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Energy Literacy of Residents in Rural Communities: Comparison of Tourism and Non-Tourism Villages

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Abstract: Energy is an essential topic owing to the severe environmental problems faced worldwide, especially in underdeveloped rural areas. Energy literacy is closely related to energy consumption and conservation behaviors in daily life. Although the energy attitudes and behaviors of communities can determine the sustainable development of rural tourism, less attention has been paid to the energy literacy of rural communities. This study adopted a measurable scale to compare the energy literacy levels between 188 questionnaires from rural residents in tourism communities and 195 questionnaires from non-tourism communities both in the Jizhou District, China. A theoretical model was constructed to investigate the relationships between the variables. Additionally, this study verified the influence of rural tourism activities on communities' energy literacy by comparing different villages. The results showed that rural communities have high levels of energy literacy in the knowledge, attitude, and behavioral sectors. Positive relationships between knowledge and attitude and between attitudes and behaviors were estimated. However, the positive impact of knowledge on behavior was inconspicuous. The most important theoretical contribution of this study is the confirmation of the significant differences in energy literacy between traditional and rural tourism destination communities, thus proving the improvement in communities' energy literacy induced by tourism development. Finally, this study presents practical implications for policymakers.

Keywords: energy literacy; sustainable rural tourism; environmental awareness; rural community; environmental conservation

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1. Introduction

Energy is necessary for daily human life and works to enhance socioeconomic development [1,2]. With the growing consumption of energy, the shortage of energy and the radical damage to the climate caused by greenhouse gas emissions are pressing issues worldwide [3]. The concept of energy literacy is related to the United Nations' Sustainable Development Goal (SDG) 07 to "ensure access to affordable, reliable, sustainable and modern energy for all" [4]. As the "citizenship understanding" of energy that encompasses broad content knowledge as well as affective and behavioral aspects [5], energy literacy can induce thoughtful decisions and responsibility for the environment [6]. With the expectation of enabling people to engage in more appropriate energy-related behaviors, energy literacy has gained attention in the fields of education, economics, and psychology [1,7]. The energy literacy literature has a wide variety of definitions and approaches and remains a matter of debate [8]. Research in the field of tourism has highlighted the significance of energy literacy because of the intimate connection between tourism activities and energy consumption [9].

Rural tourism is generally considered to be closely linked to sustainable development [4,10–12] and refers to touristic activities focusing on the consumption of rural landscapes, villages and small towns, buildings and settlements, local people and families,

cultures, and experiences [13,14]. Owing to the positive impacts of enhancing the attractiveness and vitality of rural areas, mitigating demographic challenges, and alleviating poverty in rural regions [15–18], the meteoric growth of rural tourism has occurred in China in recent years [13]. Apart from the effects on the economic and social dimensions, the most negative effects on the environment have been seen as threats to the sustainability of rural tourism destinations [11,15]. The mass use of fossil energy sources in the transportation, catering, and accommodation sectors in rural tourism has been recognized as stimulating increased demand for energy, resulting in environmental pollution and degradation [19,20]. Promoting economic growth and reducing environmental damage in rural districts are emerging issues for both researchers and administrators. Some studies have investigated the impact of tourism development on economic growth and CO_2 emissions based on methods in the field of economic geography to provide implications for policymakers [17,19–22]. Tourists' sustainability awareness, attitudes, behaviors, and sustainable decision-making regarding rural tourism have also been discussed in the literature because tourists act as important stakeholders [10,20,23,24]. On the other hand, the importance of the destination community for the sustainable development of rural tourism has been ignored by scholars, while the involvement of the community is necessary to ensure efficient sustainable tourism development that accounts for environmental, socio-cultural, and economic interests [11].

Rural tourism is the most important industry in Jizhou District, which is located in the northernmost part of Tianjin, China, approximately 100 km from Beijing. Jizhou has a nearly thousand-year history, with extensive cultural heritage and abundant attractive natural landscapes, and traditional agriculture has long been the main economic sector. Jizhou District is characterized by a hilly landscape with abundant tourism resources concentrated in the north, whereas the southern area is dominated by a plain landscape that lacks attractions. Therefore, the development of rural tourism has led to very different socioeconomic conditions in the northern and southern Jizhou District. The first B&Bs, spontaneously established by villagers in Xiaying Village, Jizhou, in 1994 became a milestone for the development of rural tourism in northern Jizhou. After rapid development in thirty years, rural tourism has become the most important economic engine for Jizhou. According to statistics from the local department, Jizhou attracted 2.641 million tourists during the five-day holiday from 30 April to 4 May 2023 and generated 1.29 billion yuan in tourism revenue, an increase of 97.9% and 121%, respectively, compared with 2019 [25]. However, the residents of the villages in the plains of southern Jizhou District still depend on traditional agriculture as the basis for their livelihood. The differences between the northern and southern regions of Jizhou make it an ideal sample for observing the impact of rural tourism development on local communities by comparing the differences between different townships.

Community energy literacy is essential for sustainable rural tourism development. Local communities are key stakeholders in rural regions, and their participation in energy-related activities determines the achievement of sustainability [12,15]. This study aimed to examine the levels of energy literacy in rural communities and investigate the effect of rural tourism on communities' energy literacy. The contributions of this study are summarized as follows: (1) this study measures the energy literacy levels of rural communities. Most past studies focused on the energy literacy of students with limited household decision-making capacities. By taking the community as the object of this study, the investigation of the communities' energy knowledge, attitude, and behavior has practical significance for the environmental protection and sustainable development of rural tourism; (2) this study compares the differences in energy literacy between residents of tourism destination areas and traditional rural areas to discuss the role of rural tourism activities in the enhancement of energy literacy in the community; and (3) this study explores the relationship between energy knowledge, attitude, and behavior to provide theoretical contributions for sustainable rural tourism.

The rest of this paper is organized as follows: Section 2 presents a systematic review of energy literacy and sustainable rural tourism; Section 3 presents the methods; Section 4

presents the results of the quantitative methods; Section 5 presents the discussion; and Section 6 presents the conclusions and implications.

2. Literature Review

To better present the theoretical foundation, this study utilizes a knowledge graph to present research hotspots and trends in the literature. "Energy literacy" and "Sustainable rural tourism" were used as search topic words. The period was from January 1998 to July 2023. Finally, 402 articles on "energy literacy" and 700 articles on "sustainable rural tourism" were obtained. CiteSpace 6.2.R4 software was used to import data and display the knowledge maps of the keyword maps [26].

2.1. Energy Literacy

2.1.1. Distribution of Energy Literacy Literature

The annual distribution of publications and citations reflects the overall level, evolutionary trend, and development stage of the field [27]. This distribution identifies two stages: the steady phase (1998–2012) and the rapid phase (2013–2022), as shown in Figure 1. In the steady stage, there was a very low number of publications on energy literacy, with an average of four per year. However, rapid development occurred from 2013 to 2022 because of the increasing concern for energy problems.

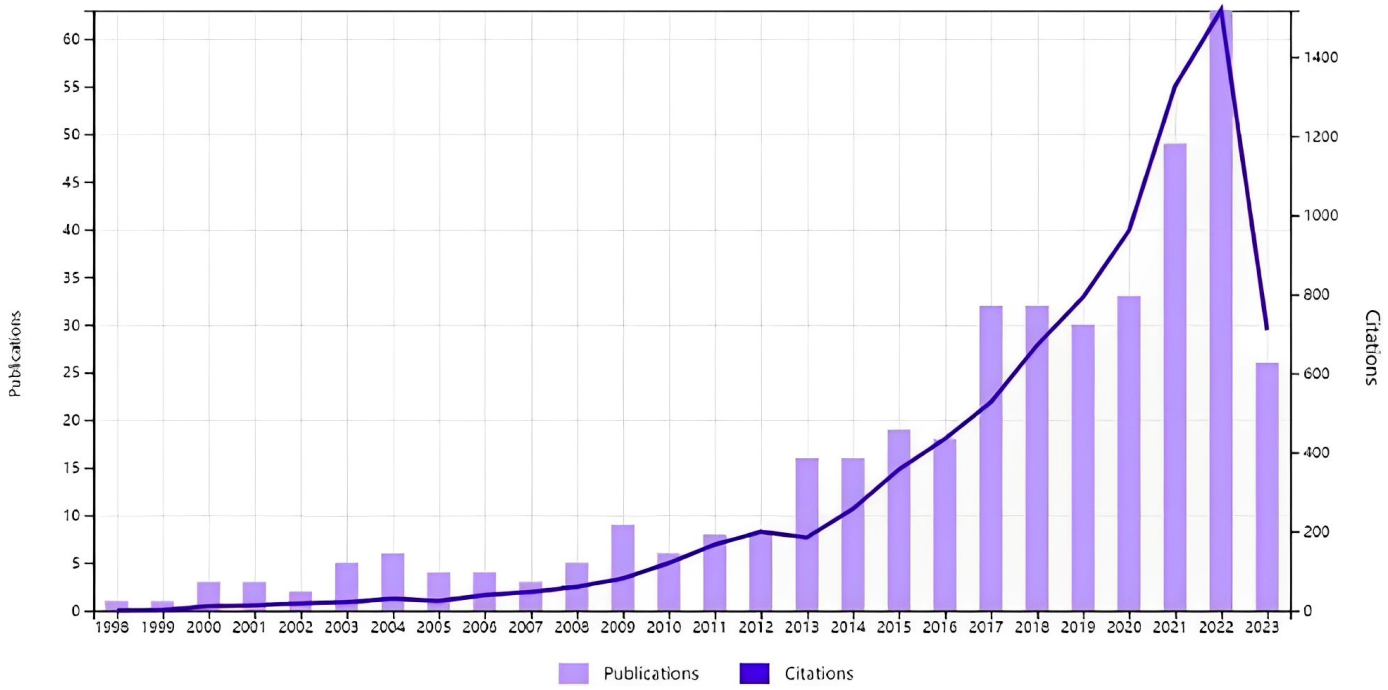

Figure 1. Annual distribution of published energy literacy literature from 1998 to 2023.

2.1.2. Research Hotspots of Energy Literacy Literature

This study adopted a co-occurrence analysis of keywords to reveal the hot research areas and frontier research topics in the energy literacy literature [27]. Following the co-occurrence analysis of keywords using CiteSpace 6.2.R4, the co-occurrence knowledge map with 271 nodes and 454 connections is presented in Figure 2. The five most frequently used keywords were literacy (F = 56, C = 0.07), energy (F = 41, C = 0.19), consumption (F = 37, C = 0.14), energy literacy (F = 36, C = 0.06), and health literacy (F = 29, C = 0.06). The five highest-frequency centrality keywords were education (F = 28, C = 0.26), energy (F = 41, C = 0.19), validation (F = 16, C = 0.18), energy efficiency (F = 16, C = 0.17), and children (F = 21, C = 0.16).

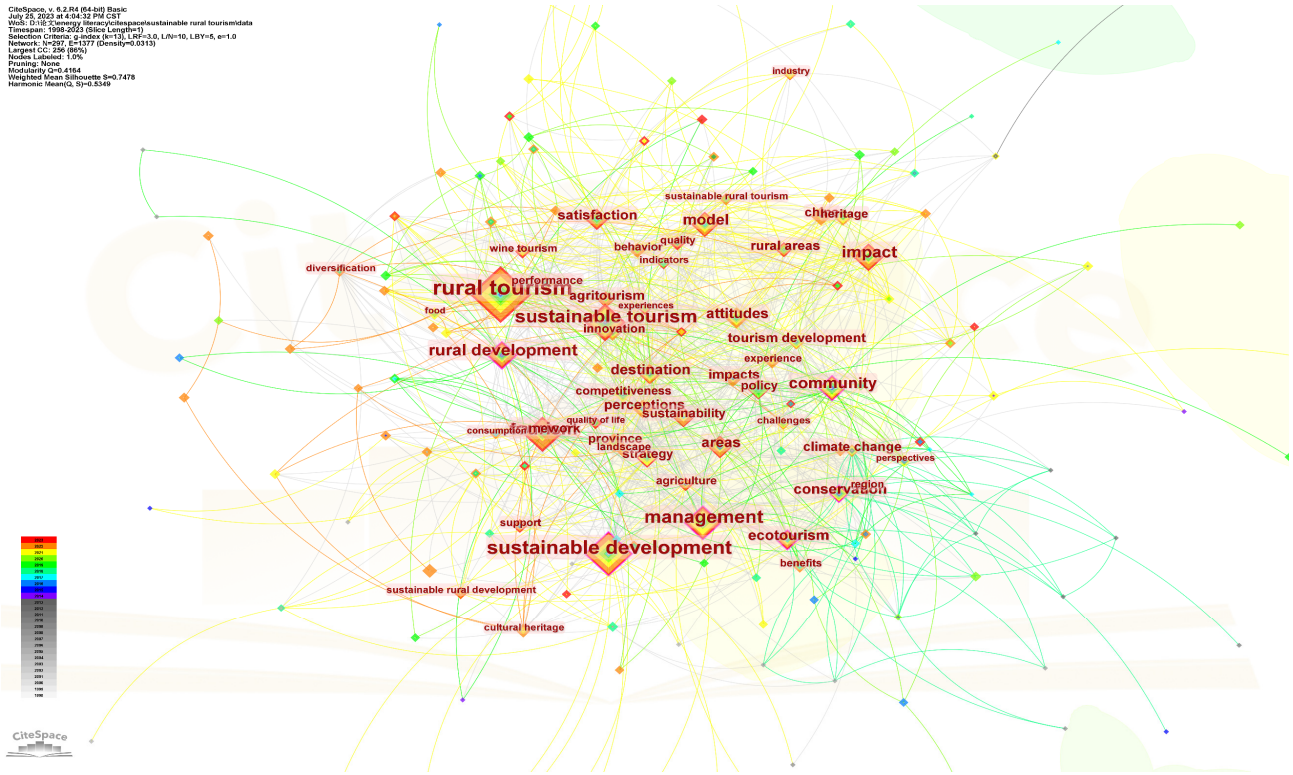

Figure 2. Visualization network map of the keyword co-occurrence analysis of energy literacy.

(1) Energy literacy and environmental education

Energy literacy is closely related to environmental literacy, which has been defined by the NAAEE as "the knowledge, skills, dispositions, and behaviors of students that enable them to make decisions and take action to address environmental issues" [7]. The literature on environmental literacy and energy education forms the basis for the definition of energy literacy [5]. University students [28–31] and middle-level education students have been the major research objects in the literature [3,7,32,33] because energy education in the existing school curricula is the best vehicle for promoting energy literacy [34]. Research goals usually include investigating the degree of energy literacy and identifying factors that contribute to students' energy literacy.

Barrow and Morrisey (1989) first defined energy literacy as energy-literate citizens caring about the need for energy conservation, searching for alternative forms of energy, and considering the impact of energy on the environment by using a Test of Energy Concepts and Values to compare the energy literacy of ninth-grade students in the USA and Canada [34]. DeWaters et al. (2013) defined students' energy literacy as their citizenship understanding of energy, including cognitive, affective, and behavioral items [33]. Based on the definition of energy literacy as "a broad term encompassing content knowledge and citizenship understanding of energy, which includes affective and behavioral aspects", Lee and Lee (2015) found that the performance of secondary students in Taiwan in energy knowledge was acceptable [3]. Martins et al. (2020) measured the levels of the energy literacy of members of Portuguese universities to understand the influence of education on levels of energy literacy. Students attending higher education courses had higher energy literacy levels [31]. Energy literacy was measured by Cotton and Zhai et al. (2021) to compare the significant differences between the energy literacy of university students in the United Kingdom and China, and the results showed that energy education and curriculum development efforts generated more energy-literate students [30].

In conclusion, most studies have demonstrated the importance of energy education in improving students' energy literacy. However, students, including college and middle-

level education students, lack practical involvement in energy consumption decisions. In addition, the community as a household practitioner has received little attention.

(2) Measurement of energy literacy

Apart from the close attention paid to the effects of energy education, the development and application of energy literacy scales are also important in the literature to investigate the levels of energy literacy.

The Test of Energy Concepts and Values consisting of thirty-nine attitude items and thirty-five knowledge items is the basic tool for measuring energy literacy as adopted by Barrow and Morrisey (1989) [34]. The Energy Literacy Questionnaire developed by DeWaters and Powers (2011) contains three subscales: cognitive, affective, and behavioral [35]. However, the measurement scale was changed into four domains, including knowledge, cognitive skills, affect, and behavior, by DeWaters and Qaqish et al. [33].

Lee and Lee (2015) designed an instrument for measuring secondary students' energy-related knowledge, affect, and behavior, which were found to be influenced by age, gender, family income, and parents' highest educational level [3]. Akitsua et al. (2017) also constructed an assessment questionnaire consisting of 73 items on three subscales of cognitive, attitudes, and behavior and indicated that female students scored higher than males on the cognitive and self-efficacy subscales [36]. Zhang and Zhang (2020) designed a detailed questionnaire including 32 items consisting of three subscales of knowledge, affect, and behavior to define and investigate the energy literacy of peasant households and to indicate the correlations between the three domains and the predictive variables in rural tourism destinations [2]. Similarly, Sayarkhalaj and Khesal (2022) conducted a study to investigate the levels of energy literacy among the citizens of Mashhad using a questionnaire containing knowledge, attitude, and effectiveness towards energy and claimed that a significant and direct relationship exists between all variables [37].

Most instruments were developed based on the theoretical frameworks of DeWaters and Powers (2011), Lee and Lee (2015), and Teng et al. (2014) [38]. Although the dimensions of energy literacy have not been uniformly identified in the literature, the main scales contain three domains: knowledge, attitude (affect), and behavior.

(3) The relationships between knowledge, attitude, and behavior

The relationships between dimensions of energy literacy have gained much attention from researchers. Sayarkhalaj and Khesa (2022) found that there is a significant and direct relationship between knowledge and energy consumption behavior as well as between attitude and behavior. The positive relationship between the knowledge of energy consumption and attitude has also been proved [37]. Zhang and Zhang (2020) underlined the significant correlation between knowledge, affect, and environmental behavior [2]. Martins et al. (2020) pointed out a positive correlation between attitude and behavior [28]. Białynicki-Birula, Paweł et al. (2022) revealed that a statistically significant impact of general knowledge on behavior exists [29]. The indirect effect of responsibility on energy-saving behavior through energy-use conscious behavior was tested by Akitsua, Y. et al. (2017). Lee, L. et al. (2015) contrasted that energy saving behavior was more predictable by affect than by knowledge [3]. In conclusion, the three dimensions of energy literacy were positively related.

According to the related research, the relationships between the knowledge, attitudes, and behaviors of rural communities were examined by the following hypotheses according to the existing literature:

(1) H1: Knowledge positively affects attitudes.
(2) H2: Attitude positively impacts behavior.
(3) H3: Knowledge positively impacts behavior.

2.2. Sustainable Rural Tourism

2.2.1. Distribution of Sustainable Rural Tourism Literature

A total of 700 publications on sustainable rural tourism from the WOS showed a general growing trend. These three stages can be identified from the annual distribution shown in Figure 3. From 1998 to 2013, the number of studies remained steady and low, followed by a rising tendency from 2004 to 2007, forming a growing stage. Subsequently, significant advancements appeared from 2019 to 2022, showing a sharp increase. It can be concluded that the field of sustainable rural tourism is gaining increasing attention from researchers, presenting its importance to rapidly increasing energy consumption and environmental damage.

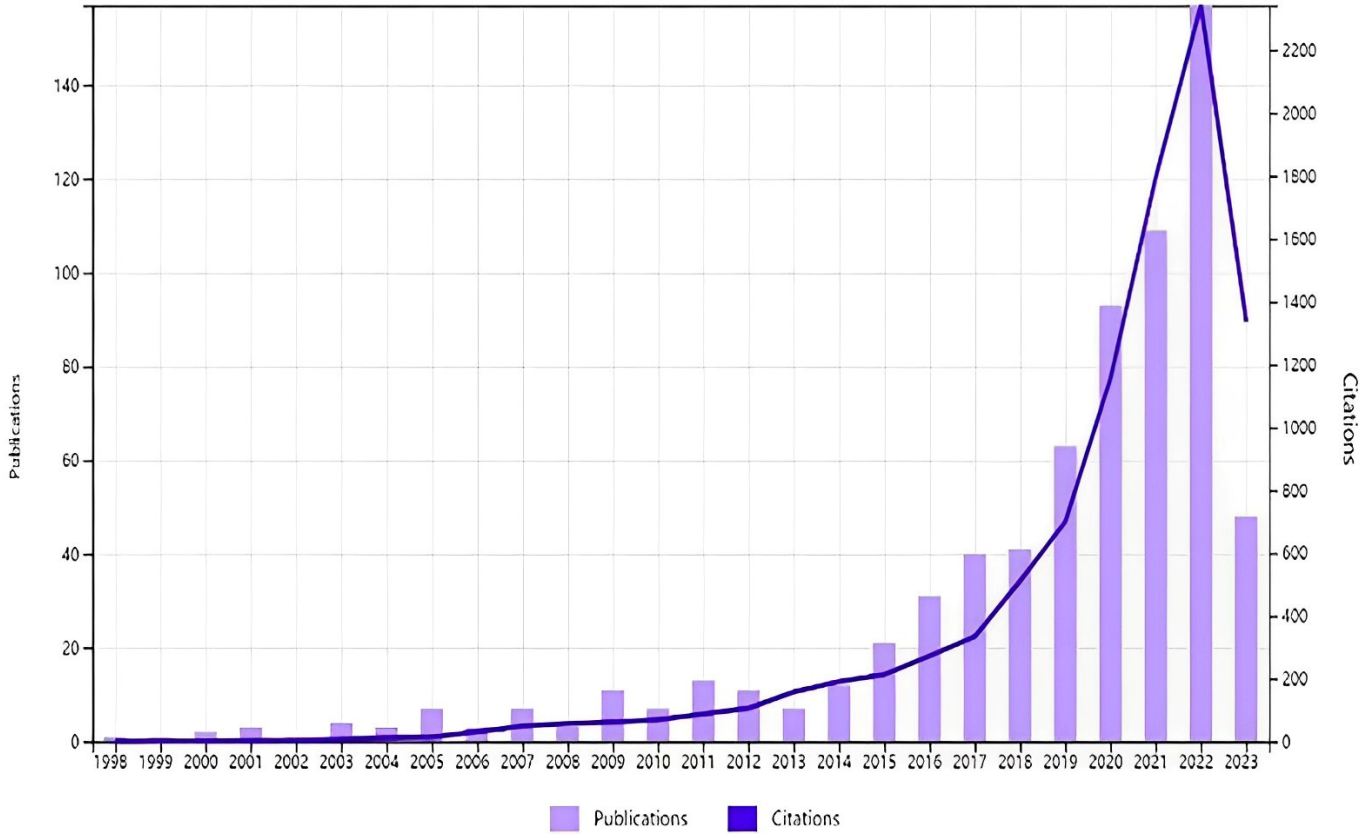

Figure 3. Annual distribution of published sustainable rural tourism literature from 1998 to 2023.

2.2.2. Research Hotspots of Sustainable Rural Tourism Literature

Keyword analysis is appropriate for identifying popular research domains and research hotspots. This study adopted a co-occurrence analysis of keywords to provide a knowledge map of the sustainable rural tourism literature. A total of 297 nodes and 1377 connections with a network density of 0.0313 are shown in Figure 4. The five keywords with the highest frequencies were rural tourism (F = 156, C = 0.06), sustainable development (F = 102, C = 0.16), sustainable tourism (F = 74, C = 0.04), management (F = 69, C = 0.1), and rural development (F = 42, C = 0.16). The five keywords with the highest frequency centralities were rural development (F = 42, C = 0.16), sustainable development (F = 102, C = 0.16), community (F = 35, C = 0.13), conservation (F = 25, C = 0.1), and ecotourism (F = 27, C = 0.1). Based on frequency and centrality, three research hotspots were identified: environmental conservation, community, and sustainable development.

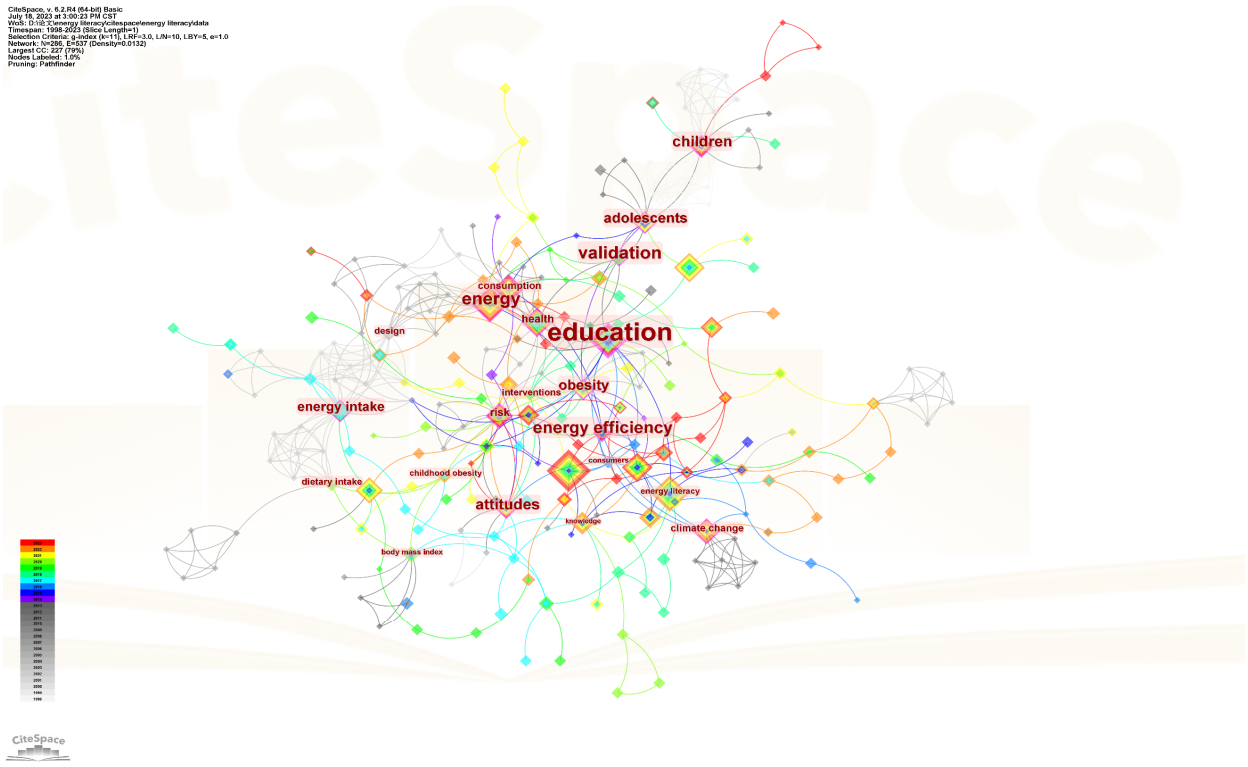

Figure 4. Visualization network map of the keyword co-occurrence analysis of sustainable rural tourism.

Community is the local residents living in tourism destinations [39]. The development of rural tourism has comprehensive impacts on local residents. On the one hand, tourism in rural regions has a positive impact on the economies of destination areas by generating more income and employment opportunities, thereby reducing rural poverty and enhancing investments [4,16]. Moreover, the diversity of residents' livelihoods was found to have improved, as well as their overall livelihood sustainability [16,18]. On the other hand, the negative effects of rural tourism have been perceived in the natural environment and social culture of rural communities, with an inburst of a massive number of visitors [4,16,39]. Thus, communities are important stakeholders at local destinations. Community-based tourism emphasizes the involvement of the community as a key factor in achieving sustainability [15]. To achieve sustainability of rural tourism, their attitudes toward and participation in tourism activities as well as their support directly affect its evolution [4,11,40]. Zhu et al. (2021) suggested that generating traditional ecological knowledge and developing hands-on educational systems are important for indigenous communities [41]. Muresan et al. (2016) proposed that enhancing residents' awareness of natural environmental conservation is important for sustainable development [11]. Nevertheless, how communities participate in sustainable rural tourism has not been sufficiently discussed because they seldom have control over the planning and management practices of rural tourism [18].

Based on the negative effects of tourism on the natural environment, researchers have reached several nearly uniform conclusions. The increased number of tourists can bring rapid infrastructural expansion, such as resorts, which can damage the ecological equilibrium [13,15,21]. In addition, tourism-related energy consumption such as fossil fuels in the sectors of transportation, catering, and accommodation is also likely to generate environmental pollution and degradation in developed and developing countries, as tourism accounts for approximately 8% of global CO_2 emissions [17,19,20,42]. With an increase in the waste and pollution from tourism activities, environmental damage to both the natural landscape and biodiversity capability occurs in rural regions, especially

those that mainly depend on traditional agricultural production before the development of tourism [4]. In addition to the impacts of tourism on the destinations, tourists also change their behavior and plans for the duration of their trip according to the pollution levels of the rural areas. Reducing energy consumption, increasing the diversity of energy resources, and encouraging tourists to adopt more environmentally friendly behavioral modes are believed to be effective for environmental conservation [14]. Based on related discussions on environmental results, few studies have drawn attention to whether the practice of tourism activities has aroused changes in communities' environmental awareness and energy-related decision-making, which are critical for the sustainability of rural tourism.

In conclusion, residents of communities in rural areas, especially in rural tourism destinations, are among the most important stakeholders. Residents' pro-environmental behavior and support for energy policies can effectively guarantee the sustainable development of rural areas. On the other hand, the development of rural tourism has a positive impact on the economy and culture of rural areas. As the income level of the residents increases, the residents' literacy also increases. However, the existing literature rarely considers residents as the focus of sustainable rural tourism. This study argues that the development of rural tourism is beneficial to the improvement of the energy literacy of rural residents. Therefore, this study compares residents of rural tourism destinations with residents of non-tourism destinations to explore the impact of rural tourism.

3. Methodology

The following sections describe the methods and procedures for questionnaire design, data collection, and data analysis. The Jizhou District, introduced in this section, is the test context for this study. A non-parametric test was used to compare the differences between the energy literacy of communities in rural regions and rural destinations. Structural equation modeling (SEM) was used to evaluate the theoretical model of energy literacy. AMOS 22.0 was adopted to estimate the Path Coefficients and model fit.

3.1. Questionnaire Design

An energy literacy scale was adopted to examine the energy-related knowledge, attitudes, and behaviors of rural communities based on Zhang and Zhang (2020), Lee and Lee et al. (2015), Bodzina and Fua et al. (2013), and DeWaters et al. (2013). The behavioral construct was measured using 10 items based on those used by Zhang and Zhang (2020) and Bodzina et al. (2013). For the attitude subscale, 10 items were used based on those used by Zhang and Zhang (2020), Bodzina and Fua et al. (2013), and DeWaters and Qaqish et al. A total of 12 items were adopted to measure the behavioral dimension by Zhang and Zhang (2020) and Bodzina et al. (2013). All 32 items were measured on a seven-point Likert scale. After the primary questionnaire was designed, a pilot test was conducted from 25 March 2023 to 15 April 2023, and a total of 59 questionnaires were collected to test and confirm the reliability and validity. After analyzing item-total correlations, reliability, factor loadings, and commonality, the items "We don't have to worry about energy problems because new technologies are being developed to solve them for future generations" and "I usually use public transport (buses, metro, scenic buses) rather than my own car" were excluded because the values of the Corrected Item-Total Correlation (CTCI) were below 0.5. Therefore, a formal questionnaire with 30 items was retained.

3.2. Data Collection

The data collection for this study was conducted in two stages. First, from 25 April to 5 May 2023, villagers in Chenmaozhuang Village, Xiaowangzhuang Village, and other villages in the southern plains of Jizhou District were selected and visited using convenience sampling methods, and 230 questionnaires were distributed, of which 188 were valid (Sample 1, n = 188). In the second stage, 250 questionnaires were distributed to residents in B&Bs, hotels, restaurants, and scenic spots in rural tourism destinations such as Guojiagou Village and Xijingyu Village in the northern mountainous area of Jizhou District from

6 to 30 May 2023, of which 195 questionnaires were valid (Sample 2, n = 195). For the convenience of the study, we formed Sample 3 by adding Sample 1 and Sample 2 together, and we introduced the demographic characteristics of Sample 3, which was used for SEM verification. A total of 480 questionnaires were distributed during the two data collection phases, with 383 valid questionnaires and an effective response rate of 75% (Sample 3, n = 383). Table 1 presents the participants' socioeconomic and demographic characteristics. Among the respondents, 46.8% were male, and 53.2% were female. Most participants were older than 30 years (69.4%). Their educational levels were relatively low, with more than half of them having a below-college degree as their highest level of education. The income levels of the respondents were relatively evenly distributed. According to the distribution of the rural tourism sectors, the participants were mainly employed in accommodation and attractions.

Table 1. Socio-economic and demographic characteristics of the participants (Sample 3).

Variables	*n*	%	Variables	*n*	%
Gender			**Monthly income (RMB)**		
Male	125	46.8	Below 1000	51	19.0
Female	142	53.2	1001~3000	64	23.8
Age			3001~5000	64	23.8
Under 18	23	8.7	5001~10,000	64	23.8
19~24	12	4.3	More than 10,000	13	4.8
25~30	47	17.4	**Whether engaged in tourism**		
31~40	82	30.4	Yes	165	43.1
41~50	47	17.4	No	218	56.9
Over 50	58	21.7	**Tourism-related sectors**		
Education			Accommodation	39	23.8
Junior high school and below	129	47.8	Transportation	31	19.0
High school/technical school	70	26.1	Catering	24	14.3
College	47	17.4	Attraction	63	38.1
Undergraduate	12	4.3			
Master and above	12	4.3			

3.3. Data Analysis

The Spss26.0 software was used for the descriptive statistical analysis and Cronbach's alpha coefficient analysis of 29 items in three dimensions: knowledge, attitude, and behavior. A non-parametric test was also investigated using Spss26.0. Then, AMOS 22.0 was used to conduct confirmatory factor analysis (CFA), and SEM was used to verify the research hypotheses proposed above.

4. Findings

4.1. Descriptive Statistical Analysis

The communities' performances on the three subscales of energy literacy were presented using descriptive statistical analysis (details in Table 2) with the mean and standard deviation values of each item. According to the knowledge domain, communities from traditional rural areas (Sample 1) agreed that saving energy is the most cost-effective way to solve the problem of energy shortage and agreed the least on the use of energy in rural tourism development. Communities from rural tourism destinations (Sample 2) agreed the most on the importance of energy consumption to society and the least on the use of energy in rural tourism development as traditional regions. Both samples exhibited relatively low fossil fuel energy scores. It can be concluded that, compared to destination communities, traditional rural communities mainly care about saving energy instead of acquiring more knowledge about energy. Despite the differences in knowledge between the two samples, both obtained the highest scores on the importance of saving energy and the lowest scores on the individual's role in addressing current environmental problems, referring to the energy attitude domain. They also agreed the most on switching off lights when leaving

a room and the least on reducing the frequency and duration of showering to save water, referring to the energy behavior domain.

Table 2. Descriptive statistical analysis of energy knowledge, attitude, and behavior.

Construct	Number	Question Items	Sample 1 (n = 188)		Sample 2 (n = 195)		Sample 3 (n = 383)	
			Mean	Std.	Mean	Std.	Mean	Std.
Knowledge	K1	I know about the definition of energy (electricity, water, gas)	3.46	1.18	4.08	0.89	3.78	1.09
	K2	I know about the types of fossil fuel energy	2.91	1.26	3.63	1.10	3.28	1.24
	K3	I know about the types of renewable energy sources	3.33	1.22	3.79	0.99	3.57	1.14
	K4	I know about the main ways of producing electricity	3.36	1.22	3.98	0.91	3.68	1.12
	K5	I know about the energy efficiency Index of electrical appliances	3.29	1.18	3.62	1.04	3.46	1.13
	K6	I am aware of the use of energy in rural tourism development	2.86	1.23	2.94	1.11	2.90	1.17
	K7	I know about the impact of energy consumption on rural tourism development	3.08	1.27	3.38	1.09	3.23	1.19
	K8	I know about the impact of energy consumption on the environment	3.78	1.16	4.05	0.91	3.93	1.05
	K9	I know about the importance of energy consumption to society	3.83	1.13	4.29	0.81	4.06	1.01
	K10	I know about that saving energy is the most cost-effective way to solve the problem of energy shortage	3.79	1.10	4.03	1.00	3.91	1.06
Attitude	A1	I believe that people have a responsibility to take control of their energy consumption and change their habits to minimize waste.	4.35	0.89	4.38	0.77	4.36	0.83
	A3	I would prefer appliances that are more energy efficient but more expensive (e.g., fridges, air conditioners, etc.).	3.27	1.09	3.79	1.06	3.53	1.10
	A4	I think I can help solve energy problems by working with others.	3.56	1.06	3.92	0.94	3.75	1.02
	A5	I think it is important to save energy	4.64	0.70	4.49	0.72	4.56	0.72
	A6	I think the way I use energy can make a difference to current environmental problems	3.24	1.07	3.71	1.01	3.48	1.07
	A7	I would do better if I knew how to save energy	4.06	0.96	4.20	0.80	4.13	0.89
	A8	I would be happy to pay attention to energy use issues related to tourism.	3.55	1.13	3.95	0.94	3.75	1.06
	A9	I think the government should develop more ways to use renewable energy sources	3.96	0.95	4.35	0.64	4.16	0.83
	A10	I think the government should encourage the use of new technologies to improve energy efficiency	4.05	0.92	4.41	0.63	4.24	0.81

Table 2. *Cont.*

Construct	Number	Question Items	Sample 1 (n = 188)		Sample 2 (n = 195)		Sample 3 (n = 383)	
			Mean	Std.	Mean	Std.	Mean	Std.
Behavior	B1	I usually walk or cycle rather than travelling by car when the journey is very short.	4.35	0.86	4.19	0.81	4.27	0.84
	B3	I will save electricity by keeping the room temperature within reasonable limits (air conditioning, heating).	4.05	0.95	4.18	0.83	4.12	0.90
	B4	I will reduce the frequency and time of showering to save water.	3.41	1.29	3.47	1.12	3.44	1.21
	B5	I usually unplug electrical appliances that are not in use at the moment (chargers, TV, microwave, etc.)	3.93	1.15	3.77	1.09	3.85	1.13
	B6	I usually switch off the lights when I leave a room.	4.39	0.83	4.31	0.80	4.35	0.82
	B7	My family and I use more environmentally friendly gas and appliances for cooking	4.02	0.89	4.10	0.87	4.06	0.89
	B8	I actively buy more energy efficient products	3.83	0.97	4.13	0.79	3.98	0.90
	B9	I often encourage others to save energy	3.74	1.15	3.95	0.85	3.85	1.02
	B10	I often encourage my family to buy energy efficient appliances	3.72	1.14	4.02	0.81	3.87	1.00
	B11	I Know exactly how much I spend on household energy consumption (water, electricity, gas, etc.)	3.53	1.198	3.80	1.03	3.67	1.13
	B12	I usually separate my rubbish and recycle cans, paper, plastic bottles, etc.	3.83	1.11	3.77	1.06	3.80	1.09

4.2. Non-Parametric Test

This study adopted the method of a non-parametric test to compare the scores of items referring to the energy knowledge, attitude, and behavior domains between the two samples based on the group of "whether engaged in the tourism industry". The results showed significant differences in the knowledge and attitude dimensions, whereas the behavior domain showed no significant differences. Combined with the results of Tables 3 and 4, the levels of energy knowledge and attitudes of communities in rural tourism destinations were significantly higher than those of communities in traditional rural regions. However, their energy behavior performance tended to converge.

Table 3. Empirical result of measurement model (Sample 3).

Construct	Number	*p*-Value	Factor Loading	*p*-Value	α	CR	AVE
Knowledge	K1	0.00	0.70	0.00	0.91	0.93	0.56
	K2	0.00	0.76				
	K3	0.00	0.80				
	K4	0.00	0.79				
	K5	0.00	0.72				
	K6	0.46	0.72				
	K7	0.03	0.73				
	K8	0.07	0.79				
	K9	0.00	0.74				
	K10	0.03	0.72				
Attitude	A1	0.80	0.63	0.00	0.82	0.89	0.47
	A3	0.00	0.52				
	A4	0.00	0.69				
	A5	0.00	0.57				
	A6	0.00	0.68				
	A7	0.29	0.77				
	A8	0.00	0.75				
	A9	0.00	0.79				
	A10	0.00	0.75				
Behavior	B1	0.02	0.61	0.17	0.91	0.92	0.51
	B3	0.21	0.74				
	B4	0.87	0.66				
	B5	0.08	0.69				
	B6	0.14	0.66				
	B7	0.36	0.78				
	B8	0.00	0.81				
	B9	0.18	0.81				
	B10	0.02	0.82				
	B11	0.03	0.66				
	B12	0.47	0.69				

If $p < 0.05$, the difference is statistically significant.

Table 4. Structural path model hypothesis test.

Hypotheses	Path	Path Coefficients	*t*-Statistic	R^2	Conclusion
H1	Attitude ← Knowledge	0.676	8.512	0.372	supported
H2	Behavior ← Attitude	0.769	7.333	0.498	supported
H3	Behavior ← Knowledge	0.051	0.859		unsupported

4.3. Construct Reliability and Validity Testing

This study proposes a model to evaluate the relationships among energy knowledge, attitudes, and behavioral dimensions. CFA was used to assess the model using AMOS 22.0 to estimate the three factors of the 30 items. The analysis showed that the factor loadings of all measured variables on the latent variables were greater than 0.5, indicating a good fit of the measurement model. Table 3 presents the Cronbach's alphas of the three factors, which range from 0.82 to 0.93, and the composite reliability, which ranges from 0.89 to 0.93. These exceed 0.7 and thus show an acceptable reliability of the internal consistency of the constructs. Moreover, all dimensions have an average variance extracted (AVE) above 0.40, which meets the recommended value suggested by Fatma et al. [43].

4.4. Measurement Model

This study explored the fit of the path and measurement models to the hypotheses. The results showed that the model had a good fit (χ^2/df = 2.698, GFI = 0.902, NFI = 0.901, IFI = 0.912, TLI = 0.889, CFI = 0.901, RMSEA = 0.066).

4.5. Path Analysis

Results from the path analysis show that knowledge significantly affects attitude, and attitude significantly affects behavior. Table 4 presents the results of the path coefficient and hypothesis testing. The positive relationship between knowledge and attitude (H1: t = 8.512, $p < 0.001$) and that between attitude and behavior (H2: t = 7.333, $p < 0.001$) were supported. However, the positive relationship between knowledge and behavior was not statistically supported (H3: t = 0.859, $p > 0.01$), as shown in Figure 5.

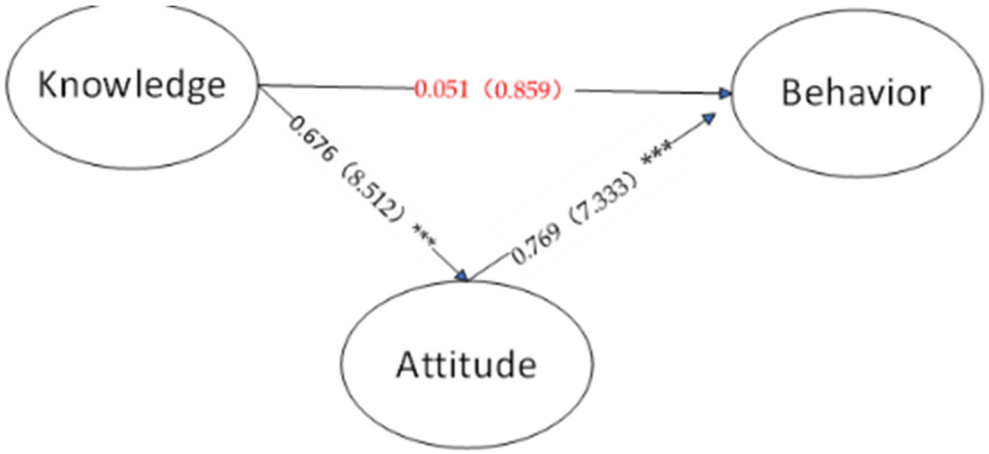

Figure 5. Results of hypothesis testing (*** $p < 0.001$. The numbers presented in the parentheses are the t-value. Red color means that $p > 0.01$).

4.6. Attitude as a Mediator

The indirect effect of knowledge on behavior was tested by a bootstrapping mediation analysis. The total indirect effect of attitude on the relationship between knowledge and behavior was 0.355. Tests of the indirect effect show the bias-corrected confidence intervals of [0.289, 0.419], as shown in Table 5, indicating that the indirect effect is present in the attitude as a mediator.

Table 5. The analysis of indirect effects.

Effects	Original Sample (O)	Sample Mean (M)	Bias	5.0%	95.0%
knowledge → Attitude → behavior	0.355	0.361	0.006	0.289	0.419

5. Discussion

This study examined the levels of rural communities' energy literacy, indicating that residents from both tourism areas and non-tourism villages both have high energy literacy. Additionally, this study verified the relationship between knowledge, attitude, and behavior, showing that attitude has a significant direct impact on behavior than energy knowledge. Moreover, the comparison of non-tourism rural areas and rural tourism destinations proved the impact of the development of rural tourism on community energy literacy.

The energy literacy of communities refers to their knowledge and awareness of energy resources and consumption behavior, which influences the sustainability of rural environments and the levels of support for government energy policies. The results showed that rural communities had high levels of energy literacy. In terms of energy knowledge,

residents generally recognized the environmental and social impacts of energy consumption and accepted the importance of energy conservation. The scores were lower for items of professional energy knowledge, such as the definition and types of fossil fuel energy and the energy efficiency index of electrical appliances. These results are consistent with Zhang and Zhang's (2020) investigation of the energy literacy of peasant households in rural tourism destinations in the Henan Province, China [2]. They designed a questionnaire to define and investigate the energy literacy of tourism peasant households and to indicate the predictive variables in rural tourism destinations. The respondents tended to self-report that they knew quite a bit about energy, which is consistent with the results of this study. The population structure in rural areas in China is dominated by the elderly, women, and children, who are less educated and lack professional environmental education owing to the underdeveloped economy. China is a relatively energy-poor country, and rural residents generally recognize energy conservation as an essential environmental component of sustainable rural development [11], which is a core element of the SDGs, encouraging conservation efforts [23].

According to the attitude domain, the community in rural regions generally approved of the government's important role in promoting the development and adoption of new energy technologies, apart from the awareness of an individual's responsibility to control their energy consumption and change their behavioral habits to minimize waste. However, they did not believe that their efforts could impact current environmental problems. Rural communities depend more on the government to play an active role in addressing environmental and energy issues because the government has genuine control over local planning and management practices [18].

In terms of energy behavior, the rural community self-reported high scores on items related to switching off lights when leaving, choosing green transport, and energy-efficient use of electric appliances such as air conditioning and heating. However, they strongly disagreed about reducing the frequency and time of showering to save water because most residents in the villages of Ijzhou District received free-living water provided by the village committee. It can be concluded that the energy behavior decisions of residents are more dependent on the financial cost of energy than on conscious implementation [2]. Perceived costs of energy have been recognized as having a negative relationship with support for sustainable tourism development [44].

This study further validated the relationship among energy knowledge, attitudes, and behavior. Through path analysis, significant positive relationships between knowledge and attitude and between attitude and behavior were verified; however, there was not a significant positive relationship between knowledge and behavior. This finding corresponds with the results of previous studies that show a closer correlation between affect and behavior than between knowledge and behavior. Zhang and Zhang (2020) demonstrated the relationship between the affective and behavioral subscales, rather than the cognitive subscale [2]. Lee et al. (2015) also confirmed a closer link between energy-related knowledge and affect than between knowledge and behavior [3]. However, Sayarkhalaj and Khesal (2022) found a significant and direct relationship between knowledge and energy consumption behavior in a sociological analysis of energy literacy among Mashhad citizens [37].

The present study investigated the impact of rural tourism development on communities' energy literacy by comparing the levels of energy knowledge, attitudes, and behaviors of residents from traditional rural regions and rural tourism destinations. The results showed that communities in rural tourism destinations had higher levels of energy literacy than those in traditional rural areas. Significant differences were mainly rooted in the knowledge and attitude domains. The energy behaviors of both subsamples showed small differences. In terms of knowledge, the destination residents scored significantly higher in the definition and types of energy than residents in traditional rural areas. Rural tourism has significantly improved the communities' energy knowledge. Moreover, the development of rural tourism has enhanced the awareness of energy conservation. Nonetheless, both destination communities and rural residents scored low in the behavior

of reducing the frequency of bathing and classifying garbage. Although the literature has investigated residents' energy literacy performance and highlighted the effect of ethnic residents' energy literacy on effective improvements in local energy use [1,2], the relationships between changes in communities' energy literacy and the development of tourism activities remained unclear. This study demonstrated the positive impact of tourism development in rural regions on residents' energy knowledge and attitudes.

6. Conclusions

Community energy is closely related to energy conservation for sustainable rural development [2]. This study used quantitative methods to measure the levels of energy literacy in rural communities and to verify the relationship between knowledge, attitudes, and energy behaviors. More importantly, this study compared communities' energy literacy among different villages in the same region to further explore the influence of rural tourism development on community energy literacy.

High levels of energy literacy in rural communities were confirmed using an energy literacy scale. Rural residents generally recognized the effects of energy consumption on the natural environment and society. They mainly adopted energy-saving behaviors, such as turning off lights, choosing public transport, and buying energy-efficient appliances, to practice their energy awareness in daily life. However, they were more dependent on policymakers to take action to develop new energy technologies to solve environmental problems. In addition, this study examined the positive relationship between energy knowledge and attitudes. The significant impact of attitude on behavior was also verified. The main contribution of this study is the verification of the improvement in the energy knowledge of communities due to the development of rural tourism by comparing residents of both traditional areas and rural tourism destinations. Overall, it has been demonstrated that destination residents possess higher levels of energy-related knowledge and attitudes than traditional rural communities. Thus, rural tourism positively affects the energy literacy of communities.

This study has two limitations. The relatively small sample size is one of the limitations of this study. Owing to the low level of education of rural residents, much time was needed to explain the purpose of the survey and the meaning of the items during the survey process, which increased the time cost of sampling and limited the sample size. The time of data survey was limited, and the researchers were not residents in the sample village and so were not familiar with the local residents. As a result, a great deal of time was spent building relationships with residents, resulting in a total of 383 questionnaires collected. In addition, this study lacks a description of the macroeconomic statistical data for destination regions making the practical condition of rural tourism destinations unclear. Future research can further verify the role of rural tourism development in promoting residents' energy literacy by adopting a panel data approach to the economic structure.

Rural tourism has attracted mass tourists to alleviate poverty, increase community income, and improve energy knowledge and awareness. Thus, rural policymakers should pay more attention to residents when promoting energy policies. Particularly, they should promote energy policies that are more closely related to daily energy consumption behaviors, such as the promotion of clean energy sources, establishment of centralized waste disposal facilities, and management of separate waste collection.

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