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Development of a smart tourism integration model to preserve the cultural heritage of ancient villages in Northern Guangxi

Wen Zhen Li[1] and Hong Zhong[2*]

Abstract

The modern rural areas represent a vulnerable category that is in special need of sustainable development these days. However, the practice shows that, in the twenty-first century, this sustainability can be assured through the construction of smart villages. The ultimate goal of this study was to create a model for the development of ancient Guangxi villages that will take into account the cultural and tourist dimensions and will be based on the Smart Village concept. Analysis of existing approaches to the implementation of the Smart Village initiatives as well as of regional and local regulatory documents in force allowed identifying key aspects (factors) in this respect. Local government officials, service providers, and local residents were surveyed, and the sample was 586 people. They were asked to rate the implementation in their village of key aspects of the Smart Village concept from 1 to 5 on a Likert scale (from "very bad" to "excellent"). According to the assessments collected, the top-rated and, accordingly, the most developed, was the Technological factor group, followed by the groups encompassing Culture and Tourism, then Economic, then Environmental, and Social factors. These data provided a good foundation for building a Smart Village-based model for the development of six ancient Guangxi villages, known for their unique cultural heritage (Xingping, Daxu, Huangyao, Jixiang, Fuli, and Longji Zhuang). In the future, it can be taken advantage of by government representatives and managers in respect to rural areas with conditions similar to those discussed within the limits of the current study (with certain regional adjustments).

Keywords: Cultural heritage, Economic growth, Guangxi ancient villages, Tourism development, Smart Village concept

Introduction

In recent years, art, food, fashion, music, tourism have become a driving force promoting the development of the "new economy" in many cities and regions. As a result, towns and rural areas in decline regained their viability and made the transition to this new economy type due to the creation of new tourist spots [1]. The People's Republic of China has as many as 220 ancient villages and towns with a history of over 100 years old. All of them are unique and have a deep cultural and historical heritage [2]. Rural tourism is a key driving force for rural revival and fight against poverty [3].

Historic villages have become attractive destinations for rural tourism, combining leisure, recreation, and education [4]. "Ancient town culture" is the deposition of natural features, morphological structure, cultural style, human resources, craft buildings, historical heritage, and landscape image that are unique to the development of towns [2]. Ancient villages are the carriers of traditional culture, lifestyle, and social ideology based on a specific economic and social structure. They represent the integration of humans and nature and the accumulation of history for thousands of years [5]. Consequently, the

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*Correspondence: zhonghong@gltu.edu.cn
[2] Rectors Office, Guilin Tourism University, 26#Liang Feng Rd., Guilin 541006, Guangxi, China
Full list of author information is available at the end of the article

ancient villages of China have become regions of tourism value and market importance, while rural tourism became a driving force for their sustainable development [6].

These days, rural areas are redefined as "places of consumption" where agricultural production, history, and traditions become the main elements of their identification and development [7]. Most cities and regions began to compete in the promotion of tourism [8–13].

By stimulating regional initiatives, the Administration of Cultural Relics of China designated the first group of historic and cultural villages, which reflect traditional features, local ethnic characteristics, and carry rich historical values or commemorative importance within certain historical periods [14]. In 2013, the Ministry of Agriculture launched the Beautiful Village Project to promote rural areas, which led to a socio-economic revitalization of the countryside, owing to the comprehensive development of production, life, and ecology [15]. Beautiful village construction has changed the traditional agricultural production structure, rural planning and layout, as well as rural culture and ecological environment. Thus, it remains an important part of Beautiful China construction [16], as well as a significant way to realize rural revitalization [17]. The development of "production, life, and ecology" during the construction of beautiful villages is equivalent to the integrated development of "production, village, and scenery" in which the "village and scenery" are the substantiation expression of the concept of "life and ecology" [18]. Under the stimulation of rural tourism, the rural area is no longer a simple material space but a social space with economic value [19]. Beautiful village construction is a typical example of China's rural revitalization strategy and is an important way to promote rural economic development, yet it is not the only way [20]. The construction of beautiful villages in China has effectively prevented the widening gap between urban and rural areas and alleviated the social crisis [21]. Nevertheless, it has not fundamentally established a benign interaction mechanism between urban and rural areas [22, 23].

The structure of the rural space and industrial relations enrich rural culture. Thus, the revitalization of the countryside is not only production environment optimization but also integrated development of "production, village, and scenery" [24]. Under the background of rural revitalization, the new integrated development mode is not isolated and is a mutually promoting symbiotic system. Based on the "production, village, and scenery," on the example of Qinganshu village, the AMD development model was proposed (Aims, Measures, and Demands) [19]. This model takes into account the diagnosis of the rural situation and combines the various elements of the village development. The model opens the prospect of maximizing the use of existing agricultural resources, the development of characteristic agriculture, and the integration of "production, village, and scenery" into the synergetic system [25]. The integrated development mode considers the happiness of residents, prosperity of industry, and beautiful environment as the criteria with which to evaluate the rural community construction [19].

The Smart City and Smart Village concepts imply new technological solutions and innovative approaches to planning, life support, and infrastructure development to increase the welfare of the population and ensure sustainable development [9, 26]. Originally, the idea of smart planning was elaborated for cities to solve emerging problems and improve their dwellers' life quality. However, over time it has moved to the provinces and villages [27]. The very concept of a Smart Village was first adopted in India [28]. Such models were a natural extension of the models developed for cities but implemented in more or less remote areas with allowances made for their regional characteristics—geographical location, recreational resources, cultural heritage, ethnic composition, and economic indicators. Nevertheless, while smart cities have similar problems (transport, management, waste, services), smart villages are more different in this respect. Some of them are characterized by developed tourism; others are economically supported by agriculture; still others suffer from natural disasters [9]. The basis for the implementation of Smart City and Smart Village concepts is information and communication technologies (ICT) [12, 29]. Though, apart from ICT, elements most frequently incorporated by the Smart Village model are governance, technology, resources, village service, living, tourism [26], energy, economy, people, and environment [9]. In the great scheme of things, the Smart Village model is the foundation allowing the full-fledged implementation of corresponding strategies [30]. In Europe, Smart Village initiatives are worked upon and realized by the Thematic Group of the European Network for Rural Development. It explores opportunities for the revitalization of rural areas through digital and social innovation, develops guidelines to facilitate the emergence and development of smart villages, acts as an information platform, and provides support to governing bodies [31–33]. In Indonesia, there are two considerable undertakings in the area. The first is the 100 Smart City movement developed in 2017 to implement the concept of Smart. The second, in turn, is represented by the Smart Kampung initiative (launched in Banyuwangi Regency) combining ICT, economic, healthcare, and education directions with poverty alleviation and serving as an example for other regions of Indonesia [26]. As for China, to achieve sustainable rural development through informatization and

smart initiatives, the country's government proposed the implementation of the Rural Revitalization Strategy (2017) and formulated the National Rural Revitalization Strategic Plan (2018–2022) and the Outline of the Smart Village Development Strategy (2019) [11].

To date, there are many theoretical studies and systematic reviews on smart villages, but the number of practice-oriented and well-reasoned studies is still not enough. Many scientific works have already taken a close look at the matters of the Smart Tourism Destinations initiative of the European Commission. What is more, the present study authors agree that tourism is the driving force of the economic development of certain areas (including the six Guangxi villages under study). However, at the same time, the authors see the need to analyze the development path of the selected villages more broadly than from the perspective of tourism alone. Therefore, this paper aims to create a model for the development of ancient Guangxi villages that will take into account the cultural and tourist dimensions and will be based on the Smart Village concept. For this purpose, several tasks are to be accomplished one by one:

– Analyze already existing approaches from previous studies to build similar models.
– Get acquainted with the current regulatory documentation.
– Determine the main components of the questionnaire for the survey of local residents.
– Summarize all the information obtained to build the final model for the development of ancient villages in northern Guangxi based on the Smart Village concept.

Methodology
Study area
Traditional villages of the northern part of Guangxi have unique historical features and cultural heritage, remaining an integral component of Chinese culture and art. For the present research, six ancient villages of Northern Guangxi, rich in tourist recreational resources and unique ethnic customs, were chosen. Among them are Xingping, Daxu, Huangyao, Jiuxian, Fuli, and Longji Zhuang villages (Fig. 1) [34].

Xingping Ancient Town is located on the east bank of the Li River, 63 km from Guilin, and 25 km from Yangshuo. Xingping attracts tourists with its famous landscapes, the preserved architecture of the Ming era, and the planning in accordance with strict Feng Shui rules. The highlights of Xingping Ancient Town include the Li River, landscapes of the Guilin Karst relief, an old fishing village, and the traditional ancient architecture of the Ming and Qing Dynasties.

Fig. 1 Ancient villages of Guangxi [34]

Daxu Ancient Town is located in the southwest of the Guilin region. The ancient settlement preserved samples of traditional Chinese architecture and flagstone streets. Along the Li River, old buildings, dated from the Ming and Qing periods, with decorated cornices and carvings on doors and windows are located. Among the must-visit highlights in Daxu Ancient Town are Wanshaw Bridge (Longevity Bridge), old dwellings of locals, flagstone roads, and a 100-year-old dock. Daxu Ancient Town, with its more than 1800 years of history, is the best of the four largest market cities in Guangxi Province.

Huangyao Ancient Town is situated in the northeast of Guangxi Zhuang Autonomous Region, on the lower reaches of Li River and 200 km from Guilin. The charm of Huangyao lies in the water cities of the Jiannan area in the Jiangsu and Zhejiang Provinces with the featured old houses, alleys, little bridges, and chanting streams crossing the town.

Jiuxian Old Town is located between Guilin and Yangshuo on the banks of the Yulong River. The main tourist attractions of the village are the Ancestor Hall of Li Family, the Guangxi oldest stone arch bridge (Xiangui Bridge), the idyllic sceneries of the Yulong River, and countryside life of Yangshuo people.

Fuli Old Town is 8 km away from Yangshuo in Guilin. Known as the "hometown of painted paper fans" in China, Fuli is one of the few best-preserved ancient towns in Guilin. People there still keep their traditional way of living. Fuli also preserves its unique old culture and the very primitive, though fascinating and mysterious, tribe culture of Nuo music, Nuo dance, and Nuo masks. The town is surrounded by mountains on three sides. To the north, the legendary Donglanshan Mountain is located.

Longji Old Zhuang Village is 100 km from Guilin. This village is famous for its colorful hills with rice terraces and the ethnic settlements of the Zhuang people. Longji Old Zhuang Village preserves the most extensive number of Diaojiaolou wooden houses and stone carvings that demonstrate the culture of the Zhuang ethnic group. Longji Rice Terraces (or Dragon Ridge Terraces) are located 27 km south of Longsheng Town. Layer by layer, they cover hills and mountains, resulted from the centuries-old agricultural activity of the Yao, Miao, and Zhuang peoples, whose culture and folklore are among the highlights of this region.

Research methods

To build a Smart Village model, the following steps were taken in accordance with the already described approach [26]:

– Literature review of similar studies touching upon the Smart Village topic.

– Analysis of existing regional and local regulatory documents and acts.
– Population survey.

For the study purposes, more than 200 scientific articles recently published in Scopus and Web of Science electronic databases, including in the journals of Springer Nature, Elsevier, IOP Publishing, IEEE, Emerald Insight, Wiley-Blackwell, and SAGE publishers, were analyzed for the "Smart Village" query. Of this number, 45 works were selected that, in the authors' opinion, most fully meet the goals and objectives of this research. They are mentioned in the list of references, with 11 of them directly related to the Smart Village concept [9, 11, 26, 27, 29, 30, 33, 35–39].

Within the next step, ISO 37122:2019 (Sustainable Cities and Communities-Indicators for Smart Cities) [40], National Rural Revitalization Strategic Plan (2018–2022), the Outline of the Smart Village Development Strategy (2019), and the information from Guangxi official website and Guangxi statistical yearbook were analyzed. This allowed identifying the main factors that were to be assessed by means of the questionnaire. Table 1 lists the literary sources from which the main groups of smart factors were taken. In the next study phase, they were evaluated through questionnaires.

The survey of local residents was conducted to obtain information on the level of economic development, technology, culture and tourism, environment, natural resources, and the social sphere of Xingping (n = 99), Daxu (n = 102), Huangyao (n = 95), Jixiang (n = 93), Fuli (n = 97), and Longji Zhuang villages (n = 100). Officials, service personnel (including those engaged in IT), as well as average local population were invited as respondents. The sample consisted of 95–102 people for each village (586 people in total), with 75–80% of the people being average locals and 20–25% being officials and service workers. Survey items were asked to be rated from 1 to 5 points on a Likert scale (from "very bad" to "excellent"). The wording of the items was exceptionally straightforward and implied respondents to rate the implementation

Table 1 Factor group in the context of the smart village, and the articles supporting the identification of the factor groups

Factor groups	The number of the article in the reference list
Technology	7, 9, 26, 27, 30, 35
Economic	7, 12, 29, 30, 32, 35
Cultural and tourism	3, 4, 7, 11, 19, 22, 26, 30, 37, 38
Environmental	12, 24, 27, 38, 39
Social	12, 7, 33, 35, 40

in their village of the Smart concept elements (hereinafter referred to as "factors") highlighted during the literature analysis. Those factors that were predominantly rated as "very bad" and "bad" were excluded from the analysis, so only the answers starting from 1173 points (1173–1758—gradations "average", 1759–2344—"good", and 2345–2930—"excellent") were considered.

The total score by factor S_f for six villages is calculated by the formula:

$$S_f = \sum_{n=1}^{6} f_n \tag{1}$$

where, f_n – a score for factor f in each village.

Group average (GA) is calculated as the average between the number of factors m in the group:

$$GA = \frac{1}{m} \sum_{i=1}^{m} S_{fi} \tag{2}$$

Results

The conducted literature analysis enabled the conclusion that the use of ICT can sustain and notably improve rural services, but this requires policy reforms and legislative initiatives, as well as action-oriented proposals from governing bodies and all the stakeholders. The driving force of the Smart Village concept lies in the fact that novel technologies should catalyze the development of the village, opening up opportunities for local businesses, bettering health and well-being, and promoting democratic participation in the life of the village and overall advancement of residents' lives.

The survey outcomes unveiled that the technological factor group is of the highest weight within the six villages studied. The next most popular groups were Cultural and Tourism and Economic, followed by Environmental, and the Social group had the lowest points.

See Appendix 1 for a complete table of respondent scores from each village for each factor.

Calculations for the other groups are made in the same way. The results for each of the factor groups are summarized in Tables 2, 3, 4, 5, 6. The first column shows the factor, the second the explanation for it, the third—the total score by factor for 6 villages by the formula (1), the fourth the sample variance (D), and the fifth the standard deviation (SD). The group average was calculated by the formula (2). The variance and standard deviation are also given for the 6 villages, but for the group of factors as a whole.

Table 2 Technology factor group

Factor, f	Description	S_f	D	SD
Internet Availability	Use of broadband, 4G networks, digital television	2457	9395	96.93
IT infrastructure	Transformation of rural infrastructure towards smart technologies (smart water conservancy, smart transportation, smart agriculture, and smart logistics) and the level of IT service	2365		
Suitability of technological services	Support for digital services, user-friendliness (language, clear interface), modern technology, matching the offer to the demand	2354		
Cloud computing	Availability of services, Storages, databases, and software, including for smartphones, which save time and allow more flexible information acquisition	2236		
Group average		2353		

Table 3 Economic factor group

Factor, f	Description	S_f	D	SD
Productivity	Effective use of the geographical advantages; consolidating productive resources; coordinated development of the village; investments in digital business, market expansion	2394	50,185.37	224.02
Employment	Engagement of working—age population and consolidation of their efforts; provision of employment; workforce training	2085		
Efficiently	Promoting the development of new industries, business formats related to agriculture or recreation; formation of the image of a healthy and attractive village; implementation of marketing activities to popularize the area and its cultural heritage	1972		
Innovation	Use of ICT in agriculture, industry, services, e-commerce	1904		
Financial stability	Development of tax and savings schemes to raise funds for agriculture, industry, Culture and art; facilitation of funding from local authorities and relevant enterprises	1789		
Welfare	High wages, lower unemployment, more jobs, and economic prosperity opportunities for businesses	1815		
Group average		1993.2		

Table 4 Cultural and tourism factor

Factor, f	Description	S_f	D	SD
Tourist destinations	Elaborating effective tourism policies and marketing strategies; attracting small businesses and locals to the development of tourist destinations	2064	1114.25	33.38
Integration of ethnic cultures	Unification of different cultures; preservation and support of cultural traditions, ways of thinking, and beliefs of various ethnic groups; provision with technological opportunities for interaction in the framework of implementing an integrated tourism product	2046		
Support of local cultural initiative	Support for cultural initiatives; promotion of cultural and artistic events in tourist programs	2029		
Cultural preservation	Preservation of cultural heritage; formation of the national importance of cultural heritage sites' conservation (historical buildings, cultural and geographical objects); promotion of the evolution of national traditions, crafts, and ethnic educational programs	1986		
Group average		2031.3		

Table 5 The Environmental factor group

| Factor, f	Description	S_f	D	SD
Energy Efficiency	Efficient use of energy; minimization of demand for fossil fuels; environmental planning that meets the microclimate; use of renewable energy sources	2032	22,249.7	149.16
Waste management	Waste recycling	1945		
Biodiversity	Maintenance of biodiversity; protection of wild animals; creation of ecological corridors; improvement of the environmental system	1863		
Environmental planning	Ecological planning and engineering	1714		
Efficient use of landscapes, Water, and land resources	Use of the village's resources to create local features and strengthen the conceptual synergy between the national culture and the wild landscapes	1682		
Group average		1847.2		

Table 6 The Social factor group

Factor, f	Description	S_f	D	SD
Social initiative and openness	Encouragement of social initiative and openness of the locals in collective decision-making regarding	1815	73,626.7	271.3424
In-touch capabilities	Technological support of high-quality communication and open information space; promotion of interaction and communication between social groups	1772		
Open educational environment	Technological and organizational maintenance of open educational space for villagers; creation of proper conditions for training, interaction, and demonstration of national craft technologies	1394		
High-quality information transmission	Provision with high-quality information sharing through the internet technologies; diversification of information channels; increase of the updating speed and improvement of information accuracy	1368		
Effective social protection and support system	Formation of an effective system of social protection and support for the locals	1195		
Group average		1508.8		

This group had 2353 points on average (SD = 90.64), indicating an "excellent" level (Fig. 2). Concurrently, the first place within its limits was given to the Internet Availability factor—2457 points (Table 2).

The results for the Economic factor group are shown in Table 3.

The highest points in the Economic group were obtained for the Productivity factor—2394, while the group's mean was on the level of 1993.2 (SD = 224.0) (Table 3). The leading factor in the Cultural and Tourism group (M = 2020.3, SD = 33.38) was the Tourist Destinations with 2064 points. Simultaneously, quite fascinating

Fig. 2 Distribution of factor groups according to respondents' estimates (average for a factor group)
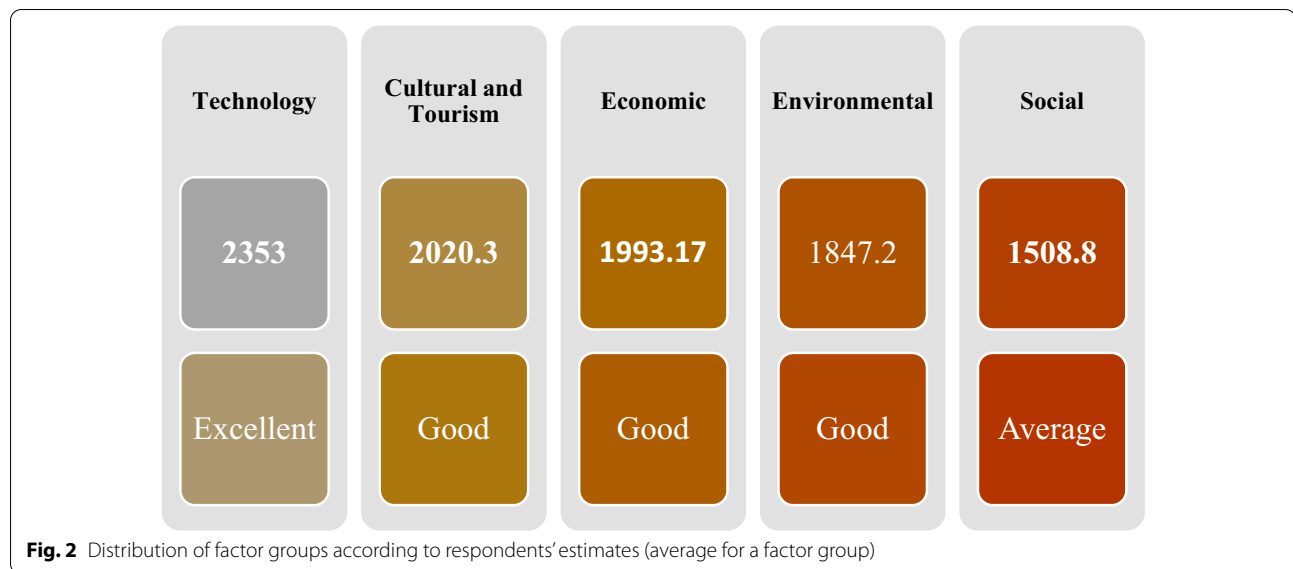
is that all factors were defined to be in a very close range of values (Table 4). As concerns the mean points, for both groups they correspond to the gradation "good" (Fig. 2).

The mean result for Environmental group factors [1847.2 (SD = 149.16)] and the overall state were defined as "good" (Fig. 2). The highest points within the group were given to the Energy Efficiency factor—2032 points (Table 5). In contrast, the worst group-wide assessments were assigned to the Social group. It received 1508.8 points on average (SD = 271.34) and correspondingly was characterized as the one with the "average" development level (Fig. 2). The Social Initiative and Openness factor was determined as the one rated best within its limits—it had as many as 1815 points (Table 6).

The final points of all indicators, sorted from smallest to largest, are shown in Fig. 3.

The data obtained allowed forming a model of ancient villages' development, consisting of the following components (Fig. 4):

The survey showed that the studied villages have technological potential, technology factors received the highest ratings from respondents (2335.5 on average, 2457 max). At the same time, the economic factor of well-being was estimated by the respondents at 1815 points, while the average for the economic factor group was 1993.2. The previous studies found what indicators can ensure the well-being of rural areas. The literature review allowed forming indicators of smartness that lead to the economic well-being of rural areas, applicable to 6 villages in Guangxi (Fig. 5).
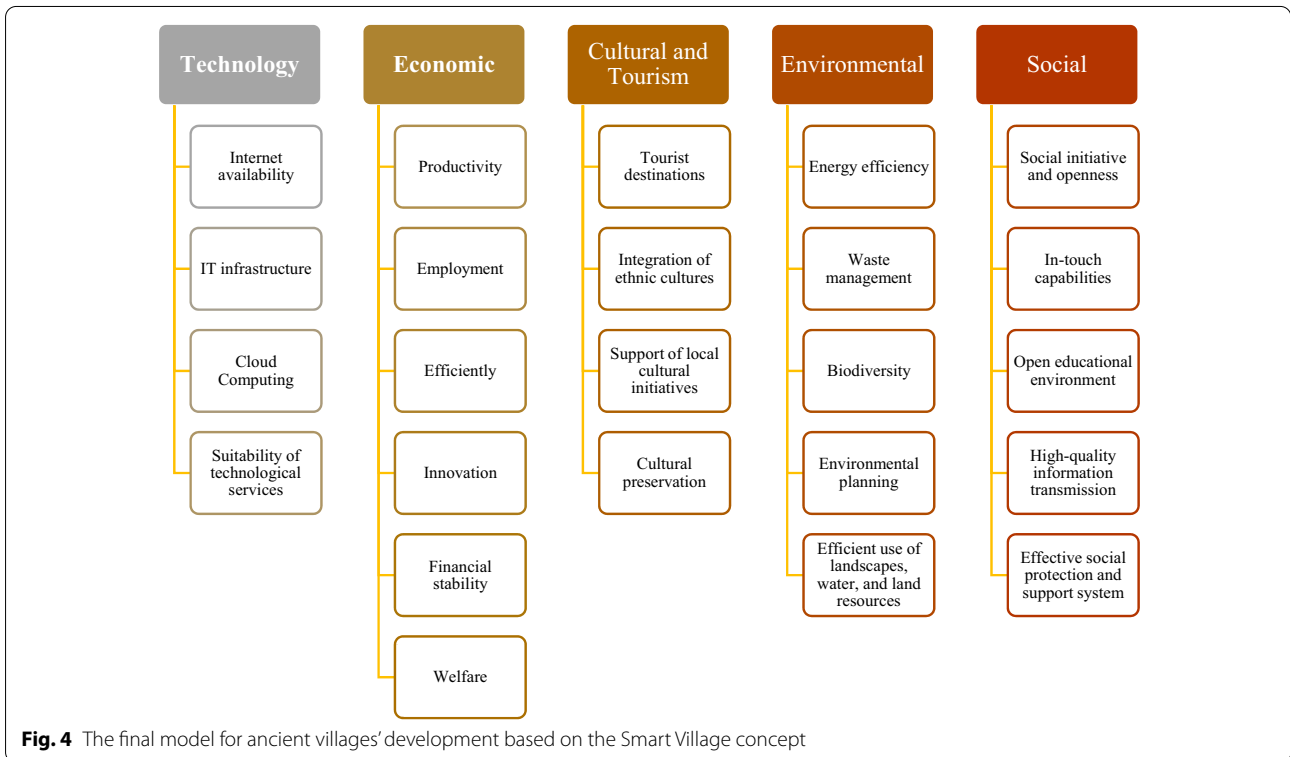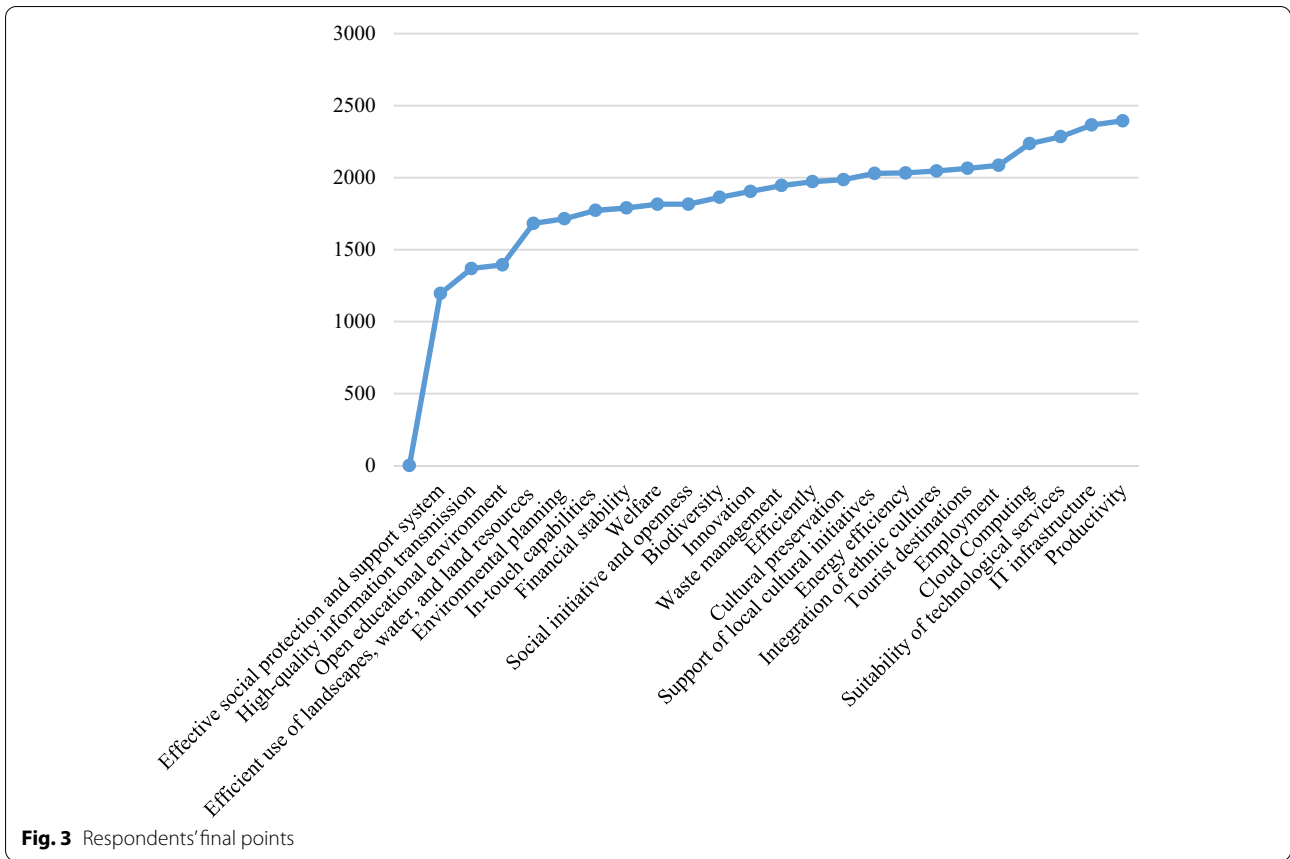
First, it is the interaction and joint participation of residents, government, and knowledge institutions in improving well-being through IT infrastructure and other technological innovations [35, 41, 42]; second, digital capabilities that enhance the activities of all stakeholders in well-being through IT [35, 43, 44]; third, coordination in technology services provision [35, 42, 44].
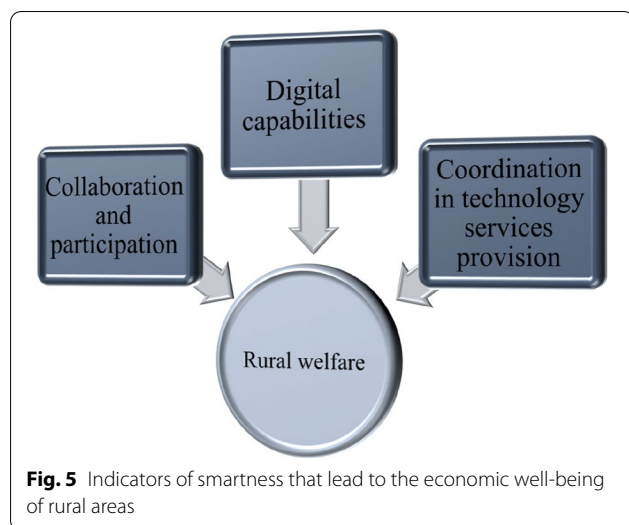
Discussion

The Smart Village is a kind of innovative concept that uses modern technological capabilities to improve the quality of life, increase the efficiency of all socio-economic interactions and production processes. Society is developing rapidly and has achieved various successes in improving the quality of life. Civilization remains a witness to many changes associated with its development through industrial, environmental, scientific, and technological catalysts. The modern era is complemented by information and communication technologies that have proven their potential in various sectors of urban and rural development. Urban areas appear to be more inclined to adopt and develop information and communication technologies because of the benefits of population literacy and better infrastructure than in rural areas [32].

The Smart Village concept has been increasingly heralded as a development strategy for the countryside but with no clear understanding as to what comprises a smart village. Smartness frequently is associated with the quality of IT infrastructure and the ability to use it. An alternative perspective argues that smartness can be understood as a phenomenon connected with self-organized, bottom-up community action that either addresses the weaknesses of both state and market to contribute to local people's well-being or exploits emergent opportunities through collective means.

Fig. 3 Respondents' final points

Fig. 4 The final model for ancient villages' development based on the Smart Village concept

Fig. 5 Indicators of smartness that lead to the economic well-being of rural areas

Colleagues report that rural smartness has an impact on the economy and business processes, namely:

– Facilitates collaboration and promotes productivity in business [43];
– Promotes a more productive use of available resources [44];
– Encourages citizens to engage in entrepreneurial activities [42];
– Introduces creativity and innovation;
– Facilitates the creation of new products and services;
– Provides access not only to a broader national market but also to a global market [44];
– Increases jobs and opportunities for economic growth [35, 41].

There is a stable opinion in the world practice that in order to implement the concept of Smart Village, it is necessary to develop a model that would take into account all the regional characteristics of the territory [11]. Such a model was proposed within the limits of the current research for six ancient villages of northern Guangxi. It identified five key groups of factors: Technological, Economic, Environmental, Social, and Cultural and Tourism. Some researchers allocate more factor groups [9]; however, the central difference here is that they rely on the theoretical material (literature reviews), while in the present work, factors for the model were selected grounding on both the conducted survey and already available findings. In view of this, the authors believe that the model proposed is more suitable for the regional characteristics of these rural areas. Researchers emphasize that it is necessary to reckon with the geographical, socio-cultural, and economic components of the Smart concept [44].

The current research work is fully in line with this point as it is this principle that the authors tried to implement. This study adds to the international knowledge of Smart Village factors, taking into account the regional characteristics of six ancient Chinese villages with their unique nature and rich cultural heritage. Architectural solutions, art, philosophical and literary works in symbiosis with the unique rural natural landscapes can be confidently deemed the calling card of China and the key to improving the well-being of the local population [45] if rational management and technological solutions are introduced.

Conclusions

The aim of this study was to build a model for the development of ancient villages in Guangxi province (Xingping, Daxu, Huangyao, Jiuxian, Fuli, and Longji Zhuang) that will allow for the cultural and tourist components of those territories and will be grounded on the Smart Village concept. The model's construction presupposed a grounded review of studies on the topic and a comprehensive analysis of regional and local regulatory documents. Such a strategy made it possible to determine the key model's factors, which were then included in the questionnaire to survey ordinary people, officials, and service providers living and working there. The survey outcomes enabled slight adjustments to theoretically assumed elements of the model—only those factors remained, the level of development of which was assessed by respondents as "average," "good," and "excellent." Thus, the proposed model demonstrates the state of certain indicators of the Smart Village strategy within the studied villages. It is assumed that this model will become the foundation for more effective implementation of Smart Village principles in relation to each group of factors (Technological, Economic, Cultural and Tourism, Environmental, Social) as all of them are closely linked with each other. For example, Technological factors, depending on their intended purpose, are highlighted as a separate group, but are also included in the Economic factor group (Innovation factor) and Social factor group (High-quality Information Transmission factor). The group of Culture and Tourism also does not go without them. In general, this implies the criticality of technology in implementing Smart Village initiatives. The carried-out survey confirmed the dominance of technology in practice—the Internet Availability factor had 2457 points, while the mean value of the Technological factor group was 2353 points (it was generally assessed as "excellent" with SD = 90.65). The IT Infrastructure and Cloud Computing factors were rated as "excellent" (2365 points) and "good" (2354 points), respectively, and gave way only to

the Productivity factor from the Economic group, which got 2394 points ("excellent"). The remaining factors of the Economic group (Employment, Efficiently, Innovation, Financial stability, Welfare) were considered to be developed on the "good" level (2085–1789 points, SD = 224.02). Next in the respondents' rating was the Cultural and Tourism group, which included Tourist Destinations, Integration of Ethnic Cultures, Support of Local Cultural Initiatives, and Cultural Preservation factors. On average, it was assessed as "good" with 2031.3 points and SD = 33.4. The Environmental factor group encompassing Energy Efficiency, Waste Management, Biodiversity, Environmental Planning, and Efficient Use of Landscapes, Water, and Land Resources factors had on average 1847.2 points (also considered "good" with SD = 149.2). Social group factors (Social Initiative and Openness, In-touch Capabilities, Open Educational Environment, High-quality Information Transmission, Effective Social Protection and Support System) had only 1508.8 points (SD = 271.3). Thus, it can be inferred that within the villages under study, technology, economy, environment, and culture and tourism should only be maintained at a stable level in the direction of smart development, whereas the social sphere should be brought up to a higher level. These conclusions are important for implementing the Smart Village strategy not only in the six villages in question but also in other rural areas with a similar state of economic development and cultural and tourist potential. Future research can focus on building Smart Village development models for rural areas having unfavorable natural conditions or relying upon industry or agriculture in their economic advancement instead of tourism as those in the current work.

Appendix 1
Respondent scores from each village for each factor.

Factor group	Factor		Points
Technology	Internet availability	Xingping	445.3
		Daxu	424.6
		Huangyao	406.4
		Jixiang	389.7
		Fuli	396.2
		Longji Zhuang	394.8
		Total score	2457
	IT infrastructure	Xingping	426.5
		Daxu	398
		Huangyao	416.4
		Jixiang	403.6
		Fuli	338.3
		Longji Zhuang	382.2
		Total score	2365
	Cloud computing	Xingping	373.8
		Daxu	407.5
		Huangyao	412.4
		Jixiang	354.2
		Fuli	361.1
		Longji Zhuang	327
		Total score	2236

Factor group	Factor		Points
	Suitability of technological services	Xingping	378.4
		Daxu	376.2
		Huangyao	399.6
		Jixiang	410.3
		Fuli	408.6
		Longji Zhuang	380.9
		Total score	2354
	Group average		2353
Economic	Productivity	Xingping	414.2
		Daxu	428.1
		Huangyao	369.5
		Jixiang	396.3
		Fuli	381.2
		Longji Zhuang	404.7
		Total score	2394
	Employment	Xingping	316.5
		Daxu	338.9
		Huangyao	356.4
		Jixiang	374.2
		Fuli	349.7
		Longji Zhuang	349.3
		Total score	2085
	Efficiency	Xingping	312.6
		Daxu	340.8
		Huangyao	298.4
		Jixiang	320.5
		Fuli	316.4
		Longji Zhuang	315.3
		Total score	1972
	Innovation	Xingping	330.3
		Daxu	324.8
		Huangyao	326.4
		Jixiang	316.5
		Fuli	305.2
		Longji Zhuang	300.6
		Total score	1904
	Financial stability	Xingping	313.7
		Daxu	340.4
		Huangyao	289.6
		Jixiang	271.5
		Fuli	299.3
		Longji Zhuang	274.7
		Total score	1789
	Welfare	Xingping	287.6
		Daxu	315.5
		Huangyao	298.9
		Jixiang	312.3
		Fuli	306.5

Factor group	Factor		Points
		Longji Zhuang	294.2
		Total score	1815
	Group average		1993.2
Culture and tourism	Tourist destinations	Xingping	349.5
		Daxu	356.8
		Huangyao	329.7
		Jixiang	341.6
		Fuli	346.2
		Longji Zhuang	340.2
		Total score	2064
	Integration of ethnic cultures	Xingping	313.8
		Daxu	332.4
		Huangyao	350.6
		Jixiang	378.5
		Fuli	319.2
		Longji Zhuang	352.1
		Total score	2046
	Support of local cultural initiatives	Xingping	346.9
		Daxu	341.9
		Huangyao	343.6
		Jixiang	345.8
		Fuli	331.2
		Longji Zhuang	319.6
		Total score	2029
	Cultural preservation	Xingping	326.5
		Daxu	319.8
		Huangyao	333.4
		Jixiang	340.8
		Fuli	339.6
		Longji Zhuang	325.9
		Total score	1986
	Group average		2031.3
Environmental	Energy efficiency	Xingping	332.6
		Daxu	324.8
		Huangyao	345.5
		Jixiang	331.2
		Fuli	329.6
		Longji Zhuang	368.3
		Total score	2032
	Waste management	Xingping	329.3
		Daxu	321.1
		Huangyao	338.5
		Jixiang	336.9
		Fuli	312.8
		Longji Zhuang	306.4
		Total score	1945
	Biodiversity	Xingping	298.5
		Daxu	313.9
		Huangyao	316.9
		Jixiang	296.5
		Fuli	324.8

Factor group	Factor		Points
		Longji Zhuang	312.4
		Total score	1863
	Environmental planning	Xingping	282.6
		Daxu	294.8
		Huangyao	289.5
		Jixiang	278.5
		Fuli	286.4
		Longji Zhuang	282.2
		Total score	1714
	Efficient use of landscapes, water, and land resources	Xingping	266.5
		Daxu	271.9
		Huangyao	253.4
		Jixiang	288.3
		Fuli	282.4
		Longji Zhuang	319.5
		Total score	1682
	Group average		1847.2
Social	Social initiative and openness	Xingping	288.8
		Daxu	312.5
		Huangyao	302.2
		Jixiang	286.4
		Fuli	340.3
		Longji Zhuang	284.8
		Total score	1815
	In-touch capabilities	Xingping	274.5
		Daxu	280.1
		Huangyao	298.2
		Jixiang	352.6
		Fuli	284.5
		Longji Zhuang	282.1
		Total score	1772
	Open educational environment	Xingping	224.5
		Daxu	237.7
		Huangyao	224.5
		Jixiang	218.3
		Fuli	239.8
		Longji Zhuang	249.2
		Total score	1394
	High-quality information transmission	Xingping	239.4
		Daxu	212.3
		Huangyao	198.9
		Jixiang	231.5
		Fuli	241.6
		Longji Zhuang	245.6
		Total score	1368
	Effective social protection and support system	Xingping	186.4

Factor group	Factor		Points
		Daxu	198.5
		Huangyao	216.4
		Jixiang	176.3
		Fuli	195.6
		Longji Zhuang	222
		Total score	1195
	Group average		1508.8

Availability of data and materials
Data will be available on request.

Declarations

Competing interests
The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Author details
[1]Academy of Arts and Design, Guilin Tourism University, Guilin, China. [2]Rectors Office, Guilin Tourism University, 26#Liang Feng Rd., Guilin 541006, Guangxi, China.

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