

Study on the Development of Forestry Industry in the Qinba Mountain Area Based on Principal Component Analysis

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Abstract: The forestry industry is a fundamental industry of the national economy that plays an increasingly important role in ecological construction. In this study, the current situation of the forestry industry in the Qinba Mountain Area was discussed systemically, and a strengths, weaknesses, opportunities, and threats (SWOT) analysis of the forestry industry was performed. The study used expert questionnaires and principal component analysis to identify the factors that had great effects on the forestry industry in the Qinba Mountain Area, to provide a scientific basis for the formulation of the forestry industry development strategy. The research revealed that ecological environmental problems, the weakness of low intensive level, the opportunity for ecotourism development, and resource strength all had major effects on the development of forestry industry in the Qinba Mountain Area. Therefore, the Qinba Mountain Area should focus on ecological construction and make good use of its location and resource strengths to develop characteristic industries, optimize the industrial structure, and accelerate the development of forest tourism, and consequently promote the high-quality development of the local forestry industry.

Keywords: the Qinba Mountain Area; forestry industry; SWOT method; principal component analysis; ecological environment

1 Introduction

The state attaches great importance toward the construction of an ecological civilization, establishing the fundamental requirements for upholding the harmonious coexistence of man and nature, attaining the goal of building a beautiful China, and implementing a major strategic plan for rural revitalization covering agriculture and, rural areas, and farmers. The Qinba Mountain Area, located within the hinterland of central China, is an important ecological shield in the upper reaches of the Yangtze River. It is China's largest area of concentrated poverty, with frequently occurring environmental and geological disasters, such as soil erosion, landslide, and debris flows [1]. Forests have ecological and social benefits; therefore, developing the forestry industry in the Qinba Mountain Area would confer great benefits by improving the ecological environment, constructing resource-saving environment-friendly industries, widening distribution channels to increase farmers' income, and promoting sustainable economic development.

Existing research has mainly focused on forest resources, forestry industry status, and problems facing forestry development in the Qinba Mountain Area [2,3]. The forestry industry within this area has been confronting new opportunities and challenges and has become a hotspot due to the diversification of forestry needs for economic

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and social development and heightened activity in quantitative and macro-based research. Our study utilized surveys and principal component analysis based on the strengths, weaknesses, opportunities, and threats (SWOT) faced by the development of the Qinba Mountain Area forestry industry, in order to provide targeted reference suggestions for the sustainable development of the local green economy.

2 Overview of forestry industry in the Qinba Mountain Area

Since forestry is the dominant industry in the Qinba Mountain Area, the area includes forests (including economic forest area 9.81×10^5 hm²), bamboo, and rattan cultivation and harvesting (plucking), processing and utilization of wood and non-wood products, and ecotourism. In terms of its output in 2016, the Qinba Mountain Area is dominated by primary and secondary industries, and the proportion of tertiary industries is relatively small (Table 1) [2].

Table 1. Forestry output of the Qinba Mountain Area (2016).

	Output (100 million yuan)	Proportion (%)
Primary industry	3672	34
Secondary industry	5616	52
Tertiary industry	1512	14
Total	10 800	100

Among the primary industries in the Qinba Mountain Area, the leading commercial activities related to forestry include: forest cultivation and planting (output is 146.961 billion yuan, accounting for 40.02%), timber and bamboo harvesting (27.184 billion yuan, 7.40%), economic forest product planting and harvesting (123.331 billion yuan, 33.59%), flower planting (67.490 billion yuan, 18.38%), and breeding and utilization of terrestrial wildlife (2.234 billion yuan, 0.61%). The primary industry is largely run by decentralized management. Moreover, the Qinba Mountain Area is well-known throughout the country as the “Gene Pool of Green Biological Resources” and “Hometown of Chinese Medicinal Materials.” There are more than 1034 types of Chinese medicinal materials found in the area, with over 370 listed in the new edition of *Chinese Pharmacopoeia*, and more than 70 listed as nationally famous and precious Chinese medicinal materials [4].

Among the secondary industries in the Qinba Mountain Area, the leading industries related to forestry include: wood processing and wood, bamboo, rattan, palm, and reed product manufacturing (300.956 billion yuan, 53.59%); wood, rattan, and bamboo furniture manufacturing (95.617 billion yuan, 17.03%); wood, bamboo, and reed pulp paper manufacturing (15.214 billion yuan, 2.71%); forest chemical manufacturing (1.499 billion yuan, 0.27%); wooden crafts and cultural, educational, and sporting goods manufacturing (108.5 billion yuan, 19.32%); non-wood product processing (39.868 billion yuan, 7.10%). On the one hand, the processing and production of non-wood products connect the forestry industry to the consumer market and become the central link to achieve value-added forest products, guide the market consumption, and promote the consumption upgrade. On the other hand, it increases the forest farmers’ income and promotes the development of beneficial forestry, which could become an important force in accelerating the industrialization process and driving the development of other industries.

Among the tertiary industries in the Qinba Mountain Area, ecotourism related to the forestry industry is growing at a significant rate. For instance, Xixiang County, Hanzhong City, Shaanxi Province received 1.396 million tourists in the first half of 2012, generating an income of 540 million yuan; in 2014, the county received 3.97 million tourists, generating a significant income of 1.97 billion yuan. The ecotourism industry has lifted approximately 20 000 people out of poverty within the county and promoted the rapid development of the county’s economy [5]. Relying on high-quality leisure agriculture and the needs of the leisure tourism market, Liuba County, Hanzhong City, Shaanxi Province has explored in depth the ecological value of mountain agricultural resources and developed a leisure ecotourism product system. This product system combines tourism, folk customs, health care, leisure, vacation, and other products, and can drive the improvement of the ecological environment and the development of the agricultural economy [6].

3 SWOT analysis of forestry industry in the Qinba Mountain Area

We retrieved and reviewed relevant literature [2,7,8] regarding the forestry industry, and performed a SWOT

analysis regarding the industry's development within the area, based on the actual situation of forestry within the Qinba Mountain Area. Overall, the location and resources are the strengths on which further development of the area can be based; however, the decentralization, crude management, inadequate infrastructure, and inadequate government policies and funding are restricting development. Therefore, in this area there is the opportunity to greatly develop the country's ecological civilization, diversify market demand for forest products, and continue development of the forest tourism industry; additionally, habitat degradation and low social and economic development are potential threats.

3.1 Strength

3.1.1 Location

The Qinba Mountain Area includes Qinling Mountain as well as Daba Mountain and its surrounding areas; spanning 119 counties across Hubei, Shaanxi, Sichuan, Henan, Gansu, and Chongqing (five provinces and one city). The area is an ecological shield for the sustainable development of China's economy and society, a water source conservation area for the South to North Water Transfer Project, and also the location of the two key areas for biodiversity protection in China (Qinling Mountain and Shennongjia Forest) [3]. The Qinba Mountain Area is in a transition zone between the warm temperate and subtropical zones. The climatic conditions are suitable for a variety of trees, enabling the use of a wide range of tree species in forestry development projects.

3.1.2 Resource

The Qinba Mountain Area has rich forest resources and forest products. For example, the southern Shaanxi area has a forest coverage rate that reaches 60%, which is significantly higher than the average level of Shaanxi Province (about 40%); the forest stock and the forest water supply capacity is $2.5 \times 10^8 \text{ m}^3$ and $1.16 \times 10^{10} \text{ m}^3$, respectively, accounting for 55% of the Shaanxi Province [9]. Forest products in the area include softwoods, fruits, woody grains and oils, teas, seasonings, edible fungus, wild vegetables, flowers, forest chemical raw materials, bamboo shoots, and rattan palm reeds that have great potential for market development.

There are rich biological resources, and many types of animals and plants thrive in the Qinba Mountain Area; with 8 national first-level protected animals and 40 second-level protected wild animals. It is also the main area for the giant panda, a treasured and endangered creature. The climate is benign, and a variety of forest fruits have traditionally been cultivated in the area, such as oranges, kiwi fruit, chestnuts, and walnuts [10].

3.2 Weakness

3.2.1 Low intensity and poor management

The Qinba Mountain Area lacks enterprises of any stature. The existing forestry industry enterprises are small in scale, little known in the market, and have weak branding. The primary industries in the area have a mainly decentralized management and operate at low intensity, which is not conducive to exerting the agglomeration effect. The related enterprises have crude management styles, backward business philosophies, low product technology content, insufficient deep processing, little equipment, few workers, and most products are seasonal. To an extent, these factors restrict the development of distinctive forest products in the Qinba Mountain Area, preventing the strength of the resource to be converted into an economic advantage, and making the potential for production difficult to attain.

3.2.2 Unreasonable industrial structure

The forest industry structure in the Qinba Mountain Area is inefficient. Primary industry accounts for a large proportion, while secondary and tertiary industries (14%) account for a relatively small proportion, which is not commensurate with the rich resources of the area. The overall scale of the forest industry is relatively small, the industry level is low, and is still in the early stage of development. Owing to the lack of further processing, the forest products are low grade, have low added value, and overall do not provide enough benefits.

3.2.3 Inadequate government policy and funding

In recent years, all levels of government have been supporting the development of forest-based industry in the Qinba Mountain Area, but, while they have provided subsidies, policies and vision for the industry have been lacking. The limited capital offered is far from meeting the development demand. Due to a lack of funding or financing, most investment costs are shouldered by the producers. The return on investment cycle is relatively long and has low benefits, which seriously affects investment interest in the forest industry. Xixiang county, Hanzhong

city, Shaanxi province decided to develop the walnut industry. However, the county is not listed as a provincial walnut area and has weak fiscal capacity. It was, therefore, unable to arrange for supporting funds, and this hampered development in the county.

3.3 Opportunity

3.3.1 The development of ecological civilization

In recent years, the country has attached great importance to construction of ecological civilization; placing importance on the concept, “lucid waters and lush mountains are invaluable assets,” and striving for a beautiful China. This new approach suggests that forestry, which has many ecological and societal functions and benefits, will have new strategic opportunities. In pursuit of its ecological vision, the state has issued complementary policies for the development of forestry. This provides favorable macro conditions and industrial support for the Qinba Mountain Area so that it can utilize its unique ecological strengths, and accelerate the development of the forestry industry.

3.3.2 Diverse market demand for forest products

Alongside the improvement of people’s material and cultural living standards and increased awareness of the importance of health, emerging industries such as forest food and biopharmaceuticals are constantly appearing and attracting a great deal of social investment. The forestry industry has outstanding development potential as a green sunrise industry. As the elderly population increases, they pay more attention to natural health, and forest tourism has become the first choice. The Qinba Mountain Area has advantages for developing forest ecotourism; it can meet the social expectations for the development of forestry, and drive other industries to develop in depth, thereby increasing the industrial income in the area.

3.3.3 Booming development of forest tourism

With the rapidly developing economy, the demand for ecotourism and forest health care has increased, and forest tourism characterized by “returning to nature” has gradually become a hot commodity. Tertiary industry in the Qinba Mountain Area, particularly ecotourism, has considerable potentials. It has a World Natural Heritage Site and a World Geopark, and there is approval for the establishment of 40 National Nature Reserves, 61 National Forest Parks, 11 National Wetland Parks, and 7 National Parks of China. Rich human resources and unique tourism resources have created extremely favorable conditions for the forest tourism development in the Qinba Mountain Area [11].

3.4 Threat

3.4.1 Ecological issues

The Qinba Mountain Area is blocked by mountains and has complex terrain. Natural disasters such as floods, drought, landslides, and mudslides are common, and poverty has become more severe as a result. Owing to the demands for population growth and economic development, over-exploitation and deforestation to reclaim land have destroyed the ecological environment, accelerated resource consumption, and reduced the environmental carrying capacity. In addition, although the increase in factories, mines, and township enterprises in the area promotes economic development, weak environmental protection measures against soil, water, and air pollution mean it has had a serious impact on the local environment and even increased the frequency of natural disasters. All these factors restrict the development of the forestry industry in the Qinba Mountain Area.

3.4.2 Low economic development level and weak infrastructure construction

The Qinba Mountain Area is the largest of 11 contiguous poverty-stricken areas in China, and the poverty incidence rate is about 30%. The infrastructure conditions and basic public services in the area are lower than the national average level. Although a transportation network has been built, basic facilities such as tourism infrastructure are poor. The existing facilities and reception services cannot meet the demands for large-scale tourism development. In addition, the social and economic development level in the Qinba Mountain Area is not high, and as a result, the area lacks the advantages and conditions to attract forestry professionals in technology, marketing, and management. These economic and basic factors have restricted the development of the forestry industry in the area.

4 Empirical analysis of forestry industry development

4.1 Data source and method

4.1.1 Data source

The study used a questionnaire survey to collect data, and the survey respondents were mainly researchers, scientific and technological extension personnel, and university teachers. Through a random survey, we acquired their professional views on the importance of the strengths, weaknesses, opportunities, and threats to the development of the forestry industry in the Qinba Mountain Area. The questionnaire adopted Likert's 5-level scaling method. The respondents scored 0–5 points for the importance of each element, and the higher the score, the higher the importance. A total of 45 questionnaires were issued, and 40 questionnaires were returned, meaning an effective recovery rate of 88.9%.

4.1.2 Method

Principal component analysis is a practical multivariate statistical method that processes data through linear transformation by using Statistical Product and Service Solutions (SPSS), and selects fewer important variables from multiple variables [12]. This method can not only eliminate the relationship between the index samples, but also retain most of the original variable information, and extract a small number of representative main indicators, specifically the principal components [13]. The analysis process proceeded as follows: SPSS was first used to complete the applicability test of the principal component analysis, followed by extraction of principal components and construction of the principal component scoring model, and finally to determine the factors that have an important effect on the development of the forestry industry in the Qinba Mountain Area.

4.2 Process of empirical analysis

4.2.1 The construction of index system

According to the strengths, weaknesses, opportunities, and threats of the forestry industry in the Qinba Mountain Area, we constructed a SWOT analysis factor index system of the development of the forestry industry in the area (Table 2).

Table 2. SWOT analysis factor index system of the forestry industry.

Factor	Element index	Code
Strength (S)	Resource	S ₁
	Location	S ₂
Weakness (W)	Low intensity and crude management	W ₁
	Unreasonable industrial structure	W ₂
	Inadequate government policy and funding	W ₃
Opportunity (O)	The development of ecological civilization	O ₁
	Diverse market demand for forest products	O ₂
	Booming development of forest tourism	O ₃
Threat (T)	Ecological issues	T ₁
	Weak infrastructure construction	T ₂

4.2.2 The applicability test

Using SPSS to operate the data via Kaiser-Meyer-Olkin (KMO) and Bartlett's sphericity test, it was found that the KMO value was 0.619 (value>0.5 is valid), the Bartlett's sphericity test probability value was 0 (value<0.05 is valid), indicating that the paper could use the principal component analysis to analyze the data.

4.2.3 Principal component scoring model

The results obtained through SPSS were shown in Table 3. According to the selection principle (eigenvalue>1), the first four principal components were extracted with total cumulative reaching 71.149%, indicating that the extracted principal components contained most of the information in the questionnaire data. The four principal components were named comprehensive elements one, two, three, and four, and their eigenvalues were $F_1 = 3.244$, $F_2 = 1.684$, $F_3 = 1.156$, $F_4 = 1.031$, respectively.

The principal component is a linear combination of the original 10 indicators, and the weight of each indicator is the corresponding principal component eigenvector, which represents the degree of influence of each indicator

on the principal component. Based on the data in the component matrix (Table 4), the following principal component scoring model was calculated:

$$F_1 = 0.135S_1 + 0.113S_2 + 0.275W_1 + 0.251W_2 + 0.321W_3 + 0.4O_1 + 0.371O_2 + 0.328O_3 + 0.417T_1 + 0.385T_2 \quad (1)$$

$$F_2 = 0.305S_1 + 0.247S_2 - 0.472W_1 - 0.456W_2 - 0.339W_3 + 0.314O_1 + 0.386O_2 + 0.172O_3 + 0.04T_1 - 0.149T_2 \quad (2)$$

$$F_3 = -0.535S_1 + 0.232S_2 + 0.056W_1 + 0.204W_2 - 0.047W_3 - 0.03O_1 + 0.177O_2 + 0.605O_3 - 0.267T_1 - 0.379T_2 \quad (3)$$

$$F_4 = 0.311S_1 + 0.828S_2 + 0.161W_1 - 0.065W_2 + 0.218W_3 - 0.294O_1 - 0.205O_2 - 0.008O_3 - 0.103T_1 + 0.015T_2 \quad (4)$$

Combining the cumulative contribution rate of each element, the principal component comprehensive scoring model is obtained as follows:

$$F = 0.324F_1 + 0.168F_2 + 0.116F_3 + 0.103F_4 \quad (5)$$

Table 3. Eigenvalue, contribution rate and cumulative contribution rate in the principal component model.

Number	Eigenvalue	Variance contribution rate (%)	Cumulative contribution rate (%)
1	3.244	32.437	32.437
2	1.684	16.843	49.280
3	1.156	11.558	60.839
4	1.031	10.310	71.149
5	0.805	8.050	79.199
6	0.692	6.922	86.120
7	0.477	4.768	90.888
8	0.420	4.203	95.092
9	0.279	2.792	97.884
10	0.212	2.116	100.000

Table 4. Component matrix of the principal component analysis.

Index	Component			
	F ₁	F ₂	F ₃	F ₄
S ₁	0.244	0.396	-0.575	0.316
S ₂	0.204	0.320	0.249	0.841
W ₁	0.496	-0.613	0.060	0.163
W ₂	0.452	-0.592	0.219	-0.066
W ₃	0.578	-0.440	-0.051	0.221
O ₁	0.720	0.407	-0.032	-0.299
O ₂	0.668	0.501	0.190	-0.208
O ₃	0.591	0.223	0.650	-0.008
T ₁	0.751	0.052	-0.287	-0.105
T ₂	0.693	-0.194	-0.408	0.015

4.2.4 Results analysis

From the previous analysis, it could be seen that the most influential elements for forestry industry development in the Qinba Mountain Area was comprehensive element one, with a contribution rate of 32.4%, and the coefficients from large to small were T₁, O₁, T₂, O₂, O₃, W₃, W₁, W₂, S₁, and S₂. Among them, the ecological issues and development of an ecological civilization were the highest, indicating that we must attach great importance to environmental issues, and make environmental protection the priority while carrying out the work.

Ranked second in impact was comprehensive factor two with a contribution rate of 16.8%, and the coefficients from large to small were W₁, W₂, O₂, W₃, O₁, S₁, S₂, O₃, T₂, and T₁. The intensive management and forestry industry structure indicators had the highest impacts, indicating that implementing intensive management and improving the brand effect of leading enterprises were still the main needs for the forestry industry in the area.

Ranked third in impact in the Qinba Mountain Area was comprehensive factor three with a contribution rate of 11.6%, and the coefficients from large to small were O₃, S₁, T₂, T₁, S₂, W₂, O₂, W₁, W₃, and O₁. Ecotourism development and resource strength indicators had the highest impact, indicating that we should seize the booming development opportunity of forest tourism, and create a unique tourist route in the Qinba Mountain Area.

Ranked fourth in impact was comprehensive factor four with a contribution rate of 10.3%, and the coefficients from large to small were S₂, S₁, O₁, W₃, O₂, W₁, T₁, W₂, T₂, and O₃. Indicators of the strengths of the area, such as location and resource, had the highest impact, implying that we should make full use of the unique resource advantages of the Qinba Mountain Area, develop advantageous industries, and improve the forestry green

recycling industry system.

5 Development strategy for the forestry industry

5.1 Prioritize ecological and environmental protection

Taking green cycling development as the guide, we should give top priority to environmental protection, and accordingly direct all aspects of the forestry industry in the Qinba Mountain Area such as: establish a strictly implemented complete forest resource management system as soon as possible; strengthen the protection of scenic spots and biological species resources in the area; eliminate deforestation and other damage to forest resources; and make every effort to advance ecological forestry.

For industrial and mining enterprises causing serious pollution, necessary compulsory measures should be taken to restore the environment such as: giving priority to the development of green forestry industries with less resource consumption and less environmental pollution, improving residents' awareness of the ecology and environment, and realizing integrated development of the ecological forestry industry.

5.2 Optimize industrial structure and cultivate leading enterprises

While promoting primary industry, it is also critical to increase the proportion of secondary and tertiary industries in the Area, and focus on the optimization and upgrades of the forestry industry structure. We should support forestry enterprises with good development momentum, strong influence, and considerable scale, to drive the high-quality development of related forestry industries. It is necessary to improve the supply of quality forest products in the production field to adapt more effectively to the market's demand for green and high-quality forest products, rationally strengthen the support for deep processing enterprises, construct a cold chain logistics for storage, and extend the industrial chain. It is also necessary to set up a forest fruit e-commerce platform, broaden the marketability, form an integrated service capacity for production, operation, and sales, and enhance the forestry industry's overall benefits.

5.3 Develop ecotourism properly

The Qinba Mountain Area has the potential for forest tourism. On the premise of not sacrificing the local environment, it can deeply exploit and moderately develop an ecotourism industry by highlighting the natural landscape and combining with folk cultural characteristics. We should strengthen the development of local forest landscape resources, improve the construction of tourism infrastructure, transform, optimize, and build new forest parks, and create new and attractive tourist routes. We should also enrich ecotourism products, develop forest healthcare tourism projects, and carry out online and offline marketing to increase the popularity of ecotourism in the Qinba Mountain Area. Eventually, the development of forest tourism can enable local people to increase their income.

5.4 Make the Qinba Mountain Area a key forestry development center

Furthermore, we should sensitively handle the relationship between the protection and development of forest resources, put the Qinba Mountain Area into the forestry industry development plan of the province and city where it is located, and give the authorities the necessary support. We should use resources in the area to develop superior forestry industries and improve the green recycling industry system. In addition, we should focus on the development of walnut, chestnut, and other forests with economic potential. We should take the county as a unit for the development of green and rich industries such as pepper, apple, loquat, soft seed pomegranate, lacquer, and gravel. In the middle and low mountains and hills, we can focus on the development of undergrowth Chinese medicinal materials, edible fungi, and rare-bird breeding. Further, we can establish breeding bases of characteristic tree species such as lacquer tree and *Eucommia*.

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