compliance with legal and regulatory requirements. This encompasses internal audit, manpower investment in the compliance department, legal consulting fees, and reporting and disclosure costs, among others, which determine notable operation costs in the income statement. Meanwhile, office expenses, software usage fees, and subscriptions to external databases that may be involved in conducting business operations such as corporate financial analysis and industry research by internal teams are subsumed under management expenses.

However, ML enhances the efficiency of various analytical processes. For instance, predictive analytics in ML can streamline risk assessment, customer behavior forecasting, and market trends analysis, which traditionally require substantial manpower and time. By automating these tasks, ML reduces the time and resources needed for data processing and analysis, which would lead to a decrease in management costs.

In addition to direct cost savings, ML applications in finance extend to optimizing operational efficiencies. Automated algorithms can perform tasks such as transaction monitoring, fraud detection, and customer service inquiries, which further reduce the necessity for large, specialized teams. In further study, Timur Narbaev et al. proposed a practical XGBoost model utilizing

available resources and earned value management, to forecast costs throughout the entire project cycle [5]. By using this model, project managers could achieve improved cost control.

2.3. Innovation strengthening

Models are built through ML after analysis of a vast amount of data. As training data keeps inputting, the model would be modified immediately. However, human analysts are not capable of aligning the model according to a large amount of new data. This results in hysteresis between the responding actions of financial service companies and market transformation, since it is not only laborious to analyze data and switch the model but also necessary to assess the new model. Conversely, these steps comprising building and testing models are already included in the procedure of ML, which is a process consuming less time. Therefore, precisely because of the minimized consumption of time, the lag of innovation relative to market changes is thereby reduced, which would dramatically increase the effectiveness of innovation in the financial services industry.

On the other hand, ML can also drive corporates to move towards innovation. According to the research by Zhou, Huang, and Zhang, it is been a universal trend that corporations chase innovation under the background of the popularity of large models [6]. Out of the reinforcement of differentiated competitive advantages, effective adaptation to market evolution, and the capture of an effective position in the market, innovation is acting as an important behavior in company operation. More importantly, the application of emerging technology provides more probability of innovation for corporates. Therefore, amid the intensifying revolution in the financial industry, the laggard ones with no innovation are meant to be squeezed out of the market, which is how ML motives innovation in the financial service industry.

2.4. Customer relationship improvement

ML could also improve the customer relationship, by revealing the customers' habits and preferences, by analyzing past data. Having analyzed the customer statistics, financial service enterprises would grasp the customer behavior pattern. Thereby, they could further comprehend the habits of diverse customers, which makes them able to provide appropriate financial products to the right customer. In some cases, big data analysis combines the internet query data and historical customer data, then demonstrates the messages that customers need [7]. Thus, it will be more accessible for financial services personnel to provide highly customized services if the enterprise introduces ML. Additionally, besides scholars, CEOs around the world generally figure that artificial intelligence is expected to influence the performance of companies positively, including reinforcing customer relationships [8].

3. Applications of ML in financial practices

After detailing what influence ML will bring, the paper drilled down into the broad spectrum of ML in the financial sector. This section provides a holistic oversight of practical applications of AI, demonstrating its versatility and critical role in shaping modern financial services.

3.1. Stock market forecast

The unpredictability of the stock market has traditionally challenged analysts, who have employed historical data, trading volumes, and a blend of company-specific insights alongside statistical and behavioral finance approaches for price prediction. Yet, the intricate web of factors influencing stock dynamics often eludes comprehensive analysis by humans. With advancements in analytical methodologies, there's a growing reliance on ML for sifting through the vast dataset characteristic

of stock markets. Predominantly, supervised learning, which is a typical brand of ML, stands out for its ability to generate predictive models from labeled datasets [9].

Deep learning, a sophisticated branch of ML, has gained traction for its ability to construct complex, layered models that excel in both forecasting and classification tasks. Its application in stock market trend prediction has been notable. For instance, Sinha et al. developed a predictive model using a combination of Deep Belief Networks (DBN) and Long Short-Term Memory (LSTM) networks [10]. DBNs are complex models that identify patterns in data, ideal for discovering hidden trends in stock prices. LSTM networks, specializing in processing sequences, remember information over extended intervals, essential for analyzing stock market transactions over time. Therefore, combining DBNs' pattern recognition with LSTMs' memory capabilities effectively enhances the accuracy of stock trend predictions.

3.2. Fraud detection

On the front of fraud detection within the financial domain, ML stands as a pivotal technology. Moving beyond the traditional analytical frameworks that focus on financial ratios, ML-driven fraud detection systems explore further. They scrutinize intricate patterns among numerous variables from critical financial documents, such as balance sheets and cash flow statements [11]. Unlike the human use of financial ratios to assess fraud risk, machine learning-based fraud detection uncovers hidden relationships between variables. This approach surpasses the constraints of traditional analytical logic, providing a more detailed insight into fraudulent activities.

Ensemble learning represents a cutting edge in ML that builds multiple models, each independently predicting the same issue, and finally assembling them into a combined prediction. So that the outcome of ensemble learning typically surpasses the accuracy of any singular model. As a result, the use of this approach to develop advanced systems for spotting financial irregularities has gained significant popularity. Concurrently, studies that apply ensemble learning to fraud detection have reported a notable improvement in the accuracy of uncovering illegal activities [11] [12] [13].

3.3. Credit risk prediction

Credit risk prediction is crucial for financial service providers to assess borrower default potential, playing a vital role in financial system stability. Over the last decade, this area has emerged as the most researched topic in financial risk, significantly influenced by the advent of machine learning [5]. The integration of machine learning techniques with traditional models has substantially improved their predictive accuracy for credit risk [14].

The exploration of machine learning in credit risk assessment began in the late 20th century, leading to the development of highly accurate bankruptcy prediction models. For instance, Tsai and Hsu introduced a meta-learning framework that showcased high prediction accuracy [15]. Continuing this trend, Shivanna and Agrawal developed a model using DSVM, an advanced classification model, for detecting credit card defaults [16]. These developments indicate a significant progression in the field, with machine learning enhancing the precision and effectiveness of credit risk prediction models.

3.4. Portfolio management

Scholars introduced ML to the field of portfolio management after it was shown to be effective in predicting market movements. ML determines portfolio options using asset allocation, evaluating risk, analyzing market outlook, selecting stocks, and valuing them. Moreover, after the investment program has been implemented, the model will modify the portfolio according to changes in the

market, economic criteria, and financial situation of investors, thereby better protecting and increasing investors' assets.

Building on ML's versatility in portfolio management, this article delves into the pioneering work of Kaczmarek and Perez [17]. Their research leverages Random Forest Models, which are used for classification and regression, for predicting stock excess returns, and for refining portfolio allocations. Their results reveal that ML-predicted portfolios outperform traditional equal-weight strategies across several benchmarks, notably in risk-adjusted returns, marking a significant advancement in investment strategy optimization.

3.5. Asset evaluation

Asset valuation is pivotal in the financial field, and traditional means of asset valuation suffer from major shortcomings. For example, the market approach ignores future profit potential, and the income approach is susceptible to the subjective judgment of analysts. In contrast, ML can predict investor sentiment and stock prices by analyzing news and streaming information. It can also more accurately determine real estate prices by evaluating multi-dimensional data, like geographic location, and assess the value of intangible assets.

Motivated by a general understanding of the importance of asset valuation and the limitations of traditional approaches, recent advances in machine learning offer a novel and promising avenue. Among them, the "News-Based Sparse Machine Learning Model for Adaptive Asset Pricing" proposes a pioneering asset pricing model that exploits financial news to explain and predict stock and sector returns [18]. The model goes beyond classical analytics by exploiting the huge untapped potential of real-time financial news through sophisticated machine learning algorithms.

4. Challenges in applying ML in Finance

While the applications of ML in finance are extensive and diversified, they are accompanied by their own set of challenges, ranging from data complexity to regulatory hurdles, which need to be carefully dealt with.

The first challenge is data quality. If machine learning is in financial forecasting, the majority of data resources that are fed into the model are corporate reports, historical transaction information, and media data. Such data is heterogeneous and complex, especially financial market data with a high noise-to-signal ratio [19]. A little carelessness in data processing can lead to an inadequate model fit, making it necessary for the data sources to be strictly monitored and for feature engineering to be paid more attention to.

Moreover, the explanatory power of ML models is also a vital challenge. Several machine learning models, especially deep learning models, possess low or no explanatory power which is considered to be "black boxes", without transparency in their logic chain. In the financial sector, where decision-making is challenging and regulation is strict, analysts, investors, and regulators need to clearly understand the decision-making basis of ML models. Ultimately, the black-box phenomenon generates a lack of trust in machine-learning models.

Another problem is homogenization. When the model's training dataset is fixed, the output is likely to be the same, if the operator provides similar instructions. In addition, using similar machine learning approaches and data to evaluate the risk of financial assets can lead to homogenization of risk assessments. In this case, multiple organizations may over-sensitize or overlook the same risk factors, jeopardizing the stability of financial markets.

5. Foresights of applying ML in Finance

With an increasing number of scholars investigating the application of machine learning in finance, the volume of this literature has increased significantly in 2018 and is expected to increase at an even higher rate in the future [20]. By tackling the aforementioned challenges directly, the future of ML in finance is promising. Continued research and development aim to increase its positive impact on the industry, suggesting more significant advancements and innovations are on the horizon.

The application of ML for personalized financial services is probably to be a new trend after ML has matured in the financial industry. Currently, the majority of academic research focuses on stock price prediction, portfolio management, and risk management. Scholars are increasingly adopting the viewpoint of financial institutions, concentrating on predicting credit risk. However, there's a growing need to shift the perspective towards the customer, exploring how to offer personalized services for diverse investor types and enhance customer experience. Further, as customer-centricity becomes more prevalent, it will increasingly enable personalized service in the financial sector through the gradual adoption of machine learning.

In the meantime, there will be more ML models working on causal analysis in the future. As the public realizes the disadvantages of the "black box" phenomenon of ML, some scholars have begun to study the causal learning of machine learning, and are committed to improving the interpretability of ML [21]. As the "black box" of ML is getting opened, financial analysis, economic forecasting, and other fields can usher in a big change.

6. Conclusion

This research investigates the revolution that machine learning will bring to the financial sector and examines how machine learning is employed in the financial services industry. Machine learning is redefining the financial sector by offering unprecedented analytical prowess, cost efficiency, a foundation for innovation, and an opportunity for customer relationship enhancement. Its application is across various domains of finance, including stock market forecasting, fraud detection, credit risk prediction, portfolio management and asset evaluation. However, the integration of ML in finance is not devoid of challenges. Issues such as data complexity, model opacity, and output homogenization necessitate more changes in the future implementation of ML in finance.

In the future, to fully utilize the potential of ML, the sector must navigate the complexity of technology adoption, ensuring high data quality, transparency, and multiformity. As this paper ventures into this new era, the focus must also expand to include personalized services and improve customer experience. The journey of ML in finance is just beginning, and its future promises a landscape where technology and human expertise converge to create a more inclusive, efficient, and resilient financial world.

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Study on the Emission Reduction Effect of China's OFDI in Countries along the Belt and Road

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Abstract: With extreme weather events occurring more frequently around the world, urgent action on climate change is becoming increasingly urgent. In the countries along the "Belt and Road", many adopt extensive development methods and face increasing pressure on carbon emissions. This paper explores the impact of China's outward direct investment (OFDI) on carbon dioxide (CO₂) emissions from 108 countries along the route that have joined China's Belt and Road Initiative, reported by Xinhua News Agency, from 2005 to 2020. The findings show that China's OFDI helps reduce carbon emissions in host countries, strongly refuting the claim that China's OFDI poses an environmental threat. At the same time, OFDI has promoted the spread of environmental protection technology and industrial upgrading in countries along the route, especially in developing countries, which may bring the phenomenon of "pollution halo". Based on the results of the study, it is suggested that China and countries along the "Belt and Road" should carry out international environmental technology exchanges and cooperation, and strengthen green and low-carbon investment in these countries. These cooperation measures will help push countries along the Belt and road towards a more sustainable development path and jointly address the challenge of global climate change.

Keywords: Foreign direct investment, Carbon emissions, The Belt and Road Initiative, Pollution halo hypothesis, Pollution paradise hypothesis.

1. Introduction

In recent years, although there has been a trend of "anti-globalization" at the international level, which attempts to weaken each other's connections through economic "decoupling" between countries, the interdependence and cooperation trends of the global economy remain strong. China will further expand its opening up to the outside world during the "14th Five-Year Plan"[1] and is committed to building a higher-level open economic system. China remains committed to actively engaging in global economic governance, fostering a new paradigm of openness that is broader, more inclusive, and mutually advantageous. As China's economy expands rapidly and its openness to the world deepens, the pace of Chinese enterprises' foreign direct investments is intensifying, positioning them as a significant player in global competition and collaboration.

However, as China's investment grows, it also faces the challenge of rapidly increasing carbon emissions. At present, China has become the world's largest carbon emitter. In September 2020,

during the general debate of the 75th United Nations General Assembly, General Secretary Xi Jinping made a significant announcement regarding China's environmental commitments. He stated that China would enhance its nationally determined contributions by implementing more robust policies and initiatives. The country aims to peak carbon dioxide emissions before 2030 and is determined to achieve carbon neutrality by 2060[2]. China is sparing no effort to plan and implement a series of plans, aiming to join hands with the international community to respond to the global climate challenge. However, on the international stage, misunderstandings and doubts about China's motivations for overseas investment still exist. Concerns surrounding China's overseas investments have somewhat impeded their progress, posing threats to investment security and heightening potential risks associated with direct investments abroad. Consequently, it is crucial to investigate the influence of China's outward foreign direct investment (OFDI) on the carbon emissions of host countries. Such exploration is essential for advancing the sustainable development of China's foreign investment initiatives.

2. Literature Review

The interplay between foreign direct investment (FDI) and carbon emissions has attracted considerable attention in academic research. Some researchers argue that FDI can help mitigate rising carbon emissions, exhibiting what is termed a "pollution halo" effect. For instance, Chu Dongmei and Wu Wei examined the influence of China's "Belt and Road Initiative" investments on climate risks in participating countries, focusing on how these investments can alleviate climate-related challenges. They pointed out that OFDI can reduce carbon emission intensity by promoting technology transfer and industrial upgrading, thereby reducing climate risk[3]. Liu Chao, Wu Chun, and Li Zenggang used panel data regression analysis to reveal the mechanism by which OFDI reduces carbon emissions by promoting energy structure optimization and technological progress, and identified that OFDI has a suppressive effect on carbon emissions in the countries along the Belt and Road route[4]. Meanwhile, Chen Yali analyzed data on FDI and carbon emissions from industrial enterprises across 30 provinces in China between 2013 and 2020. The findings indicated no significant variation in the impact of manufacturing FDI on carbon emissions, with only minor changes observed in certain coefficients[5], suggesting the absence of a "pollution haven" effect in China. Additionally, using a spatial Durbin model, Zhai Chaoying and Huang Ruoyun investigated the spatial spillover effects of China's FDI on carbon emissions. Their results demonstrated that Chinese foreign investments significantly reduce carbon emissions in host countries, and Chinese investment is an environmentally friendly investment[1].

Conversely, some researchers have found that OFDI can contribute to increased carbon emissions and support the "pollution haven" hypothesis. For instance, Joseph et al. analyzed data from 1995 to 2015 and highlighted that the inflow of FDI into countries participating in the Belt and Road Initiative exacerbated environmental pollution[6]. Similarly, Sapkota and Bastola examined time series data from 14 Latin American nations between 1980 and 2010, concluding that the pollution haven hypothesis holds true for this region[7]. Furthermore, Zhao Jun and Wang Xiaochen investigated panel data from 2003 to 2019 concerning China and Belt and Road countries, focusing on the threshold effects of financial development on the relationship between OFDI and carbon emissions. Their findings indicated that the potential for financial development in these countries has not yet been fully realized in terms of promoting carbon emission reduction[2].

Mahadevan et al. conducted a study using data from 64 countries along the Belt and Road Initiative between 2003 and 2014. Their analysis revealed that China's FDI exerts a complex influence on pollution levels in these nations. Specifically, they identified a "pollution halo" effect in low-income Belt and Road countries, while a "pollution refuge" phenomenon was observed in higher-income Belt and Road countries[8].

Other researchers have argued that FDI does not significantly affect carbon emissions. Li Zihao's research found that from 1995 to 2011, the influence of foreign direct investment (FDI) on carbon emissions in Chinese provinces and municipalities with medium per capita income was found to be negligible [9]. Additionally, Zhang et al. analyzed data from 52 countries involved in the "Belt and Road" initiative spanning from 1993 to 2018 and found that foreign direct investment inflows were positively correlated with consumption-based carbon emissions but not significantly[10].

Generally speaking, there are shortcomings in current research results in the field of research on the relationship between China's OFDI and carbon emissions in countries along the "Belt and Road". Therefore, this article will rely on the latest OFDI data from China to countries along the "Belt and Road" to conduct an in-depth analysis of the potential impact of this investment behavior on the carbon emissions of countries at different stages of development, aiming to build a green and low-carbon "Belt and Road" initiative policy. Provide strong data support and theoretical reference.

3. Theoretical Analysis

International Investment and Environmental Protection Theory: This theory focuses on the interaction between international investment activities and environmental protection. International investment helps improve the environmental quality of host countries by introducing more advanced technologies, promoting industrial upgrading, and improving environmental standards. However, inappropriate investment may bring risks of environmental pollution and over-exploitation of resources.

Pollution halo and pollution paradise hypotheses: These two hypotheses mainly focus on the two different impacts of international investment on the environment. The pollution halo hypothesis believes that the environmental protection means and methods used by multinational companies in the process of foreign investment will have a demonstration effect in the investment target country, thereby improving the host country[11]. In contrast, the pollution paradise hypothesis suggests that firms in pollution-intensive sectors often choose to invest and operate in countries or regions where environmental standards are less stringent, thereby avoiding strict environmental protection policies[12].

These theories provide an important theoretical framework for analyzing how China's outward foreign direct investment (OFDI) influences the emission reduction initiatives of countries involved in the Belt and Road Initiative. They reveal the complex relationship between international investment and environmental protection, highlighting possible challenges and opportunities. These theories not only help understand past investment practices, but also provide valuable insights for future investment decisions. This article will employ these theories to evaluate the impact of China's outward foreign direct investment (OFDI) on the emission reduction efforts of Belt and Road countries. The analysis will concentrate on three key aspects: first, assessing whether China's OFDI significantly affects carbon emissions in these nations; second, examining the extent to which China's OFDI facilitates the transfer of environmental protection technologies and promotes industrial upgrading; and third, investigating the existence of the "pollution halo" hypothesis among countries with varying levels of development.

4. Research Design

4.1. Variable Definition And Data Source

4.1.1.Explained Variable: Carbon Emissions (CO2)

Total CO2 emissions (total metric tons)

As an important indicator to measure the carbon emission level of a country or region, the total amount of carbon dioxide emissions intuitively reflects the country's overall carbon emissions. This

indicator not only helps to gain a deeper understanding of a country or region's carbon emissions, but also reveals the specific effects of economic activities on the environment. In the fields of environmental economics and climate change research, total carbon dioxide emissions are widely used as an explanatory variable to evaluate the actual impact of various policies, measures or economic activities on carbon emissions. Therefore, this article chooses total carbon dioxide emissions as the explained variable, and the data comes from the World Bank database (World Development Indicators).

4.1.2. Explanatory Variable: OFDI

China's foreign direct investment stock (10,000 US dollars)

OFDI plays a key role in the transnational movement of production factors like capital and technology. It significantly influences the host country's industrial structure, technological level, energy consumption and other aspects, thereby affecting its carbon emission level. Thus, examining the connection between OFDI and carbon emissions will provide a deeper insight into how economic activities relate to the environment. China's OFDI mainly includes stock data and flow data. However, due to China's reverse investment behavior, there are lots of negative numbers in China's OFDI flow data. Therefore, this article uses China's OFDI stock for research.

4.1.3. Control Variable

To investigate the effect of OFDI on carbon emissions and minimize potential estimation errors from omitted variables, this study incorporates several control variables relevant to the context, as detailed in Table 1.

Table 1: Variables, measures, and data sources.

	Variable	Measure Data	Source
Explained variable	Carbon emission	The total carbon dioxide emissions of the host countries along the "Belt and Road", the value is taken as the logarithm (lnCO2)	World Development Indicators(2005-2020)
Explanatory variables	China's foreign direct investment stock	China's stock of OFDI in host countries along the "One Belt, One Road" initiative, the value is logarithmic (lnOFDI)	China's Overseas Direct Investment Statistical Bulletin(2005-2020)
Control variables	GDP per capita	The per capita GDP of the host countries along the "Belt and Road", the value is taken as the logarithm (lnpGDP)	World Development Indicators(2005-2020)

Table 1: (continued)

Population density	The number of people per square meter of land area in the host countries along the “Belt and Road”, the value is taken as the logarithm (lnpOPD)	World Development Indicators(2005-2020)
Urbanization rate	The proportion of urban population in host countries along the “Belt and Road” to the total population, the value is logarithmic (lnUrbn)	World Development Indicators(2005-2020)
Industrial structure	The proportion of industrial added value of host countries along the “Belt and Road” to GDP, the value is taken as a logarithm (lnStr)	World Development Indicators(2005-2020)
Energy consumption structure	Energy usage of host countries along the “One Belt and One Road” (per capita kilogram of oil equivalent), the value is taken as the logarithm (lnpE)	World Development Indicators(2005-2020)
Trade openness	Trade openness of host countries along the Belt and Road, measured as a simple average of tax rates applied to all products (Tra)	World Development Indicators(2005-2020)

Data source: World Development Indicators (WDI), China's Overseas Direct Investment Statistical Bulletin

Gross domestic product per capita (pGDP)

Per capita GDP serves as a vital measure for assessing a country's or region's economic development. Generally, there is a relationship between economic development and carbon emissions. By controlling for this variable, we can more effectively analyze the impact of foreign direct investment on carbon emissions, reducing the influence of economic development levels.

Population Density (pOPD)

Population density has a direct effect on energy consumption and carbon emissions. In densely populated areas, lifestyle choices and energy use patterns can differ significantly, influencing overall emissions. Including population density as a control variable allows for a more precise evaluation of the effects of foreign direct investment.

Urbanization rate (Urbn)

The urbanization process is tightly linked to energy consumption and carbon emissions. As urbanization levels increase, lifestyles and consumption patterns will change, affecting carbon emissions. Controlling this variable can help clarify the distinct impact of FDI on carbon emissions across various stages of urban development.

Industrial Structure (Str)

Varying proportions of industrial added value in GDP (i.e., industrial structure) lead to notable differences in energy consumption and carbon emission intensity. By controlling this variable, we can explore the carbon emission characteristics of different industries in the development process and their response to foreign direct investment.

Energy consumption structure (pE)

Different energy sources have very different carbon emission factors, so adjusting the structure is a crucial method for lowering carbon emissions. Incorporating energy consumption structure into the analytical framework helps to more comprehensively understand how foreign direct investment affects carbon emissions by changing the way energy is used.

Trade openness (Tra)

International trade activities are often accompanied by an increase in logistics and transportation, which indirectly affects carbon emissions. At the same time, an open economic system is more likely to attract foreign direct investment. Therefore, using tax rate as an indicator of trade openness can provide a new perspective for this study, and further distinguish the independent effects of international trade and FDI on carbon emissions.

4.2. Build Model

Utilizing relevant data from Belt and Road countries spanning 2005 to 2020, this paper develops a quantitative model to investigate how China's OFDI affects carbon emissions in these nations. When selecting samples, this paper excludes 30 countries with serious data missing from the 138 countries that have joined China's Belt and Road Initiative reported by Xinhua News Agency in 2023, and finally uses 108 countries as samples for research.

This paper develops an empirical quantitative model to assess the influence of OFDI on carbon emissions as follows:

$$\ln CO2_{it} = \beta_0 + \beta_1 \ln OFDI_{it} + \beta_2 \ln pGDP_{it} + \beta_3 \ln pOPD_{it} + \beta_4 \ln Urbn_{it} + \beta_5 \ln Str_{it} + \beta_6 Tra_{it} + \beta_7 \ln pE_{it} + \varepsilon \quad (1)$$

Where i represents the country, t represents the year, \ln represents the natural logarithm of the variable; β_0 is the constant term, $\beta_1, \beta_2, \dots, \beta_7$ represent the regression parameters corresponding to each variable, and ε is the random interference term.

4.3. Descriptive Statistics of Variables

In order to reduce data volatility and eliminate heteroscedasticity, this paper uses logarithmic processing for all variables except per capita carbon dioxide emissions and trade openness before statistical analysis. The descriptive statistical results of all variables discussed in this paper are presented in Table 2.

Table 2: Descriptive statistics of all variables.

Variable	Obs	Mean	Std. Dev.	Min	Max
lnOFDI	1712	8.997232	2.657551	0	15.6049

Table 2: (continued).

lnCO ₂	1728	9.557311	2.111335	4.120662	14.34825
ln pGDP	1728	8.587059	1.248596	5.075654	11.72544
ln pOPD	1728	4.21079	1.317724	0.4985982	8.982923
ln Urbn	1728	3.969189	0.4284723	2.753661	4.60517
ln Str	1726	3.24775	0.46314	1.617269	4.462103
Tra	1728	7.825673	5.280571	-14.74	28.45
ln pE	1719	7.004007	1.242985	2.024855	9.923508

Data source: World Development Indicators(WDI), China's Outward Direct Investment Statistical Bulletin

According to the data in Table 2, it can be clearly observed that the distribution and characteristics of different variables among the 108 countries along the “Belt and Road” show significant differences. The mean value of OFDI is relatively high, about 9.0 (on the natural log scale), indicating that the sample countries generally have high OFDI levels. However, the standard deviation also reaches 2.7, which reveals that there are large differences in OFDI between different countries, and some countries may have a higher degree of internationalization and a wider overseas investment layout. The average levels of per capita gross domestic product (pGDP), urbanization rate (Urbn), and industrial structure (Str) are 8.6, 4.0, and 3.2 respectively (on the natural log scale). The changes in these indicators are relatively small, showing that The sample countries have certain commonalities in these aspects. However, trade openness (Tra) shows significant differences among countries, with a standard deviation as high as 5.3 and values ranging from negative values to higher positive values. This reflects the huge differences in the participation of different countries in international trade. Some countries actively integrate into the global economic system and promote trade and capital flows by adopting more open policies, while other countries are relatively closed and restrict Participation in external economic activities. Statistics on total carbon dioxide emissions (CO₂) and population density (pOPD) reveal significant differences in environmental protection and population distribution among the sample countries. The mean value of the energy consumption structure (pE) is 7.0 (on the natural log scale) and the standard deviation is 1.2, showing that there is a certain diversity in the energy consumption structure among the sample countries. Although there are differences, these differences are relatively small, reflecting some common trends or preferences in energy use, leaning towards a specific energy type or structure.

5. Empirical result analysis

5.1. Reference Regression

This paper uses total carbon dioxide emissions as the explained variable and adopts model (1) to explore the impact of China’s OFDI in countries along the Belt and Road on their carbon emissions, while controlling for year and country differences. According to the Hausman test, the double fixed effects model is superior to the random effects model[13], so the double fixed effects model is selected to analyze the results of the benchmark regression. The results of the benchmark regression are presented in Table 3.

Table 3: Benchmark regression results.

	(1) fe	(2) re
VARIABLES	lnCO ₂	lnCO ₂
lnOFDI	-0.019***	-0.013***

Table 3: (continued).

	(-4.33)	(-2.86)
lnpGDP	0.258***	0.217***
	(12.58)	(10.16)
lnpOPD	1.027***	0.727***
	(18.76)	(14.63)
lnStr	0.299***	0.328***
	(11.85)	(12.31)
lnpE	0.137***	0.151***
	(7.82)	(8.15)
lnUrbn	0.822***	1.044***
	(6.81)	(8.79)
Tra	-0.004*	-0.004*
	(-1.89)	(-1.70)
Constant	-1.913***	-1.484***
	(-3.99)	(-3.03)
Observations	1,701	1,701
R-squared	0.549	
Number of countrycode	108	108
r2_a	0.512	.
F	86.88	.

Note: ***, ** and * represent the significance levels of 1%, 5% and 10% respectively; the values in brackets are t values.
Data source: World Development Indicators(WDI), China's Outward Direct Investment Statistical Bulletin

As indicated in Table 3, the coefficient for OFDI is significantly negative at the 1% level, showing a value of -0.019 (in the fixed effects model), indicating that an increase of one unit of foreign direct investment will correspondingly reduce carbon dioxide emissions by 0.019 units. This is a significant result. China's OFDI in "Belt and Road" countries contributes to a reduction in the nation's carbon emissions. This aligns with China's commitment to green and sustainable development in the "Belt and Road Initiative," as well as its efforts to help countries along the route address climate challenges together. It is a strong refutation of the "environmental threat theory" of China's FDI.

Additionally, there are some situations worthy of attention in the control variables. Both GDP per capita and population density have a notable positive effect on carbon dioxide emissions, and both pass statistical tests, which reflects the close connection between economic activities and greenhouse gas emissions. As economic growth and per capita income rise, energy demand and consumption typically increase, leading to rising CO₂ emissions. This finding underscores the difficulty of balancing economic growth with environmental conservation.

The industrial structure, energy consumption pattern, and rate of urbanization all positively influence carbon dioxide emissions. Specifically, the industrial structure significantly affects emissions, with a coefficient of 0.299, suggesting that a rising industrial proportion typically leads to higher energy use and increased emissions. This is because industrial activities usually require a large amount of energy support and the emissions during their production processes are relatively high. The positive impact of energy consumption structure (coefficient is 0.137) is also in line with expectations. More energy consumption often means more fuel burning, thereby leading to higher carbon emissions. The urbanization rate has a notable positive effect on carbon dioxide emissions, with a coefficient of 0.822, indicating a clear connection between urban growth and greenhouse gas

emissions. As urbanization accelerates, energy consumption and emissions in areas such as buildings, transportation and infrastructure have increased, putting pressure on the environment.

However, unlike the above variables, trade openness negatively affects carbon dioxide emissions, indicated by a coefficient of -0.004. This result shows that high tax rates will stimulate energy efficiency improvements and clean technology innovation, and are supported by government environmental protection policies, thereby reducing carbon dioxide emissions. These mechanisms work together to make high tax rates play a key role in lowering carbon dioxide emissions.

5.2. Robustness Test

Here, this paper will use per capita carbon dioxide emissions (pCO₂) to replace the explained variable total carbon dioxide emissions (CO₂) to complete the robustness test. The findings are presented in Table 4.

Table 4: Robustness test results.

VARIABLES	(1) nl pCO ₂
lnOFDI	-0.1863*** (0.0447)
lnpGDP	0.9691*** (0.2350)
lnpOPD	-3.2834* (1.6680)
lnStr	0.1445 (0.2785)
lnpE	0.8215** (0.3220)
lnUrbn	4.0829** (1.8117)
Tra	-0.0264* (0.0148)
Constant	-10.2416* (5.6071)
Observations	1,701
Number of countrycode	108
R-squared	0.303
Indus FE	YES
Year FE	YES

Note: ***, ** and * represent the significance levels of 1%, 5% and 10% respectively; the values in brackets are robust standard errors.

Data source: World Development Indicators(WDI), China's Outward Direct Investment Statistical Bulletin

The results indicate that the direction of the regression coefficients for each variable aligns with the benchmark regression findings, demonstrating that the empirical test results in this paper are robust.

5.3. Heterogeneity Test

Here, this paper divides the countries along the Belt and Road into developed countries and developing countries for group regression and completes the heterogeneity test. The findings are displayed in Table 5.

Table 5: Heterogeneity test results.

VARIABLES	(1) developing lnCO ₂	(2) developed lnCO ₂
lnOFDI	-0.0187** (0.0076)	-0.0095 (0.0134)
lnpGDP	0.0964 (0.0848)	0.2322*** (0.0640)
lnpOPD	0.8200*** (0.2788)	0.8655*** (0.1373)
lnStr	0.2565 (0.2054)	0.2985*** (0.0871)
lnpE	0.5457*** (0.1084)	0.1147* (0.0633)
lnUrbn	0.1826 (0.4328)	0.6865 (0.4291)
Tra	-0.0040 (0.0081)	-0.0026 (0.0035)
Constant	-0.1678 (2.2332)	-0.3762 (1.6506)
Observations	382	1,319
R-squared	0.597	0.588
Number of countrycode	24	84
Indus FE	YES	YES
Year FE	YES	YES

Note: ***, ** and * represent the significance levels of 1%, 5% and 10% respectively; the values in brackets are the standard errors of the estimated coefficients.

Data source: World Development Indicators(WDI), China's Outward Direct Investment Statistical Bulletin

Based on the data in Table 5, the influence of OFDI in developing countries on total carbon dioxide emissions (lnCO₂) shows a significant negative effect (-0.0187) at the 5% significance level. This indicates that foreign direct investment tends to introduce cleaner and energy-saving production technologies and management models in developing countries, thereby reducing carbon dioxide emissions. On the contrary, in developed countries, the influence of foreign direct investment on carbon dioxide emissions is not significant, which may be because developed countries have already achieved relatively high achievements in environmental regulations, technological innovation, and energy management.

For other control variables, the impact of urbanization rate and trade openness has a minimal impact on carbon dioxide emissions at different levels of development countries. However, GDP per capita significantly affects carbon dioxide emissions in developed countries, which may be related to the larger scale of production and consumption activities in developed countries, leading to increased energy consumption and emissions. In developing countries, due to factors such as industrial structure and policy support, the impact of per capita GDP on emissions is not obvious. Population density

significantly affects CO₂ emissions in both types of countries, which may be related to increased energy demand and emissions resulting from concentrated populations. In terms of industrial structure, indicators measured by industrial proportion have a significant impact in developed countries. This may be because the industrial structure of developed countries is more diversified, including more clean and low-carbon industries. In developing countries, because the industrial structure is relatively simple, mainly composed of high-emission industries, the influence of the industrial sector on carbon dioxide emissions is negligible. In addition, in developing countries, the composition of energy consumption has a greater effect on carbon dioxide emissions. This may be due to the fact that developing countries rely more on traditional high-carbon energy, leading to a more significant influence of the energy consumption structure on emissions. Conversely, developed countries are more diversified and cleaner in their energy consumption structure, so their impact is not as significant as that of developing countries.

6. Conclusion

6.1. China's OFDI Helps Reduce Carbon Emissions in Host Countries

Regarding the effect of China's OFDI on carbon emissions in Belt and Road countries, empirical findings indicate that China's investments lead to a decrease in carbon emissions in these host nations. The result is a strong rebuttal to the "environmental threat theory" of China's FDI, and demonstrates China's determination to adhere to the idea of sustainable and eco-friendly development within the Belt and Road Initiative. With the purpose of further consolidate this achievement, the Chinese government should continue to advance the development of an environmentally friendly Belt and Road, encourage enterprises to adopt more environmentally friendly technologies and standards in overseas investment, and encourage the sustainable growth of partner nations. In the context of cooperation, China should strengthen cooperation with international organizations and host governments, jointly formulate and promote environmental standards, and further improve the level of global environmental governance.

6.2. China's OFDI Has Brought about the Transfer of Environmental Protection Technology and Industrial Upgrading

The findings demonstrate that China's OFDI has promoted the dissemination of environmental protection technologies and industrial upgrading in nations adjacent to the Belt and Road. The implementation of technology and management by China's overseas investment has brought cleaner and energy-saving production methods to these countries, helping to reduce carbon emissions. Foreign direct investment in developing countries also shows a negative effect, further supporting this result that OFDI may tend to introduce more environmentally friendly production technologies and management models. In order to further strengthen this trend, the Chinese government can formulate corresponding policies to encourage and support enterprises to actively transfer environmental protection technologies and experiences to nations along the Belt and Road in OFDI. The government can also promote international exchanges and cooperation in environmental protection technologies and support enterprises to take part in the development and execution of global policies environmental protection standards to improve further cooperation and advancement in the field of environmental protection.

6.3. Foreign Direct Investment in Developing Countries May Produce a "Pollution Halo" Hypothesis

Research results show that in developing countries, carbon emissions are negatively influenced by foreign direct investment, and this influence is more pronounced than in developed countries. This shows that FDI can help underdeveloped nations introduce cleaner and more energy-saving production technologies and management methods, thereby effectively reducing carbon emission levels. This also supports the "pollution halo" hypothesis to some degree. In order to effectively utilize foreign investment and avoid possible negative impacts, developing countries need to strengthen screening and guidance when attracting investment and give priority to the development of environmentally friendly, low-carbon and sustainable industries. At the same time, host countries must strengthen the development and execution of environmental conservation laws to ensure that foreign investments comply with local environmental standards and prevent the occurrence of "pollution havens".

These research results provide an important reference for understanding the actual effect of China's OFDI on decreasing emissions in nations, and also establish a dependable foundation for future policy formulation. In the context of globalization, countries need to work together to promote global environmental sustainable development by sharing environmental protection technologies and optimizing industrial structures.

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How Does the Intelligent Transportation System Promote the Globalization and Digitalization of Cities: Take Tesla Autopilot System as an Example

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Abstract: The globalization and digitization of smart transportation and cities are facilitated by advancements like Tesla's autonomous driving technology, which revolutionizes urban mobility. This article explores their interconnection through the example of Tesla's system. Tesla's Autopilot, based on deep neural networks, utilizes cameras and ultrasonic sensors to perceive the world around vehicles, encouraging data sharing between vehicles and driving global development of smart cities. It employs artificial intelligence to assess terrain and conditions, fostering a transportation revolution in traditional cities and advancing the evolution of smart cities. Moreover, Tesla's digital impact is altering transportation solutions, increasing visibility in development, and driving global technological progress. Tesla's unique autonomous driving technology, leveraging data from nearly one million Tesla vehicles worldwide, enhances global intelligent transportation systems, promoting global sharing among Tesla users, and facilitating the convenience of autonomous driving and the flow of global traffic information. Tesla's autonomous driving mode and intelligent traffic system promote the development of smart cities, although a comprehensive analysis of its global political, economic, and legislative impacts is needed.

Keywords: intelligent transportation system, Urban globalization, autopilot system

1. Introduction

Globalization of cities requires political, social, cultural, and economic forces that bring people closer together throughout the world. The intelligentization of cities has gradually improved as globalization and digitalization have progressed. The advancement of intelligent transportation has a substantial influence on these processes. Similarly, one of the driving forces behind urban globalization is intelligent transportation.

Tesla's semi-autonomous driving technology is cutting-edge. This technology combines the most advanced artificial intelligence and hardware technology with automated driving and real-time driving updates, as a result of smart city development[1]. It has revolutionised the navigation and transportation techniques of urban traffic to some extent, as well as accelerated the globalisation and digitization of urban traffic.

As a result, this article would use Tesla's autonomous driving system as an example to explore the relationship between the globalization and digitalization of smart transportation and smart cities via Tesla's autonomous driving technology's globalisation, digitization, and mobility.

2. Literature Review

Globalization and digitization of cities have shattered urban space and area constraints in this era of urban intelligence. According to Sassen economic globalization and digitalization generated a sort of spatiality for cities, based on de-territorial cross-border networks and territorial places with a significant concentration of resources. Many scholars recognize this view in the era of rapid development of globalization and digitalization [2]. According to Canzler & Knie the processes of digitalization are speeding and degrading present mobile behaviours patterns. The progress of digitalization is reflected in every sphere of intelligent cities: such as the interconnection of transportation between cities, the sharing of cars and autonomous driving. This point of view also demonstrates that the digital process has eroded the original urban space and region, promoted the development of smart cities and to a degree broken the urban borders and regions [3].

The development process of Intelligent Transportation System (ITS) and the progress of smart cities have a favorable link to some extent. Some cross-sectional research suggests an association between ITS and smart cities. Intelligent transportation system has been regarded as one of the primary elements of any smart city [4][5]. The intelligent development and application of transportation, according to this viewpoint, is also the foundation for the operation of a smart city. There is even a case to be made that there is no trustworthy and efficient system. In the transportation system, there is no smart city [4]. Simultaneously, the smart cities development has also aided the advancement of intelligent transportation in the future, much as has shown that globalization, urbanization, connection and personalization are some of the elements influencing the transportation's future [5]. Hence the development of intelligent transportation and the process of smart cities are complementary and mutually reinforcing processes.

However, upon further investigation, it was discovered that the previous scholars' research on Tesla had been primarily distributed on the impact of its business model and new energy models on the market, while the research direction of its advanced autonomous driving mainly pays attention to the technical aspects of the car's driving mode. There is little or no examination of this technology's applicability to urban digitalization and globalisation. Therefore, from the perspective of Tesla's autonomous driving technology, this article hopes to analyze the correlation between the advancement of this technology and smart cities.

3. Analysis of the correlation between Tesla's autonomous driving technology and urban globalization and digitalization

3.1. Tesla's autopilot promotes city globalization

Tesla's Autopilot is built on a deep neural network and perceives the world surrounding the car using cameras and ultrasonic sensors. The driver can comprehend the surrounding environment thanks to this powerful sensor and camera package, which is not perceivable by a single driver. This technology encourages vehicle-to-vehicle data sharing, allowing for a new level of insight in areas like commuting information, traffic mitigation, road network management, and research road utilization. Because of its massive linked infrastructure, it can break down spatial barriers between cities in order to share information, increasing the flow of information throughout the globe. Tesla's autopilot intelligent interconnection technology promotes Tesla vehicles globally to develop a huge Internet of Things. Almost every object surrounding us will be connected to the Internet through the Internet of Things (IoT) technology in the future smart city, almost [4]. What's new today is the power,

complexity, and worldwide reach of these networks, as well as the extent to which key aspects of the economy have been digitised and can now be transmitted at breakneck rates over these networks [2]. Therefore, Tesla's powerful interconnection system encourages the smart city's global development at an extremely fast speed while promoting the exchange of vehicle information and data.

3.2. Tesla's autopilot advances smart city transport digitization

Tesla's autopilot has subverted the traditional forms of transportation in traditional cities as a new sort of technology. AI evaluates the city's terrain and emergency conditions, and offers a bundle of information about the driver's possible encounters, from the requirement to manually identify paper maps, to the advent of GPS, to now have electronic navigation technology, and then to Tesla's automatic driving mode. Insights into the types of challenges in driving highly automated vehicles; entailing pattern confusion, mental model development, and support for accidental automated transitions Endsley [6]. Tesla's semi-autonomous driving technology is based on the advancement of computer engineering and the popularization of information and communication technology (ICT). This technology's development has transformed a smart city from a concept into a reality [4]. This succession of digital breakthroughs has substantially decreased the impact of human factors on driving, increased driving safety, and facilitated traffic technology update and iteration.

Moreover, Tesla's impact on the digital media platform also had given birth to a new effect on the transportation solutions between traditional cities. Stating otherwise, the emerging digital revolution has already influenced the transportation sector. A considerable amount of attention has been paid by the mass media to the testing of innovative driver assistance systems and driverless car prototypes, enhancing the development visibility and promoting the technological flow globally [5]. Also, profound changes to the transportation market has been inflicted upon by this impact, and would eventually remove the existing systems and paradigms [3]. Whether it's a new form of digital autonomous driving mode or the influence of digital media, Tesla's operating model has generated new ideas and had a significant impact on city digital growth.

3.3. Tesla's autopilot enhances intercity mobility

Tesla's unique autopilot technology not only supports the globalization of intelligent transportation systems on a technical level, but also enhances the mobility between cities through the interplay of traffic and terrain information.

When Tesla links worldwide traffic, it utilizes a special silicon chip that processes Autopilot to create a neural network that can recognise the unique driving situation of almost 1 million Teslas in real-time. This implies that, although Tesla can utilise the cameras onboard the car to comprehend the environment, it can also use the data collected by other Teslas globally to best decide the policy and strategy [7]. This technology facilitates sharing among Tesla users worldwide. Tesla owners across the world might rely on Tesla's displays to enjoy the ease of autonomous driving made possible by digital information interaction. Under these conditions, we, as locals, have discovered that much of the substance of experience and representation is a microenvironment on a global scale. This technology has not only promoted the flow of traffic information globally, but Tesla has also promoted the global auto-driving process [2].

4. Conclusion

To sum it up, it can be known that the application of Tesla's autopilot driving mode and intelligent transportation system in cities is from different perspectives such as globalization, digitalization, and mobility by assessing the role played by Tesla's autopilot system in the development of smart cities. Promote smart cities development. The beneficial aspects of the application of the system to the

development of smart cities from a positive perspective have been evaluated in this article, but it fails to analyze the comprehensive impact of the application of the system in global politics, economy, and legislation. More systematic and specialised study on the Tesla autopilot technology and city globalisation is needed.

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Harnessing the Power of VR and AR Technologies in Internet Celebrity Marketing and User Interaction

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Abstract: The integration of Virtual Reality (VR) and Augmented Reality (AR) technologies into internet celebrity marketing offers unprecedented opportunities for enhancing user engagement, personalizing user experiences, and creating interactive content. This paper explores how VR and AR can revolutionize user interaction by providing immersive experiences and valuable data collection capabilities. By examining various applications, including virtual events, AR advertisements, and branded experiences, we highlight the significant business opportunities these technologies present for internet celebrities and brands. The ability to monetize VR and AR content, combined with insights gained from data analysis, drives innovative marketing strategies and fosters deeper connections with audiences. Through collaborations between internet celebrities, brands, and tech companies, the potential of VR and AR to transform digital marketing and engagement is immense, offering exciting new avenues for growth and success.

Keywords: Virtual Reality, Augmented Reality, Internet Celebrity, User Engagement, Digital Marketing.

1. Introduction

The rise of internet celebrities has transformed the digital marketing landscape, creating new avenues for brands to engage with consumers. As the digital space evolves, so do the technologies that enable more immersive and interactive user experiences. Virtual Reality (VR) and Augmented Reality (AR) represent two such technologies that hold significant promise for enhancing the ways internet celebrities connect with their audiences. VR offers a fully immersive digital environment, while AR overlays digital information onto the real world, both providing unique possibilities for user interaction and marketing innovation. This paper aims to explore the applications of VR and AR in internet celebrity marketing, examining how these technologies can enhance user engagement, personalize experiences, and create new business opportunities. By leveraging VR and AR, internet celebrities can host virtual events, offer interactive advertisements, and develop branded experiences that captivate their audience. The integration of these technologies not only improves the quality and reach of content but also provides valuable data collection opportunities that inform marketing strategies and optimize user experiences [1]. In VR environments, users can interact with virtual objects and avatars, participate in virtual events, and collaborate with other users in real-time, creating a sense of presence and immersion that is unparalleled by traditional media. AR enhances the real-world experience by overlaying digital information onto the physical environment, allowing users to

engage with interactive content through their smartphones or AR glasses. This can include virtual product trials, interactive advertisements, and augmented live streams. The ability to collect and analyze data from VR and AR experiences provides powerful insights into user behavior, preferences, and engagement patterns, enabling internet celebrities and brands to refine their offerings and develop targeted marketing campaigns. Furthermore, the monetization of VR and AR content presents significant business opportunities, offering new revenue streams through virtual tickets, subscriptions, and in-app purchases. The collaborative potential of VR and AR technologies also opens up exciting possibilities for partnerships between internet celebrities, brands, and technology companies, driving innovation and expanding the impact of digital marketing efforts.

2. VR and AR in User Interaction

2.1. Enhancing User Engagement

Virtual Reality (VR) and Augmented Reality (AR) technologies can significantly enhance user engagement by providing immersive and interactive experiences. VR enables users to enter a fully digital environment, where they can interact with virtual objects and avatars, creating a sense of presence and immersion that is unparalleled by traditional media. For internet celebrities, this means the ability to host virtual events, meet-and-greets, and live performances in a virtual space, allowing fans to experience these events as if they were physically present. AR, on the other hand, enhances the real-world experience by overlaying digital information onto the physical environment [2]. This can be used to create interactive content that fans can engage with through their smartphones or AR glasses, such as virtual product trials, interactive advertisements, and augmented live streams. By integrating VR and AR into their content, internet celebrities can offer more engaging and memorable experiences that captivate their audience and foster deeper connections.

To develop a mathematical model for enhancing user engagement through VR and AR technologies, we focus on quantifying the immersive and interactive aspects. Let E represent overall user engagement, which can be modeled as a function of presence P , interactivity I , and user satisfaction for VR and AR experiences U_{VR} and U_{AR} . The sense of presence P is influenced by the number of virtual events V_{events} and interactive AR content $A_{interactive}$, and the time spent on each T_{event} and T_{AR} . The level of interactivity I depends on the same variables. Hence, we have:

$$P = \alpha(V_{events} \cdot T_{event}) + \beta(A_{interactive} \cdot T_{AR}) \quad (1)$$

$$I = \gamma(V_{events}) + \delta(A_{interactive}) \quad (2)$$

The overall user engagement E is then:

$$E = w_1P + w_2I + w_3U_{VR} + w_4U_{AR} \quad (3)$$

Assuming $V_{events} = 10$, $A_{interactive} = 20$, $T_{event} = 2$ hours, $T_{AR} = 1$ hour, $U_{VR} = 8$, $U_{AR} = 7$, $\alpha = 0.5$, $\beta = 0.3$, $\gamma = 0.4$, $\delta = 0.6$, and equal weights $w_1 = w_2 = w_3 = w_4 = 0.25$:

$$P = 0.5 (10 \cdot 2) + 0.3 (20 \cdot 1) = 10 + 6 = 16$$

$$I = 0.4 (10) + 0.6 (20) = 4 + 12 = 16$$

$$E = 0.25 (16) + 0.25 (16) + 0.25 (8) + 0.25 (7) = 4 + 4 + 2 + 1.75 = 11.75$$

This model demonstrates that VR and AR can significantly enhance user engagement, achieving a composite score of 11.75 by providing immersive, interactive, and satisfying user experiences.

2.2. Personalizing User Experiences

One of the key advantages of VR and AR technologies is their ability to personalize user experiences. In a VR environment, internet celebrities can tailor their virtual spaces to reflect their personal brand,

creating a unique and immersive experience for each user. For instance, a beauty influencer can create a virtual makeup studio where fans can try on different looks using VR headsets. This level of personalization extends to AR as well, where internet celebrities can develop AR filters and effects that users can apply to their photos and videos, enhancing their personal connection to the celebrity's brand [3]. Personalization also allows for targeted marketing campaigns, where VR and AR experiences are customized based on user preferences and behavior. This not only enhances the user experience but also increases the effectiveness of marketing efforts by delivering relevant and engaging content to each individual.

2.3. Increasing Interactivity

Interactivity is a crucial aspect of user engagement, and VR and AR technologies excel in this area by offering interactive elements that traditional media cannot match. In VR environments, users can interact with virtual objects and avatars, participate in virtual events, and even collaborate with other users in real-time. This level of interactivity creates a sense of agency and involvement that enhances user satisfaction and loyalty. AR also offers interactive features, such as touch-sensitive AR displays, gesture recognition, and voice commands, allowing users to interact with digital content in intuitive ways. For internet celebrities, these interactive capabilities open up new possibilities for content creation and audience engagement [4]. They can create interactive stories, gamified content, and participatory experiences that encourage active involvement from their fans, fostering a sense of community and engagement that is critical for maintaining a loyal following.

3. Marketing Strategies with VR and AR

3.1. Immersive Advertising

VR and AR technologies offer innovative opportunities for immersive advertising that transcend traditional banner ads and video commercials, creating engaging and interactive experiences that capture the user's attention in unprecedented ways. In a VR environment, advertisements can be seamlessly integrated into the virtual world, providing a dynamic and engaging context for users to interact with brands. For example, a fashion brand can create a virtual showroom where users can explore the latest collections and try on clothes using VR avatars, offering a highly personalized and immersive shopping experience that goes beyond the limitations of physical stores [5]. This level of interactivity not only captivates the user's attention but also allows for a deeper connection with the brand. AR advertising, on the other hand, enhances the real-world experience by overlaying digital information onto physical products, making the shopping process more informative and engaging. Users can scan a product with their smartphones to see AR animations, detailed product information, and promotional offers, effectively blending the physical and digital shopping experiences. For instance, a user could scan a pair of sneakers to see a 3D model that they can rotate and examine in detail, watch a short video of someone wearing them, and instantly receive discount coupons. By leveraging VR and AR for advertising, internet celebrities and brands can create memorable and impactful marketing campaigns that resonate with their audience and drive engagement. These technologies enable brands to tell compelling stories and create rich, interactive experiences that traditional media cannot match. For internet celebrities, this means being able to offer their followers unique branded experiences, such as virtual meet-and-greets, exclusive behind-the-scenes content, or interactive product demos, all within a VR or AR framework. This not only enhances the celebrity's connection with their audience but also provides brands with highly effective advertising solutions that can increase brand loyalty and conversion rates [6]. The immersive nature of VR and AR ensures that advertisements are not just seen but experienced, leaving a lasting impression on the user and significantly boosting engagement and recall.

3.2. Virtual Product Launches

Virtual product launches are another exciting application of VR and AR technologies in marketing. Internet celebrities can use VR to host virtual launch events that are accessible to fans worldwide, eliminating the need for physical venues and travel. These virtual events can include live demonstrations, interactive Q&A sessions, and exclusive behind-the-scenes content, providing a rich and engaging experience for attendees. AR can enhance product launches by allowing users to interact with virtual models of the product in their own environment [7]. For example, a tech influencer launching a new gadget can use AR to let users see a 3D model of the device, explore its features, and even place it in their own space to get a sense of its size and design. Virtual product launches not only generate excitement and buzz around new releases but also provide valuable data on user engagement and preferences.

3.3. Branded VR and AR Experiences

Table 1: User Engagement Scores for Branded VR and AR Experiences

Experience Type	User Engagement Score (out of 100)
Virtual Tours	80
Immersive Storytelling	70
Interactive Games	75
AR Filters	90
AR Effects	85
AR Interactive Features	88

Creating branded VR and AR experiences allows internet celebrities to offer unique and memorable interactions that reinforce their personal brand and engage their audience. Branded VR experiences can include virtual tours, immersive storytelling, and interactive games that reflect the celebrity's interests and persona. For example, a travel vlogger can create a VR travel experience that takes users on a virtual tour of exotic destinations, complete with interactive elements and educational content. AR experiences can include branded filters, effects, and interactive features that fans can use in their own social media posts, spreading the celebrity's brand organically [8]. By creating branded VR and AR experiences, internet celebrities can enhance their brand presence, attract new followers, and create deeper connections with their existing audience. Table 1 illustrates the potential user engagement scores for various types of branded VR and AR experiences. Virtual tours and immersive storytelling provide substantial engagement, while AR filters, effects, and interactive features tend to score higher, reflecting their popularity and effectiveness in enhancing user interaction and reinforcing the personal brand of internet celebrities.

4. Business Opportunities in VR and AR

4.1. Monetization of VR and AR Content

The monetization of VR and AR content presents significant business opportunities for internet celebrities and brands, offering a wide array of innovative revenue streams that extend beyond traditional sponsorships and advertising. By leveraging the immersive and interactive nature of VR and AR, celebrities can provide premium experiences that entice users to pay for access, such as virtual tickets to exclusive VR events, paid subscriptions for access to a library of VR content, and in-app purchases for AR filters and effects. Additionally, brands can collaborate with internet celebrities to create sponsored VR and AR experiences, generating revenue through brand

partnerships and product placements [9]. For example, a beauty influencer could sell AR makeup filters that fans can use to virtually try on different looks, while a fitness trainer could offer AR workout guides that overlay exercise instructions onto the user's real-world environment. The ability to monetize VR and AR content not only increases the financial viability of these technologies but also encourages continued innovation and investment in immersive experiences, ultimately enhancing fan engagement and loyalty.

4.2. Data Collection and Analysis

VR and AR technologies offer invaluable opportunities for data collection and analysis that can significantly enhance marketing strategies and improve user experiences. By meticulously tracking user interactions within VR environments and AR applications, internet celebrities and brands can gather detailed insights into user behavior, preferences, and engagement patterns. This wealth of data allows for the optimization of content and the personalization of user experiences, ensuring that the material provided resonates more deeply with the audience. For instance, by analyzing user interactions in a VR shopping experience, brands can identify which products attract the most attention and which features keep users engaged the longest. This information can then be used to refine product offerings and tailor marketing messages to better meet consumer needs and preferences. Additionally, data on user preferences can help in developing targeted marketing campaigns that are more likely to convert, by delivering relevant content at the right time to the right audience [10]. The ability to collect and analyze data from VR and AR experiences thus provides a powerful tool for enhancing user engagement, fostering customer loyalty, and driving business success. By leveraging these insights, internet celebrities and brands can create more impactful and engaging VR and AR experiences, ultimately leading to a more personalized and satisfying user journey. Figure 1 illustrates the effectiveness scores of various aspects of data collection and analysis in enhancing user engagement, showcasing the significant benefits of leveraging data-driven strategies in the digital marketing landscape.

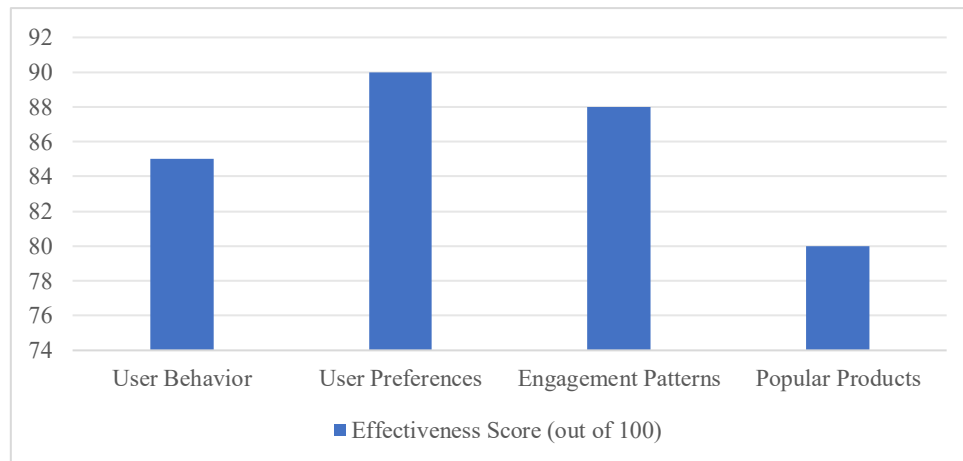


Figure 1: Impact of Data Collection and Analysis on User Engagement

4.3. Partnerships and Collaborations

The growing popularity of VR and AR technologies creates abundant opportunities for partnerships and collaborations between internet celebrities, brands, and technology companies, allowing these entities to leverage their respective strengths to create innovative and engaging experiences that captivate audiences and drive business growth. By working together, internet celebrities can enhance their content with cutting-edge technology, while brands can reach new demographics through

immersive and interactive experiences. For example, an internet celebrity might partner with a leading VR company to develop a branded VR experience that offers fans a unique, immersive glimpse into their daily life or behind-the-scenes activities. Similarly, a fashion brand could collaborate with an AR developer to create interactive AR advertisements that allow users to virtually try on clothing or accessories, providing a more engaging and personalized shopping experience. These partnerships not only improve the quality and reach of VR and AR content but also facilitate cross-promotion and mutual benefits, as each partner can tap into the other's audience and technological capabilities. Furthermore, such collaborations can lead to the development of entirely new types of content and experiences that neither party could achieve alone, pushing the boundaries of what is possible with VR and AR technologies [11]. The collaborative potential of VR and AR technologies thus offers exciting possibilities for expanding the impact and influence of internet celebrities and their associated brands, creating a dynamic ecosystem of innovation and engagement [12].

5. Conclusion

The integration of VR and AR technologies into internet celebrity marketing and user interaction holds immense potential for transforming digital engagement. By providing immersive and interactive experiences, these technologies enhance user engagement, personalize user interactions, and offer valuable data collection opportunities. The ability to monetize VR and AR content creates new revenue streams for internet celebrities and brands, encouraging continued innovation and investment in these technologies. Collaborations between internet celebrities, brands, and technology companies further expand the possibilities for creating unique and engaging content that captivates audiences and drives business growth. As VR and AR technologies continue to evolve, their application in internet celebrity marketing is poised to revolutionize the digital marketing landscape, offering exciting new avenues for growth, engagement, and success.

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