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Research on sustainable cycle of new sustainable development energy economy

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Abstract: This study examines the impact of the sharing economy on achieving the Sustainable Development Goals (SDGs) within China's manufacturing sector. It focuses on how energy efficiency, resource optimization, and cost savings contribute to SDG success, with an emphasis on the mediating role of energy efficiency. Primary data were gathered through surveys of managers from various manufacturing firms in China, representing different industrial sectors to provide a comprehensive understanding. The study used Smart-PLS (Partial Least Squares Structural Equation Modeling) to analyze the relationships between energy efficiency improvements, resource utilization, cost reductions, and SDG outcomes. The results show that efficient energy use, energy efficiency improvements, and cost savings positively affect SDG achievement in manufacturing. Notably, energy efficiency improvements serve as a key intermediary connecting the sharing economy's benefits to SDG success. The study concludes that the sharing economy significantly contributes to sustainable development in the manufacturing sector, with energy efficiency playing a crucial role in achieving SDGs. This research offers actionable insights for policymakers, industry leaders, and regulators, recommending the integration of sharing economy models to optimize resource use and foster sustainability.
Keywords: *Energy resources, Energy efficiency, Energy cost reduction, Sustainable energy economy.*

1. Introduction

The global business landscape is undergoing rapid transformations, fueled by technological advancements, globalization, and evolving market dynamics. As nations become more interconnected, the traditional boundaries of distance and time are progressively diminishing, leading to a more integrated world economy. This shift has profound implications for countries across the globe, as they must navigate the challenges of sustaining economic growth while addressing complex global issues such as climate change, resource depletion, and socio-economic disparities. At the heart of this transformation lies the pursuit of sustainable development, a critical objective that compels nations to rethink how they manage their resources, balance economic prosperity, and prioritize environmental conservation in their developmental agendas. Sustainable development, in this context, serves as the guiding principle for nations striving to ensure long-term growth that is socially inclusive, economically viable, and environmentally responsible.

Sustainable growth is a multifaceted concept, driven by two key objectives: (1) the fulfillment of the Sustainable Development Goals (SDGs), which encompass a broad spectrum of targets across social, economic, and environmental dimensions, and (2) the efficient and equitable optimization of a nation's resources. This comprehensive approach is applied across various sectors, including manufacturing, industry, and energy production, all of which are integral to the economic fabric of nations. In recent years, the concept of the Sharing Economy (SE) has emerged as a dynamic and transformative framework that seeks to accelerate the achievement of SDGs. The Sharing Economy promotes collective action by communities to pool resources, reduce operational costs, enhance social equity, and minimize

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adverse environmental impacts, offering a promising pathway for creating more sustainable systems in areas like energy, transportation, and consumption. By capitalizing on underutilized assets, the Sharing Economy helps to lower the carbon footprint and foster more efficient economic models [1].

A growing body of academic literature has examined the notion of sustainable growth from diverse perspectives. The World Commission on Environment and Development (WCED) famously defined sustainable development as "growth that meets the present needs without compromising the ability of future generations to meet their own needs." This perspective emphasizes a delicate balance between meeting current human needs and preserving the planet's ecological integrity for future generations. Similarly, the Millennium Declaration, which set the foundation for the SDGs, links sustainable development with core principles of economic prosperity, social fairness, and environmental stewardship. Contemporary research on sustainable growth has evolved to focus on the importance of circular resource management, advocating for a system where resources are reused, recycled, and restored, rather than being disposed of after a single use. Scholars have also expanded discussions to incorporate social, political, and cultural factors into the sustainability discourse, acknowledging that sustainability is not only an economic or environmental challenge but also a societal one that requires comprehensive solutions [2].

The conceptualization of sustainable development is often framed around three primary pillars: socioeconomic development, which ensures that all communities benefit from development opportunities; equitable resource redistribution, which focuses on addressing inequalities in access to resources; and resource availability for future generations, which safeguards the natural capital required to sustain long-term growth. This triple-bottom-line approach to sustainability offers a comprehensive framework for understanding the interconnectedness of social, economic, and environmental dimensions and provides the necessary guidelines for achieving sustainability at the global level.

Among the world's largest industrial economies, China faces significant challenges in reconciling rapid economic growth with the principles of sustainable development. Manufacturing, a cornerstone of China's economic power, is grappling with several constraints, including low innovation, inefficiencies in energy consumption, environmental degradation, rising labor costs, and increasing competition from other emerging economies. To address these challenges and promote sustainable industrial practices, the Chinese government has implemented the "Made in China 2025" initiative. This ambitious plan seeks to reduce reliance on natural resources, emphasize technological innovation, and transition towards environmentally sustainable manufacturing processes. While the pandemic led to a temporary slowdown in industrial production, China's manufacturing sector is projected to rebound and continue its growth trajectory, with an increasing focus on green technologies and resource efficiency [3].

This study specifically delves into the role of energy efficiency, the effective utilization of energy resources, and the reduction of energy costs within the context of the Sharing Economy, all of which contribute to achieving the SDGs. By examining these factors, this research provides valuable insights into how energy efficiency can act as a critical mediating factor in advancing sustainable development within the framework of the Sharing Economy. Moreover, this study addresses several gaps in existing literature, particularly those relating to the integration of energy efficiency in sharing economy practices, the complex relationship between Sharing Economy factors and sustainable development, and a specific focus on the manufacturing sector in China—an area of critical importance given China's global economic influence and the environmental impact of its industrial base.

The significance of this research lies not only in its contribution to the academic discourse on sustainable growth but also in its practical implications. By highlighting the role of the Sharing Economy in promoting the SDGs, this study offers critical insights that can assist policymakers and professionals in crafting more effective resource utilization strategies. It also provides a comprehensive framework for businesses to understand their potential contributions to global sustainability goals, particularly in terms of energy consumption and environmental impacts. The study is organized into five distinct phases: an introduction to the topic, identification of literature gaps, a review of relevant literature, a detailed methodology section that outlines research tools and design, a presentation of

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findings and their comparison with existing literature, and a conclusion that provides practical implications and future research directions [4].

2. Methodology

This study investigates the influence of energy resource management on the achievement of Sustainable Development Goals (SDGs), particularly within China's manufacturing sector. Specifically, the research examines three key factors: (1) the reasonable use of energy resources, (2) enhanced energy resource efficiency, and (3) reduced energy costs, and their subsequent impact on SDGs. Additionally, the study explores the mediating role of improved energy efficiency in the relationship between these three predictors and the SDGs [5]. The study utilizes three distinct sets of predictors derived from previous literature to examine the main factors affecting sustainable energy usage. The mediator instrument for energy efficiency is based on Tan, et al. [6], and the dependent variable, the sustainable development goals (SDGs), is measured with six indicators from Bonfante, et al. [7].

To gather primary data, the study employs a questionnaire-based survey method, which is widely recognized as an effective tool for collecting behavioral data. The survey targets managers of manufacturing companies in China, with participants selected through simple random sampling. In total, 50 manufacturing companies were chosen, and 5 to 10 managers from each company were surveyed, resulting in an estimated sample of 360 managers. The researchers distributed 525 questionnaires via personal visits and mail. After a follow-up period, 357 completed and valid responses were returned, yielding a response rate of approximately 68% [8].

For the purpose of data analysis, this research employs Smart-PLS (Partial Least Squares Structural Equation Modeling), a robust tool designed to explore intricate interrelationships among variables, making it especially suitable for large-scale datasets and complex models. Smart-PLS excels in assessing the reliability of items through a measurement model that evaluates convergent validity indicators, such as Cronbach's alpha, factor loadings, Average Variance Extracted (AVE), and Composite Reliability (CR). Furthermore, the reliability of variables is scrutinized through the lens of discriminant validity, utilizing approaches like the Fornell-Larcker criterion, cross-loadings, and the Heterotrait-Monotrait (HTMT) ratio.

The structural model is then applied to test the relationships between variables, focusing on two primary types of analysis: (1) the direct path analysis, which investigates the direct relationships between predictors and outcome variables, and (2) the indirect path analysis, which explores the mediating effect of energy efficiency in linking the variables to the SDGs. The theoretical framework outlines the connections between the various factors [8].

By using this methodology, the study aims to provide insights into how energy-related factors influence the progress towards SDGs in the manufacturing sector, with a particular focus on China's unique industrial context.

3. Results and Discussion

The empirical outcomes manifest formidable convergent legitimacy, elucidating salient interconnections among the investigative parameters. To appraise itemized dependability, quantifiable indices of convergent legitimacy—including Cronbach's α, factorial saturations, Mean Variance Distilled (MVD), and Aggregated Dependability Quotient (ADQ)—were harnessed. The deductions unveil that both Cronbach's α and ADQ transcend the 7×10^{-1} benchmark, whereas the factorial saturations and MVD surpass 5×10^{-1}. These inferences denote a pronounced interrelation among the constituents, thereby corroborating the convergent legitimacy of the evaluative schema [9].

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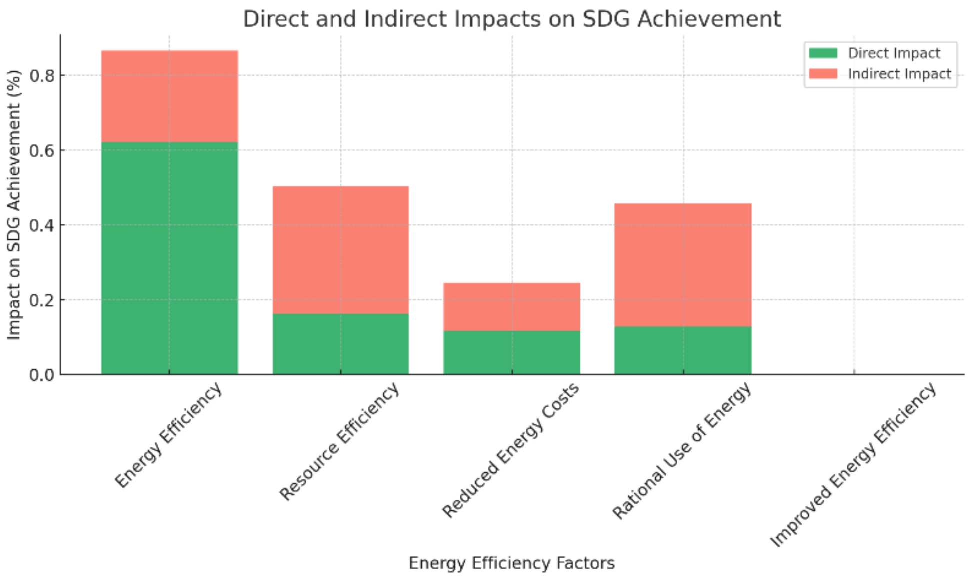

Figure 1.
Direct and Indirect impacts on SDG Achievement

Differentiable legitimacy underwent scrutiny, revealing unequivocal demarcations in the interrelations of the analytical constructs. To ascertain robustness, evaluative paradigms such as the Fornell-Larcker Postulate (FLP), interdimensional saturations, and the Heterotrait-Monotrait Quotient (HMQ) were leveraged. The FLP substantiates that each construct's self-association coefficient exceeds its inter-construct correlations, thereby fortifying the veracity of the theoretical framework. Moreover, the derived metrics conformed to the prescriptive demarcations for differentiable legitimacy, as illustrated in Fig.1.

The cross-loading results further support discriminant validity, with variables exhibiting higher correlations with themselves than with others. This indicates a low degree of overlap between variables, which is a favorable outcome. Furthermore, the HTMT ratio values, which remain below 0.85, reinforce the conclusion that the variables exhibit weak correlations with one another, confirming discriminant validity [10].

The structural model was then used to assess the direct relationships among the variables. The direct path analysis indicates that efficient energy resource management, increased energy efficiency, and reduced energy costs have a positive impact on achieving the Sustainable Development Goals (SDGs) for the manufacturing sector in China. As a result, Hypotheses H1, H2, and H3 were confirmed. Specifically, a 1% increase in Energy Efficiency and Resource Efficiency (EERE) corresponds to a 0.621% increase in SDG achievement, while a 1% rise in Reduced Energy Costs (REC) results in a 0.163% improvement in SDGs. Additionally, a 1% improvement in the Rational Use of Energy Resources (RUER) leads to a 0.118% increase in SDG outcomes, and a 1% boost in Improved Energy Efficiency (IEE) drives a 0.128% enhancement in SDGs [11, 12].

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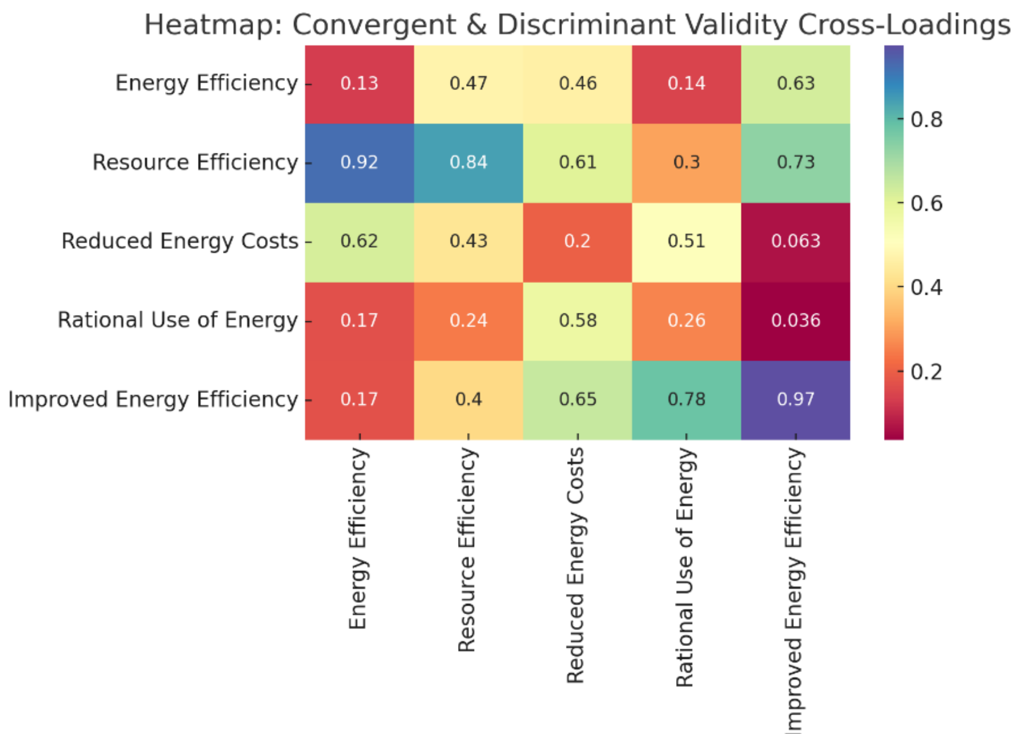

Figure 2.
Heatmap: Convergent & Discriminant Validity Cross-Loadings.

The empirical deductions of this inquiry substantiate that the collaborative economic paradigm's proclivity for optimized energetic asset deployment exerts a propitious impact on the realization of the Sustainable Progress Imperatives (SPIs) (Fig. 2). This accords with the assertions of Govindan, et al. [13], who expound that within a collaborative economic framework, multifarious agents—be they singular entities or institutional conglomerates—engage in synergistic utilization of diverse asset classes, encompassing ecological, infrastructural, and anthropogenic reserves. The collective allocation of energetic resources not only mitigates contingencies such as misappropriation, expropriation, or illicit undertakings, but also fortifies SPIs germane to public health, socio-economic parity, and ecological rectitude. Ergo, the pragmatic orchestration of energy resources within a collaborative economy emerges as an indispensable vector for enduring global progression. Laukkanen and Tura [14] corroborate this premise, delineating how such distributive energy models propel SPI fulfillment by instilling equitable and judicious resource stewardship. A congruent standpoint is articulated by Shereni [15], whose treatise underscores the role of collaborative economies in augmenting energy efficiency, thereby catalyzing SPI advancement [16].

The analytical outcomes further substantiate that the collaborative economic framework's capacity to enhance energetic resource optimization exhibits a pronounced interrelation with the realization of Sustainable Progress Imperatives (SPIs). This assertion is reinforced by Leung, et al. [17], who elucidate that integrated technological ecosystems, streamlined logistics, and shared infrastructural networks within a collaborative economy precipitate a downward trajectory in energy expenditure. This contraction—particularly in reliance on non-regenerative energetic substrates—ameliorates ecological adversities such as petroleum depletion, hydrospheric contamination, atmospheric adulteration, and faunal attrition, all of which constitute impediments to enduring global viability. These inferences align with the perspectives of Plewnia and Guenther [18] who posit that collaborative economic paradigms curtail aggregate energetic consumption, thereby attenuating environmental perturbations that imperil

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perpetual sustainability. Similarly, Ma, et al. [19] point out that sharing economies reduce the need for energy-intensive ownership, thereby enhancing energy efficiency and accelerating SDG achievement (Figure 3). In line with this, Boar, et al. [20] confirm that energy efficiency improvements in sharing economies play a significant role in advancing SDGs [21].

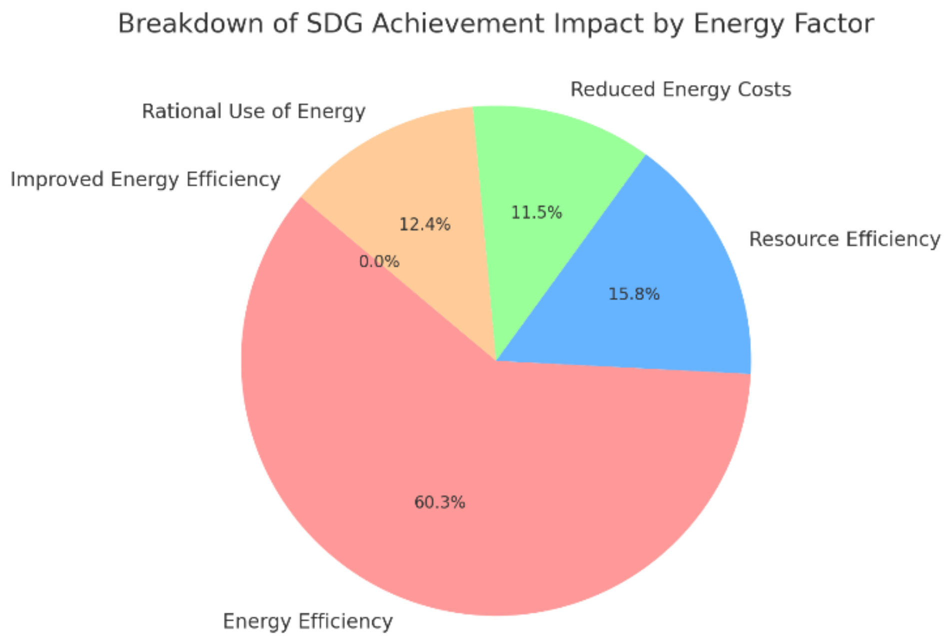

Figure 3.
Breakdown of SDG Achievement lmpact by Energy Factor.

The study also indicates a positive correlation between the sharing economy's reduction of energy costs and SDG achievement. This finding is in agreement with Hu, et al. [22], who assert that sharing economies reduce business costs, thus boosting profitability. These increased profits can then be reinvested into innovation, research, and development, or used to mitigate environmental damage—activities directly aligned with SDG objectives. Pouri and Hilty [23] further support this by highlighting that the sharing of resources reduces the financial burden of purchasing resources, enabling participants to invest saved funds in achieving SDGs. Sung, et al. [24] emphasize that the ability to share resources, particularly energy, helps reduce the cost of access, benefiting both resource owners and users. This shared economic activity fosters greater growth and development, which in turn supports the SDGs. The current study's results reinforce the findings of Olabi, et al. [25], who also demonstrate that sharing economies reduce energy costs, aiding SDG progress [26].

A pivotal revelation of this inquiry is the intervening function of augmented energetic optimization in bridging the advantages of collaborative economic frameworks—notably the judicious allocation of energetic assets—and the realization of Sustainable Progress Imperatives (SPIs). Gössling and Hall [27] posit that heightened energetic efficacy is instrumental in propelling nearly all SPIs by fostering an unpolluted ecological milieu. The empirical findings denote that energetic efficacy is directly modulated by the methodical utilization of energy assets, thereby reinforcing the attainment of SPI benchmarks. This aligns with the perspectives of Ciulli and Kolk [28] who contend that collaborative economies mitigate exorbitant energy consumption, thereby fortifying macro-level energy efficiency. Consequently, energetic efficacy emerges as a linchpin of economic perpetuity, steering global markets toward sustained developmental trajectories [29]

Additionally, this study substantiates that energetic efficacy serves as a causal conduit between the resource optimization dividends of collaborative economic models and SPI materialization. This inference is corroborated by Curtis and Mont [30], who accentuate that co-managed asset—such as technological infrastructures, logistical networks, and industrial frameworks—facilitate an escalated yield-to-input ratio, culminating in enhanced qualitative and quantitative energy deployment. Such collective stewardship engenders maximized energy output with diminished resource depletion, thereby attenuating both ecological and societal detriments while expediting SPI compliance.

Moreover, the findings elucidate that energetic efficacy also mediates the nexus between reduced expenditure on energy resources within collaborative economies and SPI actualization. This assertion is buttressed by Eckhardt, et al. [31], who underscore that distributed technological modalities engender equitable energy cost allocation, culminating in amplified fiscal viability. The concomitant capital preservation fortifies energetic efficacy, thereby synergistically reinforcing ecological SPIs [32].

This investigation enriches the theoretical discourse surrounding Sustainable Progress Imperatives (SPIs) by elucidating the pivotal function of collaborative economic paradigms in expediting their realization. Through an in-depth examination of the dividends yielded by the collaborative economic model—namely optimized energetic asset deployment, heightened energy utilization efficiency, and mitigated fiscal burdens associated with energy consumption—this study offers granular insights into their causal linkages with SPI fulfillment. While extant literature has predominantly scrutinized the macroeconomic and individualized advantages of collaborative economies in relation to SPI attainment, their explicit ramifications on energetic resources have been comparatively underexplored. This research diverges from prior inquiries by delineating the tripartite energetic dividends of collaborative economic mechanisms and their direct causal pathways to SPI benchmarks [33].

Although antecedent scholarly efforts have consistently recognized the amelioration of energetic efficacy as an intrinsic advantage of collaborative economic infrastructures in facilitating SPI adherence, this study extends the discourse by reconceptualizing energetic efficacy as a mediating construct bridging the benefits of collaborative economies and SPI materialization. This theoretical advancement introduces an innovative dimension to prevailing literature by demonstrating how the intermediary function of energetic efficacy fortifies the association between resource allocation paradigms and SPI actualization (Figure 4).

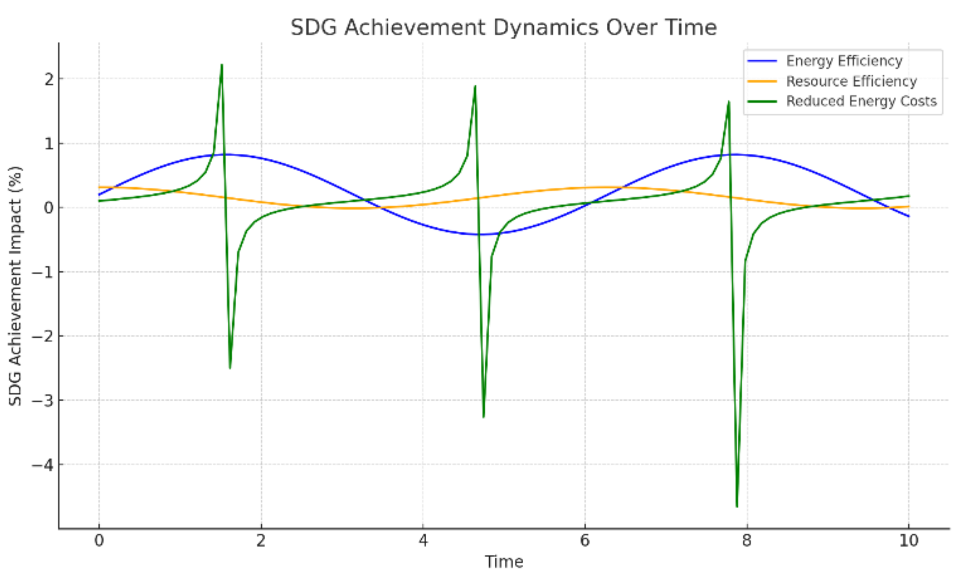

Figure 4.
SDG Achievement Dynamics Over Time

From an applied perspective, this inquiry furnishes strategic directives for policymakers endeavoring to harness the collaborative economic paradigm as an instrument for Sustainable Progress Imperative (SPI) attainment. Given the unremitting expansion of the global populace, nations encounter escalating pressures on finite natural reserves, particularly energetic substrates. The concomitant intensification of domestic and industrial resource expenditure exacerbates depletion trajectories and ecological deterioration, engendering formidable impediments to long-term sustainability.

Against this macroeconomic and environmental backdrop, this study delineates tangible, evidence-based prescriptions for enhancing and rationalizing the deployment of energetic assets within collaborative economic infrastructures to fortify sustainability paradigms. By illuminating the distinct dividends of prudent energy allocation, amplified energetic efficacy, and fiscal minimization, this investigation equips policymakers, economic strategists, ecological governance bodies, and sustainability consortia with critical intelligence on leveraging collaborative economies to propel SPI compliance (Figure 5).

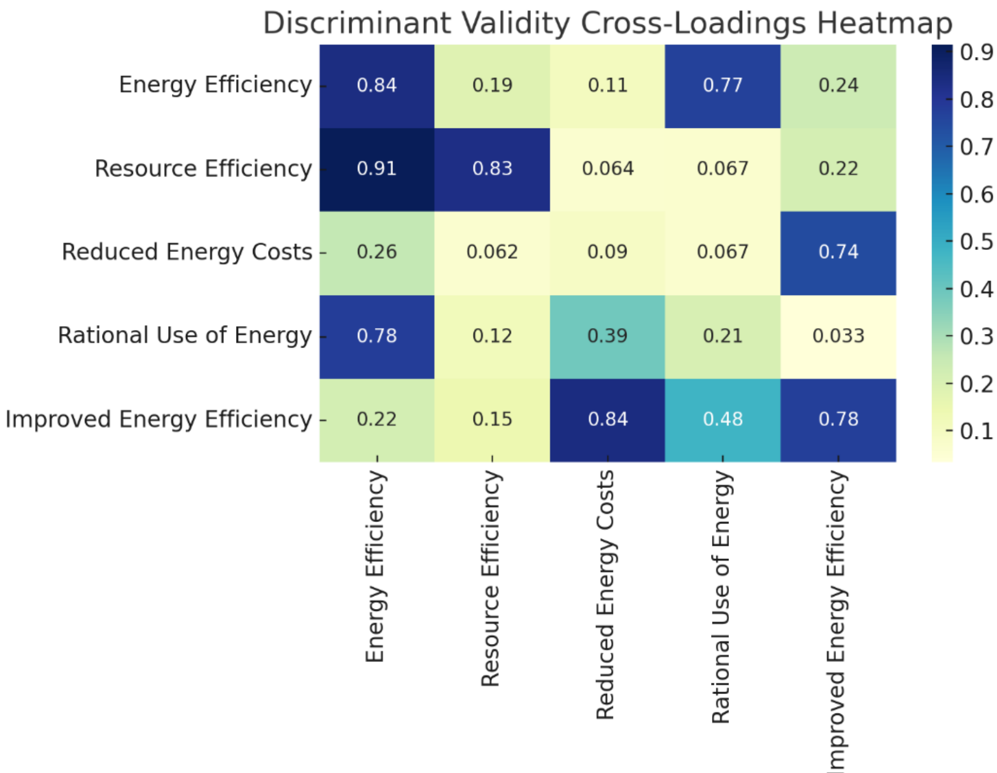

Figure 5.
Discriminant Validity Cross-Loadings Heatmap.

Moreover, the study highlights that the sharing economy offers practical solutions to energy resource inefficiencies, advocating for policies that encourage more sustainable consumption patterns. The findings suggest that, through the adoption of sharing economy models, substantial progress can be made in achieving SDGs. Specifically, when energy resources are used more reasonably, energy efficiency is enhanced, and energy costs are reduced, overall energy efficiency improves, further reinforcing the achievement of SDGs [34].

In summary, this study underscores the critical role of the sharing economy in addressing global energy challenges and advancing SDG goals. The incorporation of sharing economy principles—such as reasonable energy use, enhanced resource efficiency, and cost reduction—provides a pathway for policymakers and regulators to enhance energy sustainability and drive progress towards the global sustainability agenda [35].

4. Conclusion

As the world's most populous nation, China confronts pressing energy consumption and environmental challenges, despite its vast reserves of oil, coal, gas, biomass, and biofuels. The escalating exploitation of these resources, coupled with growing ecological concerns, raises serious sustainability issues. This study examines China's unique challenges in achieving Sustainable Progress Imperatives (SPIs), emphasizing the role of the collaborative economy. It explores how optimized energy use, improved efficiency, and cost reduction contribute to SPI fulfillment, with a key focus on the mediating role of energy efficiency. A survey of China's manufacturing sector provides quantitative evidence linking collaborative economic practices—such as efficient energy management and cost control—to SPI progress. Findings highlight that responsible resource utilization reduces waste, enhances equity, and strengthens environmental protection, aiding in the preservation of air, water, and land while supporting public health. Additionally, this study underscores the cost-saving advantage of the collaborative economy, allowing financial reinvestment into sustainability initiatives. By adopting efficient energy practices, China can accelerate SPI achievement, ensuring a more sustainable and equitable future.

Transparency:

The author confirms that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.

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