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Research Progress on Village Eco-Industry and Rural Industrial Revitalization and Its Inspiration for the Karst Desertification Control

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Abstract

Under the strategy of rural revitalization, it is urgent to apply the concept of ecological civilization to the development of rural industries. The study of ecological industry and industrial revitalization of karst village ecosystems can help to promote the revitalization of villages in ecologically fragile areas. However, the current status and progress of research on eco-industry and industrial revitalization of village ecosystems in ecologically fragile zones are unclear, and there is an insufficient summary of research results and problems. Therefore, based on 319 related literature, this paper focuses on the current status and progress of research on ecological industries and rural industrial revitalization in village ecosystems and reveals the current research results and shortcomings of ecological industrial revitalization in village ecosystems. We found that (1)village ecological industry and rural industry revitalization are becoming a hot topic; (2)Existing studies mainly focus on index system, driving factors, mechanism research and strategy research. (3) Research regions are mainly concentrated in Asia, North America and Africa. However, the main scientific and technological research such as the construction of indicator systems and the study of driving mechanisms are lagging behind. While summarizing the general rules, it also provides targeted insights and enlightenment for the sustainable management of karst desertification control ecosystem and the revitalization of rural industry.

Keywords: karst desertification control, villages, ecological industry, industrial revitalization, driving mechanism

1. Introduction

According to studies (Bański and Wesołowska, 2020; Markey et al., 2008; Viñas, 2019), many villages worldwide face economic decline, poor living conditions, unfavorable agricultural environments, low farming incomes, and inadequate infrastructure, leading to out-migration and environmental degradation. This trend is particularly evident in China and other developing countries like Nigeria and India (Baker, 1965; Liu et al., 2020; Nelson and Nelson, 2011; Pose et al., 2020). In response, China has implemented a rural revitalization strategy to improve living standards, agricultural conditions, and infrastructure, aiming for advanced production, better livelihoods, and effective governance (Doyle, 2023; Pinilla and Sáez, 2021; Sørensen, 2021)

Agriculture, as the backbone of rural economies, provides raw materials and supports agro-tourism (Wu et al., 2022). Rural tourism and counter-urbanization have spurred economic growth in some areas (Pose et al., 2020; Wu et al., 2019), but industrialization and population growth have also caused ecological damage and climate change (He and Xie, 2022; Wang and Gong, 2021). To address these issues, the concept of eco-industry emerged, emphasizing resource efficiency and waste recycling. Introduced to China by Professor Liu Ze Yuan (1994), eco-industry promotes sustainable development through ecological agriculture, tourism, and energy (Li and Zhang, 2019; Li et al., 2021b).

In ecologically fragile rocky desertification areas, mixed agriculture and forestry have been implemented to balance environmental restoration and economic growth (Fang and Li, 2017; Liao et al., 2018). However, challenges remain in forming sustainable industries and transforming farmers' livelihoods (Cai et al., 2014; Chen and Yu, 2019). Developing eco-industry is crucial to aligning ecological construction with socio-economic development and supporting rural revitalization.

Research on village eco-industry and rural revitalization has grown, but gaps remain. This study analyzes trends using WOS and CNKI databases, identifies key scientific and technological issues, and provides a roadmap for future research and sustainable development in rocky desertification areas.

2. Method

To achieve the study's objective, a comprehensive literature review on ecological industries and rural revitalization was conducted using the China National Knowledge Infrastructure (CNKI) and Web of Science (WOS) core databases, with data collected until August 31, 2024. In CNKI, a two-step search strategy was employed: first, using "ecological industry," "industrial revitalization," "industrial prosperity," or "tourism" as theme keywords, followed by a secondary search with "village," "settlement," "community," or "mountain area." This process initially yielded 233 articles, which were narrowed down to 165 after manual screening. Similarly, in WOS, a search using "TI" as the parameter with keywords such as "industry cluster," "revitalization," "rural industry," "agriculture," "tourism," "village," or "settlement" returned 221 articles, with 154 retained after screening. In total, 319 articles were selected from both databases for analysis.

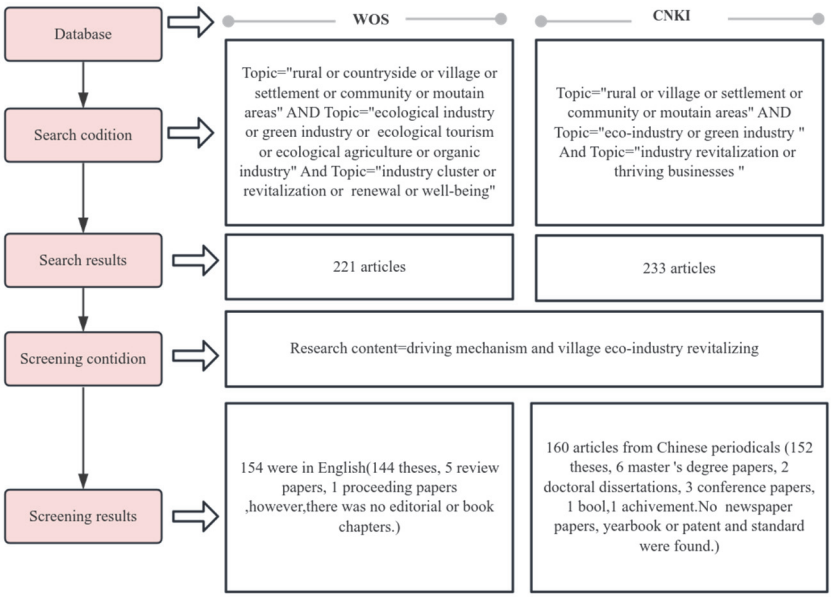

Figure 1. Literature retrieval process

3. Results

3.1 Phase Distribution of Literature

Research on the relationship between ecological industries and industrial revitalization is more prevalent in China than internationally. Pan Hua emphasized the need to develop ecological agriculture tailored to the regional characteristics of western China to stimulate economic growth. Internationally, ecological industry research began in 1989, with studies linking it to industrial revitalization emerging in 2000. Analysis of Figure 2 reveals three distinct phases from 1980 to 2023: the initial phase (1980–2000), with fewer than 10 publications and minimal annual output, marking the field's infancy; the slow growth phase (2000–2015), showing a gradual increase in literature; and the rapid expansion phase (2015–2023), characterized by over 10 publications annually and a deepening of research content.

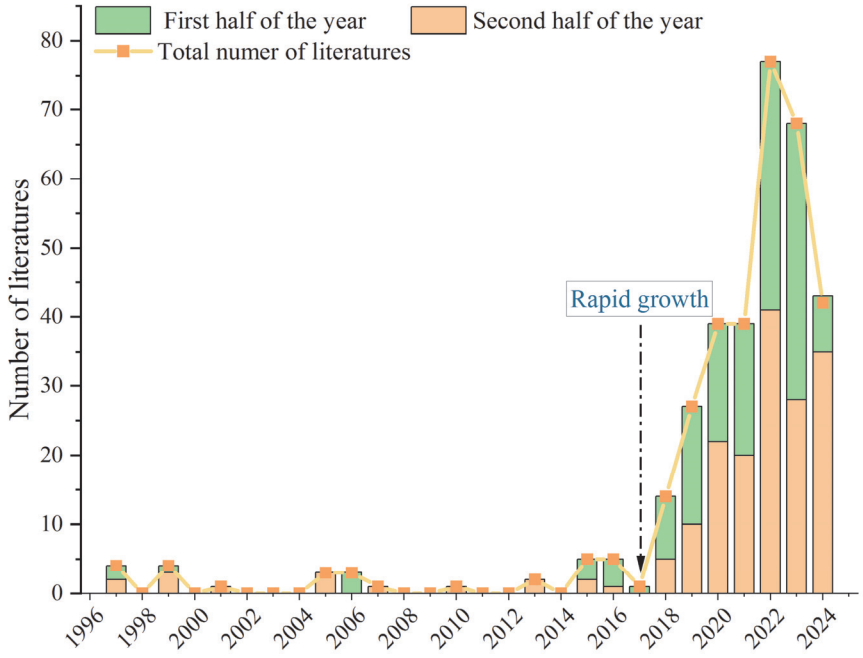

Figure 2. Annual distribution of literature

3.2 Regional Distribution of Literature

Among the 319 reviewed articles, foreign literature is primarily focused on Asia, North America, and Africa (Figure 4). China dominates with 56 publications, accounting for 83% of the total. The analysis shows that research on ecological industries and industrial revitalization is concentrated in regions with strong agricultural development, advanced economies, and technological innovation. Geographically, the eastern regions have the highest volume of literature, followed by the central regions, while the western regions have the lowest.

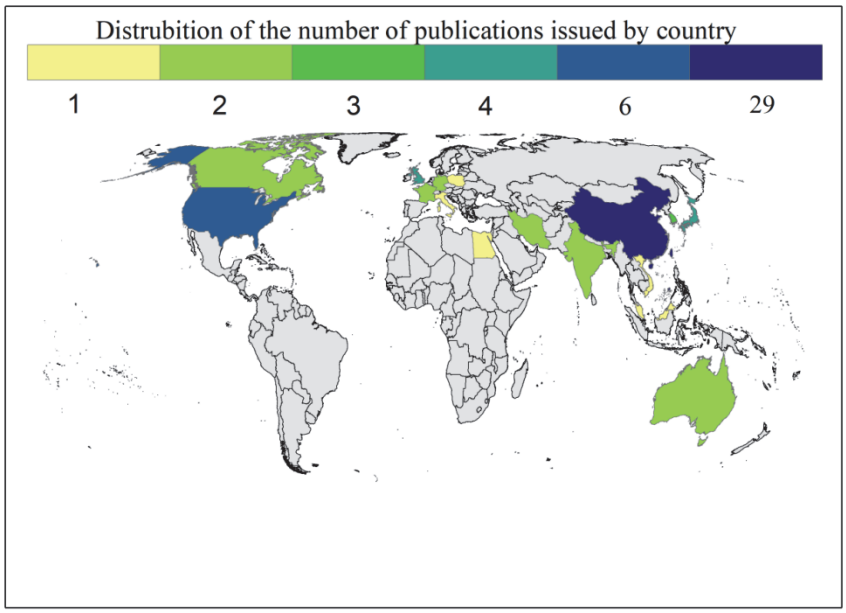

Figure 4. Regional distribution of literature

3.3 Hotspots and Trend Distribution of Literature

The keyword co-occurrence network for rural industrial revitalization research in China (2015–2024), generated using Vosviewer software, is illustrated in Figure 5. The network comprises 105 nodes and 964 links, with a density of 1.9. Keyword frequency highlights research hotspots, where higher frequency is represented by larger text and node sizes. Centrality also plays a crucial role, with higher values indicating greater importance. Figures 4 and 5 show that keywords such as "rural revitalization," "industrial integration," "rural tourism," "sustainability," "specialized industries," "urbanization," "villages," and "mountainous areas" appear most frequently, reflecting their prominence in the field.

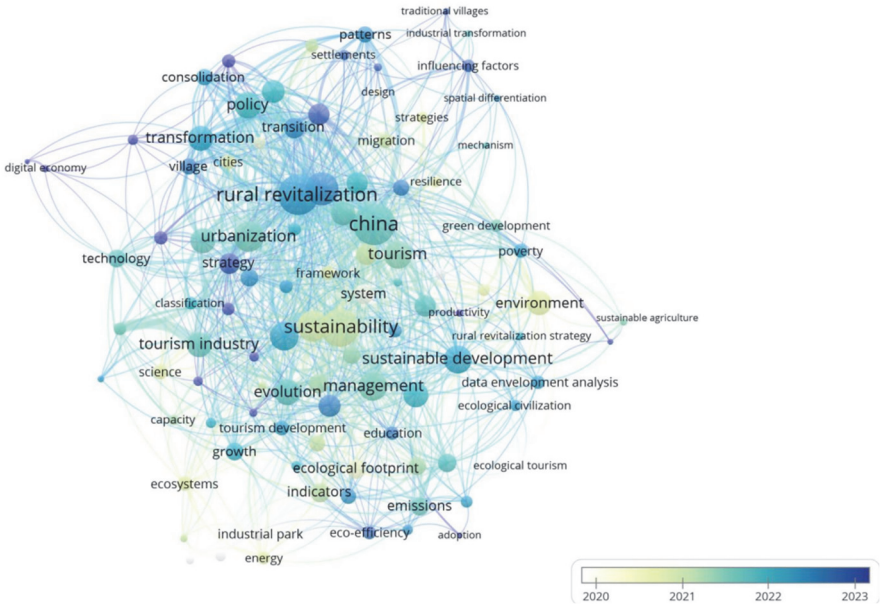

Figure 5. Regional distribution of literature

4. Main Progress and Landmark Achievements

4.1 Research on the Theory and Development Level of Village Ecological Industry and Rural Industry Revitalization

4.1.1 The Current Development Status of The Village Ecological Industry

At present, scholars focus on the conflict between environmental protection and economic development in village small farmers. In environmentally fragile areas, environmental protection and development are often contradictory(Tang et al., 2022). In mountainous areas, the development vulnerability of farmers is high, resulting in a low level of industrial development and poor medical facilities(Luo et al., 2021). The karst area in southern China is dominated by plateau mountains. Due to the influence of rocky desertification, the surface vegetation coverage rate is reduced, the land resources are lost, and the grain production is reduced, which restricts the development of rural industries in this area (Lu, 2016; Xiong and Chi, 2015; Zhu et al., 2021). After the implementation of the rocky desertification control project, the ecological industry in the karst area has achieved good benefits(Hu et al., 2014), The agricultural ecological economic system shows a coordinated development trend(Fu et al., 2019), The development level of eco-tourism has been improved, but it still faces challenges such as difficulties in consolidating achievements, low level of industrialization and imperfect industrial chain (Wang, 2022; Xiong et al., 2016). The main reasons for this phenomenon are the external environmental influence and the weak development of the main body. The external environmental influence is mainly due to the low efficiency of land circulation and the fragile ecosystem (Xiao and Xiong, 2022)、 land deterioration (Cao et al., 2008)、Market development potential is small (Zhang et al., 2021)、market size (Siqiao Fang et al., 2023)、Extreme weather hazards(Xiong and Chi, 2015)， Among them, the main development includes the lack of new agricultural production and management team (Binfan Lai, 2019)、Loss of the rural labor force (Yang and Yang, 2021)、Farmers' lack of ecological awareness (Zhang et al., 2020), Industrial scale and specialization (Kunyan Luo et al.,

2022). The disharmony between the external environment and the development of the main body makes the area fall into a "vicious ecological vicious circle", which is the main reason that restricts the development of ecological industry in the karst area. The above research lacks a systematic evaluation of the barriers of the village ecological industry, and the evaluation system has not been unified, so more in-depth research is needed.

Figure 6. Ecological industries in rocky desertification control areas are mainly small-scale, and industrial development is highly restricted by the geographical environment and the industrial level is low

4.1.2 Rural Revitalization Strategy

In the early stage of development, China adopted urban-rural dual planning. The influence of the urban bias strategy makes more resources prefer cities, and a large number of the labor force integrates into cities, leaving a large gap between urban and rural areas (Lin, 1992). In addition, the large-scale urban expansion in the 21st century promoted the expansion of industrial parks, rural decline, and rural problems gradually serious (Liu and Li, 2017). Rural areas have the function of ensuring social stability and regulating the livelihood of farmers, but this function is gradually unbalanced in the traditional rural areas and modern rural areas (Liu et al., 2020). In order to solve the long-term problems of agriculture, rural areas and farmers, scholars use the system, dual growth theory, stakeholders theory and method to alleviate the rural problems. Systems theory was first proposed by Ludwig von Bertalanfy, indicating that any field can be explained by a whole system. However, since rural revitalization is a complex system, it requires more in-depth analysis and identification of the interaction process of the key elements in the system. The researchers further proposed the binary growth theory and the stakeholder theory. The dual growth theory introduces the field of economics to the analysis of rural problems, pointing out that the surplus labor force in the most traditional sectors of rural areas will be transferred to the cities (modern sectors), and this phenomenon is more often seen in developing countries such as China and Africa (Goedkoop et al., 2022). However, the theory ignores the complex role of traditional departments, and the conclusion is too arbitrary and questioned by many scholars. In order to further explore the issues related to the urbanization process and rural revitalization, the scholars have further introduced the stakeholder theory. Focus on key actors in rural issues, and how key actors can work together towards one goal (Nuruzzaman et al., 2023). Reform organizations, government, and community leaders are key actors in rural revitalization (Greene, 1988; Kawate, 2005). The government plays a guiding role in the coordinated development of industries by guiding agricultural subsidies, and the government's supervision forces the cooperation of industrial subjects to promote the coordinated development of industries (Zhu et al., 2023). Secondly, the interest connection between stakeholders is helpful to realize agricultural development in the underdeveloped areas with weak agricultural foundation (Gou, 2018), By mobilizing the village subjectivity and autonomy, cultivating social capital, realize social capital reproduction, build the relationship of endogenous transformation network, the government by adopting fuzzy governance flexible, mobile to alleviate the problem of limited rural industry development, build and improve the autonomy, rule of law, the combination of rural governance system to promote the endogenous industry revitalization (Tang and Chen, 2022; Yang and Zhong, 2023; Zhang and Peng, 2022). The above research analyzes the mechanism of industrial revitalization from the influence of the subject of industrial development and external resources on industrial revitalization, while social network analysis mainly analyzes the relationship between individuals, groups or social institutions (Figure 7).

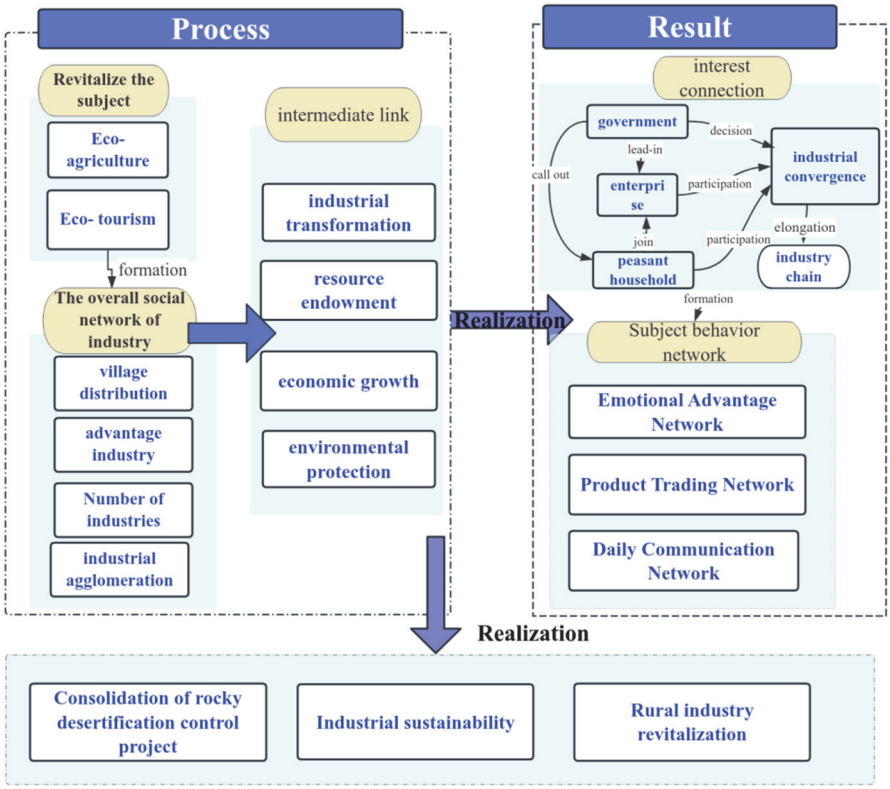

Figure 7. Social network network of single village ecological industry stakeholders and the mechanism process of realizing industrial revitalization

4.2 The Driving Mechanism of Ecological Industry to Industrial Revitalization

4.2.1 Driving Factors of Rural Ecological Industries

The push-pull theory, initially applied to population migration (Bogue, 1957), has since been expanded to areas such as farming intention (He and Xie, 2022), industrial transfer (Wang and Si, 2013; Yu and Yang, 2015), and ecological industrial chains (Sun and Du, 2016). Huang and Cao (2022) highlighted rural internal resources and external capital as key forces in rural revitalization. However, urbanization poses challenges to traditional villages, complicating revitalization efforts (Liu and Li, 2017). Rural tourism, leveraging local natural and cultural resources, is seen as a solution, promoting handicraft production, improving living conditions, and preserving heritage (Ghaderi and Henderson, 2012; Kimbu and Ngoasong, 2013). Li (2022) identified internal tourism demand as a thrust and external tourism products as a pull, emphasizing their combined effect. In Karst World Heritage Sites, unique ecological resources drive industrial revitalization, supported by policies, economy, and society as external forces (Zhang, 2019). Resources and products are central to high-quality industrial development, with industrial integration enhancing ecological products and promoting revitalization (Xiong et al., 2023a). Government initiatives, such as introducing leading enterprises and specialized technologies, are also crucial (Shen et al., 2022). In summary, rural industrial revitalization in karst regions is driven by the interplay of internal thrusts (ecological resources, tourism demand, farmer willingness) and external pulls (government policies, capital, industrial integration).

4.2.2 Using Actor-Network Theory, This Study Examines the Interactions and Connections Between Human and Non-Human Actors in Village Ecological Industry Development, Revealing Their Roles in The Process

The network management and development of the village industry are highly valued, including the stakeholder network (Junzi Chen and Dajun Liu, 2021; Kimbu and Ngoasong, 2013; Liang and Liu, 2023; Nogueira and Pinho, 2015; Wang and Li, 2021; Xin, 2023)、Rural e-commerce (Chen and Yu, 2019; Ye et al., 2021)、Village industry revitalization (Deng et al., 2023; He and Huang, 2021)、 rural tourism (Dedeke, 2017; Li and Zhang, 2019; Albrecht, 2013). Network interaction encourages collaboration, collaboration, partnerships and collective action (Albrecht, 2013). It can bring about a richer understanding (Erkuş-Öztürk, 2009)， And reduce the cost of

resolving conflicts between stakeholders (Erkuş-Öztürk and Eraydın, 2010). And reduce the cost of resolving conflicts between stakeholders. At present, scholars' research on village ecological industry mainly focuses on rural tourism (Xiang, 2021; You Zhou et al., 2023)、To achieve industrial revitalization (Wu et al., 2022)、And promoting interstakeholder cooperation (Arnaboldi and Spiller, 2011; Crick and Crick, 2020; Liu and Li, 2022; Ren et al., 2020). Ren et al (2022) used actor-network theory (ANT) to analyze how rural cooperatives in karst rocky desertification areas promote ecological industries, focusing on their formation and operational processes. Wang (2019) emphasized that sustainable rural renewal requires governance systems aligned with rural land resources, actor characteristics, and interaction dynamics, as misalignment can hinder revitalization efforts. Similarly, Li (2021a) highlighted the need for actor networks in ecological restoration projects, involving central and local governments, households, ecosystems, enterprises, NGOs, and scientists. Studies consistently demonstrate that ANT effectively examines stakeholder collaboration and its impact on industry development.

4.3 Key Scientific Problems and Prospects to be Solved

4.3.1 Boost Rural Ecological Industries by Introducing Talent, Transforming Governance, and Integrating Urban-Rural Industries

The endogenous driving forces of rural industrial development include endogenous resources, organizational identification, and local participation, which are interconnected and iteratively updated to enhance rural value and promote high-quality industrial growth (Liang, 2022; Zhang, 2019). Currently, rural industrial development relies heavily on external interventions, such as government subsidies and financial incentives to attract capital (Luo et al., 2021). However, these measures often lack alignment with local contexts, leading to systemic challenges and a limited understanding of rural development patterns, resulting in an exogenous development model (Guo et al., 2012). In karst areas, labor loss hinders agricultural intensification and green land use, weakening the endogenous power of farming and cooperative development (Ren et al., 2020; Zhang et al., 2023).

To advance ecological industries in rocky desertification control areas, it is essential to leverage endogenous development by transforming government roles, empowering rural elites, aligning industries with local resources, exploring traditional governance systems, and fostering stakeholder collaboration to achieve sustainable industrial revitalization.

Figure 8. Karst villages are typical mountainous terrain, villagers rely on the mountains to eat -the mountains, the development of ecological industries around the settlement near the geological and geomorphological limitations of the industry endogenous vitality is poor

4.3.2 Aiming at The Problem of Unclear Driving Factors, The Driving Mechanism of The Ecological Industry to Industrial Revitalization in Karst Areas Is Studied

Xiong et al (2023b) pointed out that in the future, it is necessary to focus on the development and management of ecological products for rocky desertification control and the driving mechanism of the formation of regional ecological industries. At present, the relevant research mostly discusses the driving mechanism of the rural ecological industry itself, or focuses on the driving mechanism of the promotion of economic development, and discusses the driving mechanism of the revitalization of the rural ecological industry to the rural industry, Xiang (2021) studied the driving mechanism of rural tourism driving rural revitalization and believed that rural ecology, life, production, culture, human resources and organizational tourism resources are the driving force of rural revitalization. This study provides some ideas for this paper, but the research is not systematic enough.

4.3.3 Targeted Critical Issues of Existing Rural Community Networks with Weak Subgroup Relationships and Lack of Attention for Nonhuman Actors. Strengthen The Social Network Within the Community, and Promote the Sustainable Development of Ecological Industry in Karst Areas

Existing rural industries face challenges due to weak community subgroups, hindering the development of community-based ecological industries (Tridakusumah et al., 2022). Previous studies in sociology have focused on how rural social relationships ensure production (Fu et al., 2019) or examined local enterprises through economics and management perspectives (Chen et al., 2021). However, most research emphasizes single subjects, such as village collectives, with insufficient attention to the roles of different rural actors, including farmers (Chen, 2022). There is also limited exploration of subgroup dynamics, individual roles, and nonhuman actors within rural communities. In karst areas, rural communities are often isolated in remote mountains with poor transportation, leading to weak social ties and low trust in collective entities. Driven by self-interest, locals often adopt a passive or skeptical stance toward external actors like enterprises. To address this, it is crucial to strengthen social networks, coordinate stakeholder interests, and integrate participants with social and material resources. Quantifying the structural and individual characteristics of ecological industry development can promote its sustainable growth in karst regions.

4.3.4 Given the Regional Inapplicability of Top-Down Government-Led Governance Mode, The Rural Governance Mode Should Be Adopted According to Local Conditions; Due to Insufficient Social Capital and Excessive Dependence on Government Resources, The Mechanism to Encourage Rural Stakeholders and The Farmers to Reduce the Government-Led Governance Mode

The government-led governance model, relying on mandatory public power, often conflicts with personal interests and rights, leading to farmer reluctance and social tensions, hindering sustainable rural revitalization (Liu, 2022). Strict ecological and food security policies further exacerbate livelihood risks for farmers who lose land without alternative options. In karst rocky desertification areas, ecological restoration projects and poverty alleviation relocation policies have accelerated labor loss and village hollowing, severely depleting social capital (Li, 2022). To address this, industry development should prioritize horizontal network structures and stakeholder participation, increase investment in rural collective action, and respect local actors' roles. Shifting from government dominance to a self-organized governance model, with government support, can promote sustainable rural revitalization in these areas.

5. Conclusion

This paper systematically reviews the progress of research on village eco-industry and rural industrial revitalization. Studies in this field are growing, with a focus on coastal regions in Asia, North America, and Africa, particularly in China, the United States, and India. Most research is conducted by universities and research institutes in these countries, covering topics such as indicator systems, influencing factors, driving mechanisms, and strategic approaches. Based on the analysis, eight key scientific and technological issues are identified to guide future research. Current studies lack a comprehensive theoretical framework, with underdeveloped methodologies and reliance on quantitative evaluations using existing models, often lacking innovation and relevance.

Future research should: (1) Strengthen theoretical and methodological studies, compare eco-industry development across regions, and construct a robust evaluation index system. (2) Investigate the unique formation mechanisms of different types of village eco-industries, considering their distinct obstacles and system interactions. (3) Develop a mature quantitative framework for rural industrial revitalization, refining weight determination and indicator selection. (4) Analyze the synergistic effects of industrial subjects and external resources to reveal the mechanisms of rural industrial revitalization. (5) Deepen research on the driving mechanisms of village eco-industries, including factor identification and indicator system construction. (6) Explore governance models suitable for local industrial development, addressing the limitations of top-down government-led approaches. Addressing these challenges is crucial for advancing research on eco-industry and rural revitalization in rocky desertification areas.

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