

Article

Construction of a National Trail Research Framework under a Natural Protected Area System

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Abstract: National Trail is an integral component of the system of natural reserves. China's study on the creation of National Trail is scattered and lacks theory and policy at present. Here, the theoretical framework, technical procedure, and construction management of National Trail are examined based on the national conditions of China and the building experience of foreign National Trail. A research framework for National Trail is then established. The research framework encompasses a theoretical framework of policy and related theories, a technical process of analyzing National Trail resource management and public recreation, and construction management, which includes planning and management as well as laws and regulations. This research framework provides a theoretical foundation and policy basis for the future establishment of National Trail as well as general guidance for the planning and design of trails and facilitates the integration of diverse natural space resources.

Keywords: National Trail; natural protected area; trail construction; trail management; planning and design; trail planning



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1. Introduction

The report of the 19th Party Congress emphasizes “establishing a nature reserve system with national parks as the mainstay”, indicating that China's nature reserve system has shifted from mainly nature reserves to national parks. China's protected natural areas are categorized into three categories based on their ecological value and protection intensity: national parks, nature reserves, and natural parks. There is no connection between the representative themes of the various types of nature reserves. National Trail is an important part of the nature reserve system, and China needs to build such linear nature reserves—National Trail—as linear open spaces that not only connect natural protected areas and ecological resources, but also protect natural and cultural resources. They can also effectively transmit historical and cultural heritage and meet people's needs for frequent and convenient outdoor recreation.

The concept of the National Trail originated from the Appalachian National Scenic Trail proposed by the United States in 1921. Up to now, numerous countries and regions have developed a comprehensive National Trail management system in accordance with national conditions, including National Trail construction standards, management systems, and evaluation systems. The basic consensus of all countries on National Trails refers to the long and high-level trails that traverse a country's distinctive natural features, such as deserts, swamps, grasslands, mountains, valleys, rivers, forests, and various heritage sites, and are managed by the state or national departments [1]. National Trail span numerous cultural and natural heritage resources, reflecting the country's natural and cultural qualities, and require special measures for protection management and publicity by the state, as National Trail construction is of great significance [2]. Foreign research on National Trail has entered a more mature application stage, while China's National Trail have only recently begun, so preparations for the construction of National Trail are imminent.

The concept of trails in China is often confused with similar concepts such as national forest trails, national mountaineering fitness trails, greenways, and scenic byways. There are many kinds of trails, and they are not well managed. At present, National Trail is only mentioned in various “Opinion” documents, and the policies given at the national level are insufficient. Management is also lacking, and there is no special National Trail management agency [3]. Existing hiking trails, forest trails, mountaineering fitness trails, and other trails are not connected, the planning and development orientations are not harmonized, and allowing this matter to develop would have catastrophic results. Therefore, a National Trail research framework is needed to establish a National Trail in the future and thus provide a unified planning and management of linear heritage. This article starts with the construction of a National Trail research framework and provides a systematic overview of National Trail, so as to prepare for the construction of these trails.

Constructing China’s National Trail research framework entails analyzing international cases of National Trail and conducting systematic research on them. Firstly, we analyze existing literature and official documents. Secondly, we explore the theoretical aspects of National Trail, as well as the basic research on potential technical methods. Finally, we summarize the theory, technology, and practices to arrive at a research framework. China has planned 12 forest trails and numerous mountaineering fitness trails. In the future, forest trails will be the basic route of National Trail, and forest trails and mountaineering fitness trails will be an important part of National Trail [4]. The construction of National Trail in China has been unfolding from the development of other types of trails, but the research framework and other foundational work still needs to be refined.

2. Literature Review

2.1. Research Status of the National Trail

Trail development in foreign countries originated from the development of outdoor recreation in the 20th century. The Appalachian National Scenic Trail (AT) is the world’s first National Trail, proposed by an American regional planner in 1921 [5]. The Appalachian National Scenic Trail was completed in 1937, and others have since followed in its footsteps around the globe. In 1965, the Pennine Way National Trail, planned and constructed by the Rural Authority of England, was opened, marking the beginning of the development of National Trail construction in the UK. With the establishment of National Trail in England and Wales and hiking trails in Scotland [6], the British government produced a bill outlining the purpose classification, construction standards, and management system of National Trail [1]. In 1968, The United States Congress passed the National Trails System Act, marking the official start of the construction of the National Trails System in the United States [7]. In 1971, the Ministry of Environment in Japan was established; it handled the construction and development of National Trail, and a National Trail management system was established [8]. In Korea, National Trails are referred to as “ecological trails”, and the Forestry Agency put forward the Forest Road Project in 2007. Since then, relevant agencies have proposed plans for “national eco-trails” and have begun to promote and advertise National Trail [9].

China first established its first national mountaineering fitness trail in 2009, the name of which translates to “National Trail”. In May 2010, the Chinese Mountaineering Association issued the National Standard for Mountaineering Fitness Trails. In-depth research has been conducted in terms of route, service facilities, and trail planning based on 3S (GIS, GPS, RS) space technology [10]. In 2017, the State Forestry Administration released a list of the first batch of National Forest Trails and promulgated the National Forest Trails Construction Standards. National forest trails are popular in planning and designing healthy forests, and some research results have been obtained.

Due to the varied historical and cultural background of National Trail construction, a standard management system for it must be tailored to national conditions. For instance, the construction of National Trail in Britain and the United States should prioritize land

ownership. The National Trail in the United States are part of the national park system, and the National Trail in Korea are short-range trails based on mountaineering tourism.

2.2. Research Trends

Studies of National Trail have been conducted on every continent. By April 2022, a total of 184 articles were retrieved from the Database of China National Knowledge Internet (CNKI) with the keywords “National Trail” OR “trail system” NOT “greenway”. Among them were 117 journal papers, 16 Master’s theses, 9 domestic and international conference papers, and 9 newspaper papers. All retrieval results were visually examined in accordance with the CNKI database information collation, and the “general trend” analysis chart was downloaded.

The annual number of articles is shown in Figure 1.

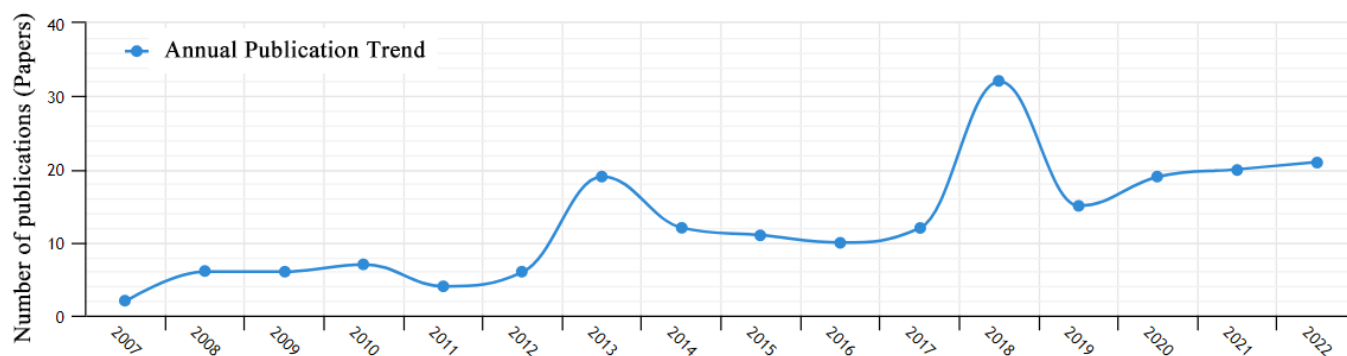


Figure 1. Annual distribution map of National Trail (data source: CNKI; photo credit: CNKI).

Domestic studies on National Trail primarily began after 2007, reached a small peak in 2013 with 19 published papers, reached another, larger peak in 2018 with 32 published papers, and then increased slightly and tended to be stable, which is roughly consistent with China’s National Trail construction and the year in which national documents were released. In 2011, the State Council issued the National Fitness Plan (2011–2015), proposing to make full use of parks and natural environmental conditions to provide the society with outdoor fitness venues. In 2013, Beijing Mentougou National Trail System Planning was released. Mentougou’s local government said that it would be committed to building China’s first National Trail system in line with international standards [11]. On October 28, 2016, the General Office of the State Council issued the Guidance on Accelerating the Development of Fitness and Leisure Industry (No. 77, 2016), stating that they intend to “fully exploit water, land and air resources to study the creation of a National Trail System [12]”. In June 2017, the state Forestry Administration released the National Forest Trail Construction Specifications and announced five national forest trails, marking a brand new step in the development of National Forest Trails. In recent years, national policies have been issued successively against the backdrop of ecological civilization construction, and the construction of National Trail has become one of the primary directions of the system construction of natural protected areas.

Temporal clustering mapping in the Citespace software focuses on the relationship between clusters and the time span between individual clusters. A larger centrality indicates a more critical node. The network modularity index Q value is between 0 and 1, where the closer it is to 1, the better the cluster is, and this is used as the basis for judging the mapping effect [13]. The data of 184 documents were imported into Citespace to calculate centrality, analyze keyword clustering, and perform keyword co-linear mapping, as shown in Figure 2.

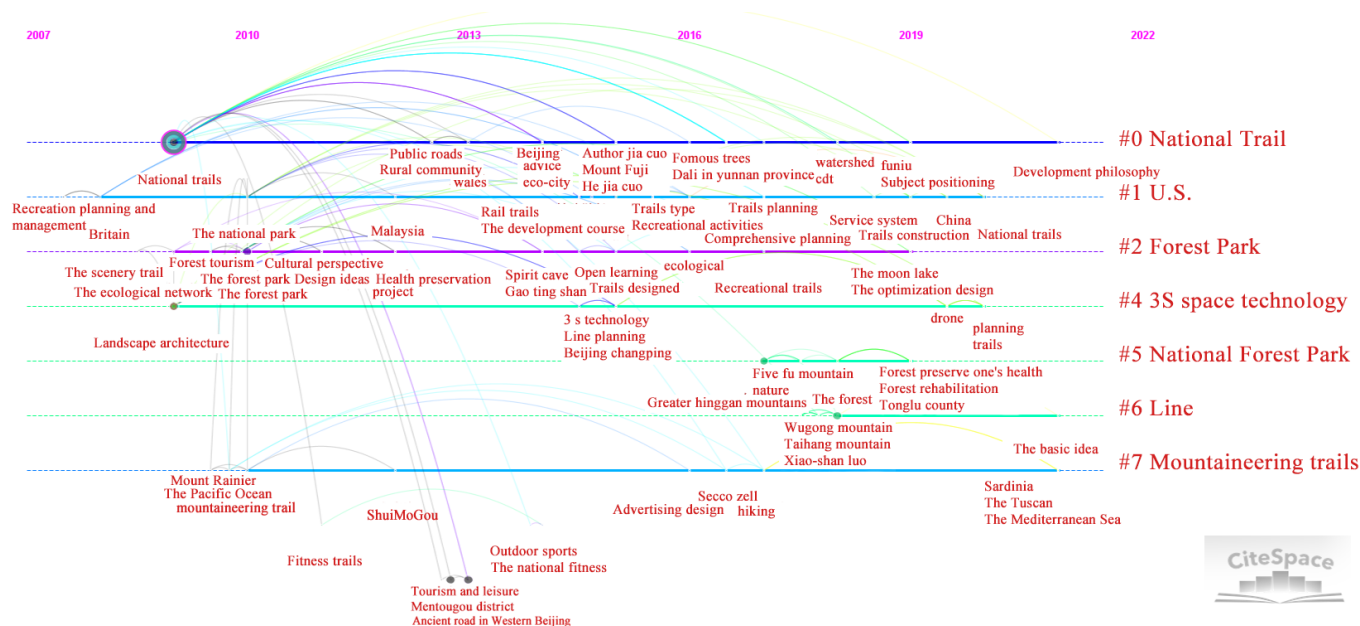


Figure 2. Time cluster map of National Trails keywords (data source: CNKI; photo credit: Citespace).

The figure shows 271 network nodes, 419 connected lines, a network density of 0.0115, a keyword co-occurrence frequency of 143 (52%), a network modularity index Q of 0.8599, and a significant network aggregation structure. The clustering labels shown on the right side of the results need to be analyzed in the context of the study as a whole. “#0 National Trail” is the main research object. “#1 U.S.” indicates that most of the research on National Trails in China is in the stage of analyzing the cases of, and learning from, foreign National Trail. “#3 Forest Park” and “#5 National Forest Park” are more oriented towards the study of national forest trails. “#7 Mountaineering trails” indicates a type of trail. “#4 3S space technology” and “#6 Line” indicate National Trail research methods and the shape of National Trails.

A century has passed since the world's first National Trail were established. At present, China's National Trails are in study and exploration stages. Although some practical achievements have been made in partial planning, many aspects need to be further studied due to its late development. For example, definitions of National Trail, trails, and scenic byways, forest trails, fitness trails, and forest swim trails, both in English and Chinese, are inconsistent, and the powers and responsibilities of trail management are unclear. There are no unified management institutions, and supporting service facilities are not comprehensive. The establishment of National Trail needs to be standardized. Establishing a theoretical framework, a technological system, and a National Trail construction procedure is the initial step. In addition, the construction of National Trail faces practical problems such as capital investment and development, regional cultural differences, and environmental pollution. Through sorting out these data, it can be seen that the development of National Trail has the following characteristics: Theoretically, the formation of trails in foreign nations mainly derives from the rapid expansion of resources and industrialization, which causes the constant degradation of the environment, hence advancing the resource and environmental preservation movement. The rapid development of urbanization leads to a yearning to return to nature and wilderness, the rise and management of outdoor recreation activities, and the emergence of recreation in the form of walking to National Trail. In this process, people become closer to natural wilderness, and the idea of wilderness has a wide impact on the world [14]. Many countries have established relevant laws and regulations for National Trail, such as the National Trail System Act of the United States, the local legal document Appalachian Trail Act of Pennsylvania, and the Royal Law Draft of Spain regulating the National Nature Trail Network. This government-led management

and these laws and regulations have significantly ensured the standardization, legalization, and sustainable development of National Trail development.

In China, the demand for outdoor travel is growing as the living standards of society continue to improve. Data show that the national total retail sales of outdoor products in 2014 were 10 times what they were in 2007, which indicates the substantial market demand for outdoor travel in China [1]. Currently, hiking trails in China include the Three Gorges of Yangtze River and Sichuan Inagi, national mountaineering fitness trails such as Ninghai in Zhejiang and Shenchu in Shanxi, national forest trails such as Taihang Mountains, Qinling Mountains, and Wuyi Mountains, and other types of trails. The concept of National Trail is less mentioned at present, and this concept, along with the concepts of “national forest trails” and “national mountaineering fitness trails”, has not been clearly illustrated. On a policy level, the State Forestry Administration started preliminary preparations for the construction of national forest trails in early 2016; the construction of national mountaineering fitness trails was carried out by the China Mountaineering Association. China’s vast territory and the diversity of natural resource types such as forests, wetlands, and mountains provide a resource base for National Trail construction; state-owned land provides the road base, and the appropriate use of existing resources can control the capital and encourage a low level of investment.

At the technical level, from the perspective of route selection, most National Trail give priority to traversing wilderness and natural areas and use existing environmental resources to build small wooden bridges and warning signs, which are necessary to guide exploration in areas with relatively safe and well-preserved natural resources [15]. Trail can be classified according to route length. For example, Japanese mountaineering trails are short-distance trails, and nature trails are long-distance trails [16], and South Korea’s national ecological trail is a collection of short trails, which can be divided into three types: riverside roads, coastal roads, and forest roads [17]. Trail can be categorized as national or local. For example, the National Trail network of Spain is divided into National Trails, regional trails, and supporting trails, which aids hierarchical management. From the perspective of trail construction, most of the more mature foreign countries promulgate standard rules for route width, material selection, service facilities, and other aspects of the National Trail to standardize management.

China has started to plan, design, and construct various types of trails since 2009, from the earliest planning and design of trails in scenic areas to the planning of mountaineering fitness trails and forest trails across regions and mountains, the research and design of infrastructure around trails, etc. Trail planning relies on traditional methods such as empirical analysis, and they lack applications of spatial technology methods, standards and norms for trail construction, and top-level designs for trail systems [18]. Shallow mountain national mountaineering fitness trail construction managers in Shunyi Wucui in Beijing tried to apply 3S technology in 2013 and proposed guidelines for construction standards for trails and service facilities based on ecological engineering method technology. National mountaineering fitness trail planners in Changping, Beijing, used 3S technology in 2014 to evaluate and plan trail impact factors, and they generated 3D trail routes and produced 3D terrain topography and planning schemes [18].

In terms of construction management, there are primarily two methods of National Trail construction. One is planning and selecting National Trail based on the upward proposal of the United States: National Trail are mainly created by the Department of the Interior or the Department of Agriculture of the relevant governments. The feasibility that a route becomes a National Trail is debated, and the environmental impact of the trail’s construction and surrounding area is evaluated. The National Trail System Act was amended to clarify the legal status of routes [1]. The other method involves the national government establishing a special National Trail management agency to carry out the planning, selection, and construction of a National Trail in a unified manner and to solve the problems in the planning and management of the trail’s implementation, including financial issues. Foreign National Trail are managed at the national level and under the

supervision of national institutions. A dedicated National Trail department is established, and a form of cooperative labor division and management involving partners, stakeholders, and volunteers is adopted.

In terms of legal documents, China first proposed to make full use of the natural conditions of mountains and water to establish fitness trails, mountaineering trails, and other outdoor sports facilities in 2011, when the State Council issued the National Fitness Plan (2011–2015). In March 2022, the General Office of the CPC Central Committee and the General Office of the State Council issued the Opinions on Building a Higher Level of Public Service System for National Fitness, which proposed to develop a National Trail system construction plan and construction guidelines. Most of the research on the construction and management of National Trail in China has been borrowed from the management methods of developed National Trail abroad, and in the management process, emphasis is placed on the division of labor and cooperation at national, regional, and local levels [16].

3. Theoretical Framework of National Trails

3.1. Construction Background

China's enormous territory, numerous natural resources, and complicated natural conditions and landforms in different regions have resulted in the establishment of a large number of diversified natural protected areas. Since the 1960s, China has achieved significant progress in the creation of its protected natural area system through the establishment of forest parks, scenic spots, a protected natural area system, a national park system, and other nature reserves. The general office of the central committee of the communist party of China in 2017 and the General Office of the State Council issued the National Parks System Overall Scheme and printed and distributed the Guidelines on Establishing a System of Protected Natural Areas with National Parks as the Main Body in 2019. Thus, the Chinese nature reserve system will be in line with international standards, and the main body of natural protection will shift from a nature reserve to a national park [19].

In the broad sense, the national park system refers to the system of state-managed natural protected areas. Constructing a classified and graded system of natural protected areas is ideal for many countries with vast territories and diversified natural resources. Although the current classification standards of various types of natural protected areas are simple, China is facing a transition period and has not yet formed a perfect system of natural protected areas in terms of management systems and protection policies [19,20].

In 2018, China established the National Forestry and Grassland Administration and created the National Park Administration. National Trails must be approved by the state and coordinated by comprehensive management agencies entrusted by the State Council to enhance the unity and effectiveness of natural ecological environment supervision [21]. Future National Trails will be an integral part of the national natural protection area system, which will be administered on behalf of the nation by the National Forestry and Grassland Administration.

3.2. Function Orientation

The National Trail is an important means of preserving the linear historical and cultural heritage, preserving the ecological corridor, showcasing China's natural environment and biodiversity, and transmitting the national cultural character. As a summary of the functions and objectives of trails in foreign countries, their primary characteristics include nature protection, wilderness, and the provision of places to enjoy nature, among others. Based on China's national conditions, China's National Trail should have the following functions:

Open recreation: Recreational behavior can alleviate the pressures of daily life and allow individuals to experience the beauty of the environment. The recreation function of the National Trail is one of the primary reasons for the development of the National Trail, which provides a public outdoor sports space that is open, fair, free, and diverse.

Ecological protection: National Trail provide locations for people's leisure and pleasure, thereby mitigating some of the usual difficulties associated with free mobility, such as

environmental degradation, disorderly activities, and safety incidents. The construction of a trail incorporates an ecological idea, which is closely centered on the aspects of route selection and material selection, and integrates trails with nature.

Culture and education: As the carrier of landscape cultural resources, the National Trail is a place for shaping the national landscape cultural image and displaying the soft power of national culture. Along the route, resource interpretation and experience facilities are installed so that tourists can fully appreciate the natural and cultural history of the region [22]. The Silk Road, the Beijing-Hangzhou Canal, the Tea-Horse Ancient Road, and other cultural concepts are established on the National Trail, which can not only protect these precious cultural resources but also allow people to enjoy these resources [2].

Economic use: The ecological resources along the National Trail connect urban and rural areas virtually, form a system, and promote the interaction and common development of urban and rural areas. The development of National Trail solves the problems of too many people, too little land, and a lack of public resources in China [23]. National Trail is constructed with a preference for poor rural areas, thus promoting rural rejuvenation, driving regional economic development, and providing additional development space to the local economy [22].

3.3. Theoretical Framework Construction

It is proposed in the Guidelines on Establishing a System of Protected Natural Areas with National Parks as the Main Body that a protected natural area system should be initially established by 2025, and a protected natural area system with national parks as the main body should be fully established by 2035. As a resource for linear space, the National Trail is an essential component of a system of natural protected areas. As with other protected areas, we must adapt to changing times and policies and use the opportunities presented by the expansion of the system of protected areas. National Trail construction needs to maintain intimate touch with the economy, society, and ecosystem in accordance with the principles outlined below, in Figure 3.

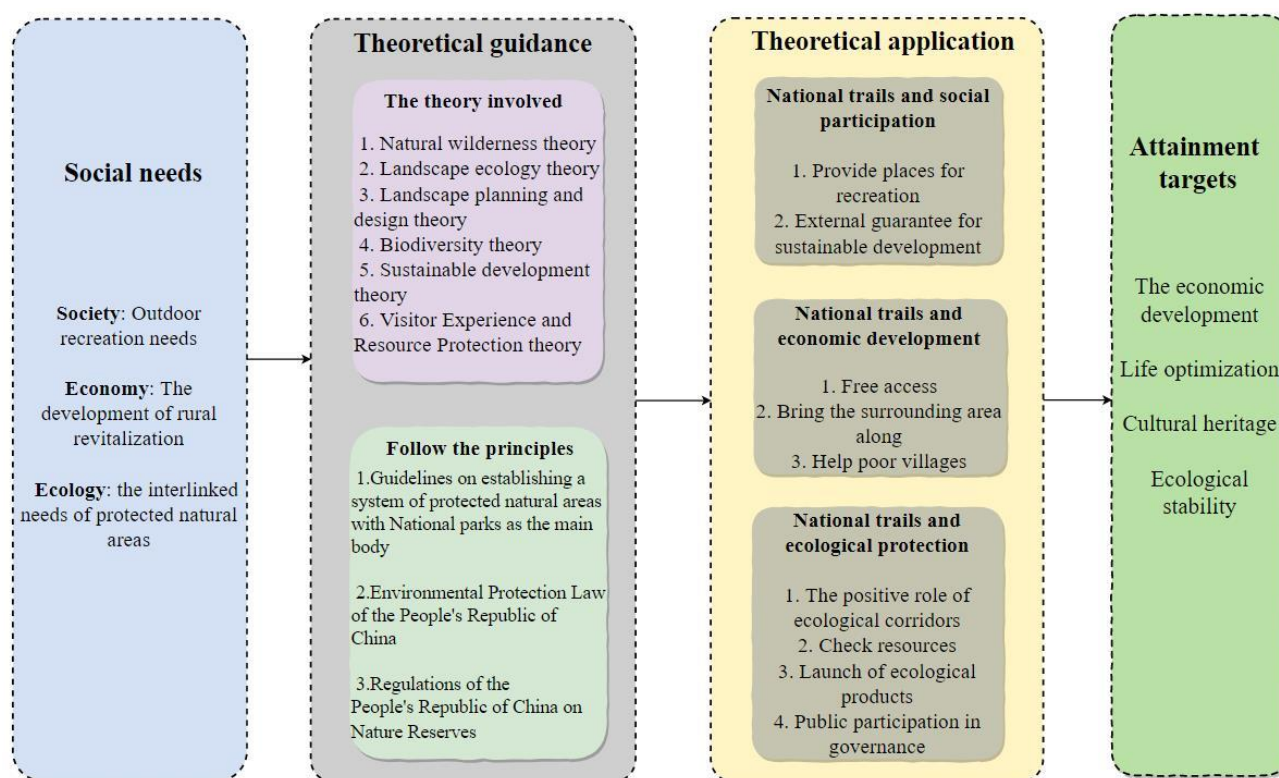


Figure 3. Theoretical framework of National Trail (photo credit: the author).

3.3.1. Social Needs

Since the 18th National Congress of the Communist Party of China (CPC), China's economy has grown significantly, its ecological environment has improved significantly, and new breakthroughs have been made in rural reform. Concurrently, we are aware that the rural economy has a weak basis, a weak economic foundation, and a delayed development. The development of National Trails provides a direction for the rural revitalization strategy, that is, to prioritize the planning and development of National Trails in poverty-stricken areas to generate income for the rural economy. While the urbanization process is accelerating, the need for nature and outdoor recreation increases. Pristine natural landscapes and authentic local culture are desired, so the proportion of hikers continues to rise. Hiking is characterized by a balanced regional economy, low requirements for service facilities, and low investment in construction and operation [1]. National Trail is an excellent basis for hiking. According to landscape ecology theory, National Trail can provide landscape corridors for living organisms and be used for enjoyment, address the requirement for linkage between natural protected areas, and promote the construction of an ecological civilization.

3.3.2. Theoretical Guidance

The construction of National Trail involves a wide range of subjects, such as territorial space planning, the ecological environment, and sports tourism. Abiding by laws and regulations mainly involves the following theories:

Natural wilderness theory: The wild is the epitome of true nature. The construction of National Trail is intended to allow humans to enjoy the natural while preserving the valuable natural outdoor environment by preventing excessive water loss and soil erosion, pollution, and environmental noise.

Landscape ecology theory: National Trail connect national parks and other natural protection areas, act as wildlife movement corridors, and connect diverse natural resources.

Landscape planning and design theory: The planning of National Trail not only exists in the field of natural science, but also considers historical and cultural environmental factors in addition to national standards and standards for trails. On the basis of landscape planning theory, cultural connotations are added to details, and the needs of landscape planning at various scales are fully considered to propose scientific and reasonable planning and design schemes [24].

Biodiversity theory: To establish a balanced state that meets the needs of social ecological security and maximizes the protection of biodiversity, the building of National Trail adheres to several management systems of National Trail and biodiversity-related treaties.

Sustainable development theory: National Trail should not exist at the expense of long-term ecological benefits or for short-term economic gains. To preserve the environment as much as possible, pathways based on sustainable development should be developed.

Visitor experience and resource protection theory (VERP) [25]: Trail construction managers should consider the tourist experience, monitor the impact on resources, find a balance between tourist experience and resource protection, and plan and manage any recreation problems of National Trail.

In accordance with the Environmental Protection Law of the People's Republic of China, the Wildlife Protection Law of the People's Republic of China, the Regulations of the People's Republic of China on Nature Reserves, and other relevant laws and regulations, regulations and suggestions on the construction of National Trail will be established, and national laws and regulations and overall planning plans will be issued as soon as possible. On the basis of relevant policies, the principles and standards of National Trail construction will be articulated, and a standard system will be developed to provide a technical basis for leading National Trail construction [26].

3.3.3. Theoretical Application

The construction of National Trail involves society, the economy, and ecology. Based on the above-mentioned theories, all areas of the development of National Trail generate linkages, mainly including the following:

National Trail and social participation. The National Trail not only provides public recreation areas, but also serves as an excellent classroom for natural education. The National Trail's wilderness enhances the scientific understanding of the environment and stimulates the love and conservation of natural mountains and rivers. On the other hand, public participation in protection governance is an external guarantee for the sustainable development of National Trail [27], and every visitor to a National Trail has a social responsibility to protect it.

National Trail and economic development. National Trail follow the principle of public welfare. The overall concept of development is: freely accessible to the public and play a vital role in constructing a beautiful country and in addressing the growing needs of the people for a better life. The development of National Trail contributes to the economic growth of neighboring regions. The construction of National Trail in impoverished areas and the development of tourism in poor areas will drive the economy, the development of infrastructure construction, and the achievement of a socialist nation.

National Trail and ecological protection. The National Trail, as a linear space connecting significant ecological protection zones, can serve as an ecological corridor from the standpoint of landscape ecology [28]. Trail constructors can carry out resource investigation and the scientific monitoring and analysis of the animals, plants, soil, and humanity of National Trail and their surrounding areas, can establish a unified monitoring index system, effective monitoring data management, and a sound monitoring implementation mechanism [29,30], and can establish a National Trail resource database and master resource dynamics. National Trail ecological products should be developed, natural resources should be appropriately allocated, ecological quality should be improved, and regional man-land conflicts should be eliminated [31]. In the course of utilizing the National Trail, the public can participate in the ecological management of National Trail while engaging in recreation, apply ecological ideas for amusement, and learn about the ecosystems of the area.

3.3.4. Achievement of Goals

From National Trail design and construction to operation, the most direct way to address the requirements for outdoor recreation is to build and operate trails. Trails offer visitors the opportunity to connect with nature and people, relax and rejuvenate, and enjoy the stunning scenery of the natural setting, while they also allow people to challenge themselves physically and mentally through self-reliant wilderness activities. The construction and follow-up management and operation of National Trail construction provide substantial development for the local economy and regional economic development, so as to achieve the goal of economic development and life optimization [32].

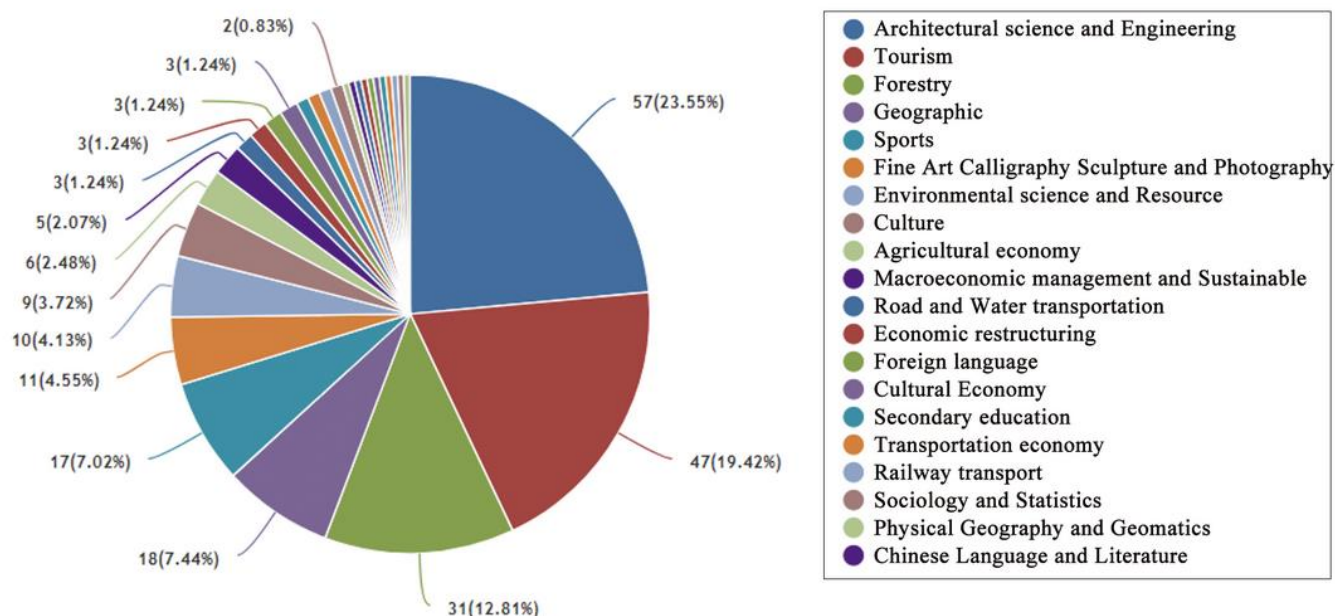
The National Trail collaborates with educational institutions to offer a range of educational experiences that enable path visitors to learn, enjoy, and explore the trail's natural and cultural heritage. National Trails run through the country's representative natural and historical cultures, connecting vast forest landscapes with a wide variety of aquatic and terrestrial habitats, and unifying the understanding, management, and conservation of representative natural resources in a way that no other single nature reserve can provide [23]. At the same time, visitors have the ability to see, hear, and feel the surrounding nature, as well as experience the cultural accumulation through the historical landscape. In terms of the construction of the trail, such as plane layout, material selection, spatial scale, and humanized design, ecological landscape construction techniques are adopted [33] to protect natural and cultural resources and promote their effective utilization in the operation process.

4. The Technology Process of National Trails

4.1. Technical Methods

4.1.1. Scientific Basis

The research on National Trail construction covers a wide range of disciplines. The disciplinary distribution analysis was conducted in cooperation with related disciplines for the purpose of integrating disciplines. The analysis results of the visual analysis of discipline distribution of the 184 articles mentioned above according to the CNKI search results are shown in Figure 4.



Note:

Data not shown in the chart: Secondary Education 2 (0.84%), Physical Geography and Mapping 1 (0.42%), Chinese Language and Literature 1 (0.42%), Literary Theory 1 (0.42%), Preventive Medicine and Health 1 (0.42%), Archaeology 1 (0.42%), Demography and Family Planning 1 (0.42%), Jurisprudence, History of Law 1 (0.42%), Medical and Health Policy 1 (0.42%), Chinese and International Politics 1 (0.42%), Sociology and Statistics 1 (0.42%), Trade Economics 1 (0.42%), Service Economics 1 (0.42%).

Figure 4. Distribution of National Trail research disciplines (data source: CNKI; photo credit: CNKI). Note: The unmarked part of this pie chart accounts for 7.02%.

The research on National Trails and trail systems involves a wide range of disciplines, which are mainly classified as architectural science and engineering, tourism, and forestry, accounting for 55.78% of the total. The development of a National Trail entails a vast region, complex and diversified natural resources, and so on. National Trail construction involves a series of problems such as budget management and resource protection. National Trail construction is an interdisciplinary study in the context of ecological civilization construction, which requires a comprehensive consideration of ecology, heritage, and cultural resources, and addresses the relationship between humans and nature [34].

4.1.2. Utility Methods

The second part of the 20th century was dominated by the creation of trails in other nations, and various technological solutions have been developed for the construction of National Trail, including the Environmental Impact Assessment System (EIA) in the 1970s, the theory of Recreation Opportunity Spectrum (ROS), which was first applied in the Handbook of National Scenic Trails in the North of the United States [35] in the 1980s, and the Limit Acceptable Change (LAC) theory and the Visitor Impact Management Model (VIMM) in the 1990s [36]. In China, actor–network theory was first applied to the management of national mountaineering fitness trails, ROS Theory [37], and Interpretative

Structural Modeling (ISM) [38], combined with the operation and management of national mountaineering and fitness trails.

In recent years, as a result of the unceasing advancement of science and technology, the use of analytic methodologies and geographic information technology has been progressively more extensive, and research methods have become progressively more diverse.

SWOT strategic analysis. SWOT is an acronym for strengths, weaknesses, opportunities, and threats. On the basis of a comparative examination of their own condition and external environment, the SWOT approach is utilized to examine the advantages, disadvantages, opportunities, and threats of China's natural protected areas.

3S planning technology. 3S includes Remote Sensing (RS), Geography Information Systems (GIS), and Global Positioning Systems (GPS). The range value is set according to the standard and applied to the study of trail planning and route selection [39,40].

Big data analysis. The method commonly used in trail research abroad is Visitor-Employed Photography (VEP), which requires manpower and material resources. In 2007, Goodchild, the father of geographic information science, proposed Volunteered Geographic Information (VGI) [41], which includes mobile phone signaling data and social network data uploading and analysis.

4.2. Technical System and Practice

The development of the National Trail technology system requires a theoretical framework and technical procedures. The National Trail technology system is built by combining the aforementioned theoretical framework with scientific principles and technical methodologies, as shown in Figure 5.

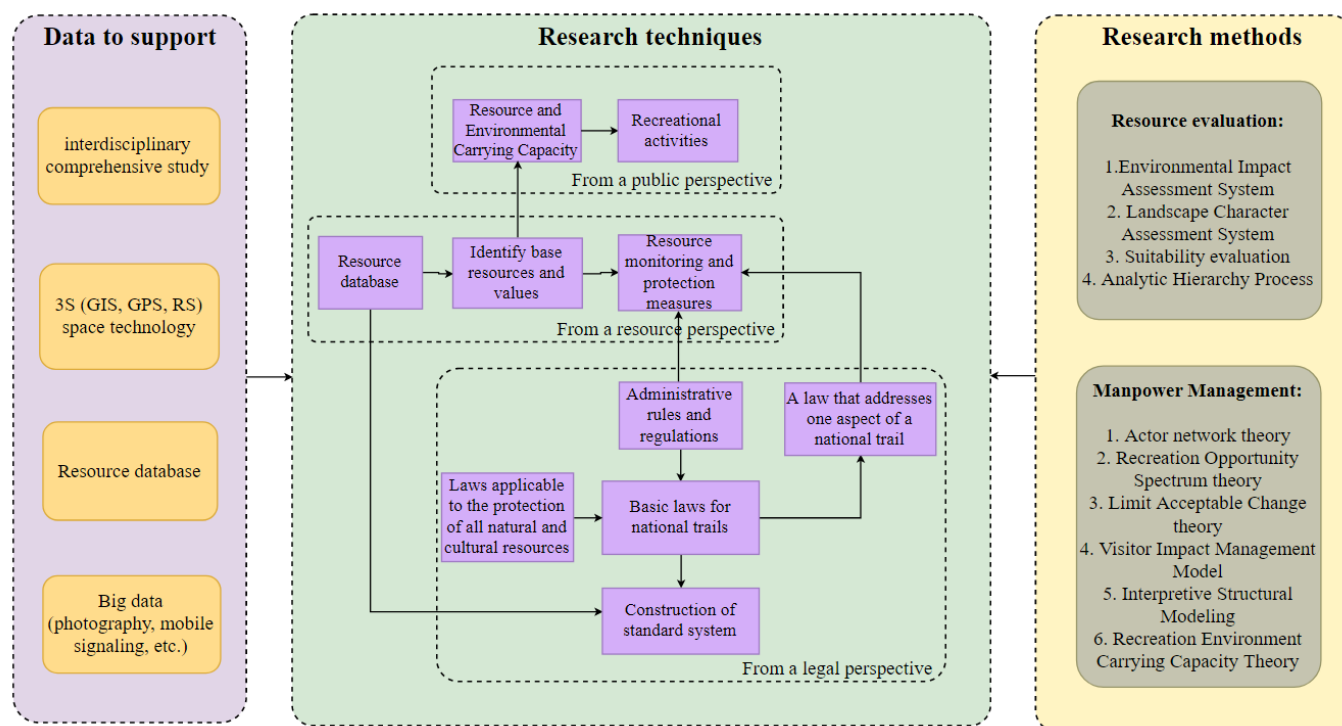


Figure 5. National Trail Technology System Diagram (photo credit: the author).

4.2.1. Data to Support

Planning and maintenance of National Trail are impossible without data management. The research on National Trail is an interdisciplinary comprehensive study that employs the ArcGIS platform in the context of territorial space planning and big data era in order to build a resource database and regularly update it throughout the planning and operation of National Trail. It provides not only detailed data for the effective protection of natural and

cultural resources, but also data for the cooperative development of the social, economic, and ecological benefits of National Trail landscapes.

4.2.2. Research Techniques

As a specific type of natural protected area, the trail's use and landscape resources differ significantly from those of conventional natural protected areas. The operation period of the National Trail mainly includes two parts: the utilization of resources and the use of the public, which are guaranteed by laws and norms.

Natural and cultural heritage resources have the integrity and limitations of general resources, and the National Trail landscape is distinctive and irreplaceable from the standpoint of resource utilization. A National Trail resource management department will examine the region's basic data in order to determine the significance of regional resources, evaluate and grade the human and natural resources using the resource database, and then determine the value of protection and resource utilization in addition to planning protection measures.

Public Use Angle: Resource and Environmental Carrying Capacity (RECC) [42] refers to the maximum supporting capacity or maximum guarantee degree of the natural environment for human activities, and can also be used as a quantitative indicator of the coordination degree between the human social system and the natural environment system [43]. The big data analysis of the daily capacity of tourists, the annual capacity of tourists, and other scale indicators plays a role in National Trail planning and construction management, identifying the optimal environmental capacity of National Trail, and scientifically advancing recreation planning.

From the standpoint of law and regulations, a basic database can provide data support for the construction of standard systems and promote National Trail legislation based on all applicable laws pertaining to the protection of natural and cultural resources.

4.2.3. Research Methods

A National Trail mainly traverses iconic natural and cultural landscapes, including national nature reserves, national parks, ancient villages, historical ancient roads, and other cultural relics. The scope of planning and design mainly includes natural resources, routes, function, materials, signs, service facilities, and peripheral resources.

Route planning requires length, width, elevation, and slope details. Trail planning uses 3S space as the carrier, so 3S technology is integrated into the trail planning process to construct the trail scientifically and efficiently. Planners can thus define the functional positioning of National Trail, determine the appropriate crowd, select appropriate difficulty levels, determine the needs of a crowd, select the environmental themes of trails [18], evaluate the value of resources, collect spatial data, build a traffic network and service facilities, and conduct real-time monitoring. A trail and surrounding service facilities should be supplemented by public transport stations, rest facilities, road signs, information signs, cultural signs of trail symbols, guidance manuals, and regular surveys of public opinion about the trail [44]. We will construct National Trail with extensive auxiliary amenities and clean roads to satisfy the public.

5. The Construction Management of National Trails

On the basis of the aforementioned theoretical framework and technical system of National Trail construction, the major components of National Trail construction management, including planning, management, laws and regulations, are shown in Figure 6.

5.1. Planning

The establishment of a National Trail planning system is the most fundamental aspect of National Trail construction and affects the quality of National Trail construction as a whole. The construction of a National Trail planning system mainly includes basic

document planning, general management planning, strategic planning, and detailed and special planning.

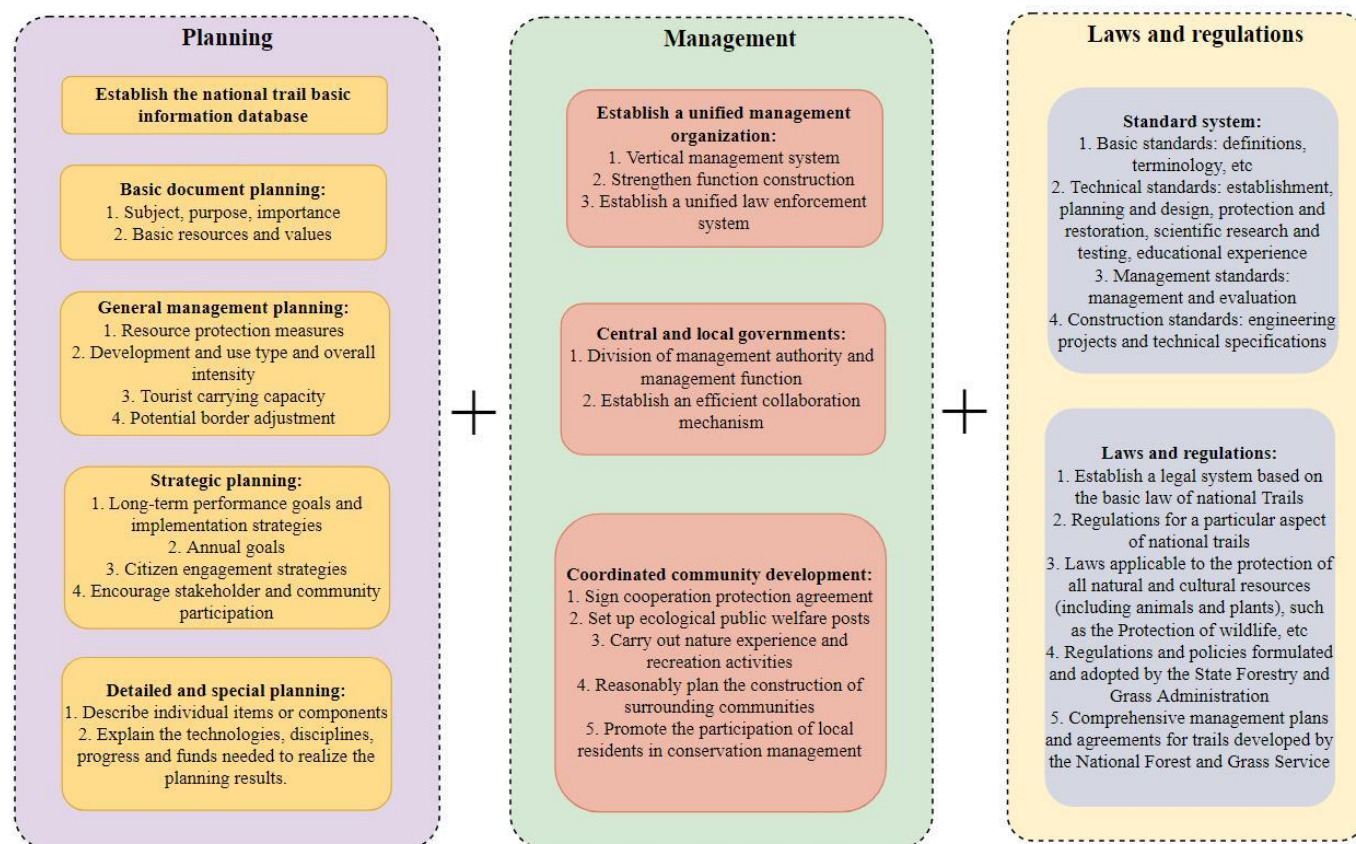


Figure 6. Analysis chart of National Trail construction management (photo credit: the author).

To establish a National Trail planning system, the first step is to establish a National Trail basic information database and explore the research. First, basic documents of the National Trail, including documents on the purpose, importance, basic resources, and value of the trail's development, are planned, along with the National Trail's overall plan and general planning documents. The second is a comprehensive management plan, which includes the conservation measures for the trail resource, the kind and overall intensity of development usage, the visitor carrying capacity, and the potential for boundary modifications.

Secondly, strategic planning is carried out, including long-term performance goals and implementation strategies, annual goals are described, civic engagement strategies are determined, stakeholders and communities are encouraged to participate, and key external factors that can significantly affect the realization of goals are identified [45]. An exclusive strategic plan for each trail, considering the release of information related to the trail, trail management and protection, trail publicity, community relationship maintenance, volunteer recruitment, etc., is developed [46].

Finally, individual projects or individual components are explained through comprehensive planning and special planning, and the technologies, disciplines, equipment, infrastructure, schedules, and funds required to achieve the planning outcomes are outlined in depth in a specific operational plan.

5.2. Management

A uniform, standardized, and efficient National Trail management organization needs to be established. This entails establishing a "government-led, multi-party participation, zoning management" method of management, developing a vertical management system, and enhancing National Trail function construction. To handle the stakeholders, funds, and

operations of National Trail, a uniform law enforcement framework should be constructed. Within the framework of National Trail, stringent and effective measures must be adopted to conserve natural resources and the ecological environment.

The central and local management authority of the National Trail must be clarified, and management functions must be clearly reflected. The administrative power and collaboration mechanism of National Trail district governments should be clarified. Combined with domestic tourism resources management, foreign partners and volunteers should participate in the management mode, considering advantages and disadvantages, the implementation of local conditions, and effective management [7].

We will enhance the mechanism of coordinated community development. Signing co-operation agreements on natural resource conservation and establishing public service posts for ecological environment can lead to the development of a community co-management system that conserves the resources of surrounding National Trail. The community planning and construction of small towns around the National Trail should be carried out, natural experiences and recreational activities should be allowed, and local and surrounding residents should be invited to participate in the protection and management of National Trail and franchising [46].

5.3. Laws and Regulations

It is important to accelerate the strengthening of the system of laws and regulations governing natural protected areas, provide additional clarifications on National Trail, and develop management and implementation guidelines for each National Trail. Rules and regulations are conducive to maintaining the uniqueness of each National Trail, reducing the duplication of other laws, and standardizing various National Trail construction and recreational activities [47]. First, the formation of a legal system based on the fundamental law of National Trail should be paired with laws relevant to the protection of all animals, plants, and natural and cultural resources. At the national level, laws for establishing a certain aspects of the National Trail (such as resource utilization and recreational utilization) should be introduced, including natural resource protection, franchise systems, and legal liability. Secondly, local legislation should be carried out. Relevant regulations and policies should be formulated and adopted by the National Forestry and Grass Bureau, and comprehensive management plans and agreements should be formulated for each trail [48].

The formation of norms and standards should be predicated on compliance with laws and regulations. The establishment of National Trail standards can be divided into basic standards, technical standards, management standards, and construction standards. National Trail is properly delineated and categorized based on national indicators. Such technical standards include a standard formulation of basic conditions for National Trail construction, an investigation of National Trail resources, an evaluation of resource values, and National Trail construction specifications [48]. Volunteerism, public welfare posts, community environmental governance, and other components should be detailed in management standards, and resource assets, management effectiveness, and ecological service values, among other factors, should be evaluated. Thus comprises the ideal construction standards for the actual design and construction of applicable technical specifications and rules.

6. Conclusions

6.1. Results and Discussion

China is incorporating national parks into its numerous nature reserves, which are abundant in natural resources. The development of the national park system has established a new direction for the nature reserve system. National Trail, a vital component of the system of natural reserves, have a clear path for future development. The building of National Trail in China satisfies the demand for ecological civilization development as well as construction and management standards, as has been demonstrated. Governments at all

levels should grasp the opportunity to aggressively promote the growth of National Trail, so that they become an important link between nature reserves as quickly as possible.

This article synthesizes the requirements of China's current stage of development and the accumulated experience and lessons of foreign National Trail, and proposes the planning and preparation of National Trail construction, the integration of existing trail resources for unified management, and the construction of a National Trail research framework. It concentrates on the theoretical foundations, technical procedures, and construction systems of National Trail. Beginning with the premise that theory is applied with technical methods as a guide, a detailed analysis of social needs and feasible operations is conducted. Data on National Trail resources are integrated using appropriate methodological tools. Finally, the standardized management of National Trail is explained. The framework for the study of National Trail in China is organized and summarized in Figure 7.

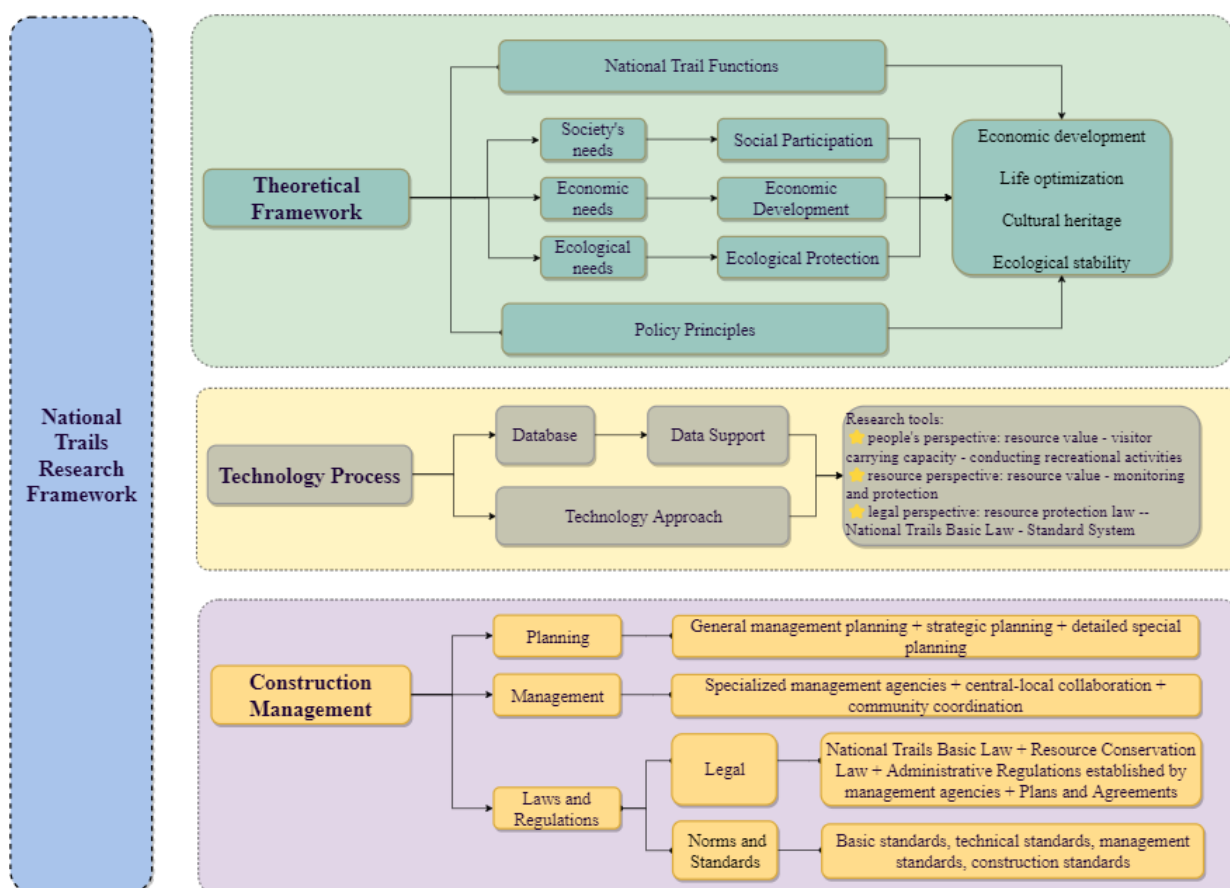


Figure 7. Framework of China's National Trail research (Photo credit: the author).

In many foreign nations, the development of National Trail has reached maturity, whereas the planning and construction of National Trail in China has only evolved within the past decade. The general status of research is disorganized, and the research on National Trail focuses mostly on the definition of concepts, foreign references, landscape planning, and design. This is not only detrimental to inter-disciplinary communication and dialogue, but also to in-depth research on National Trail and research on the planning of a National Trail system. For inter-institutional collaboration and multidisciplinary cross-fertilization, it is necessary to clarify the creation of National Trail at the national level in order to investigate the research framework and practical application of National Trail research in greater depth.

The creation of National Trail in China cannot be isolated from the system and construction experience relating to the building of nature reserve and national park systems. The construction of a National Trail is a process of constant improvement and long-term de-

velopment. At present, National Trail are only mentioned in various “Opinion” documents, policies given at the national level are insufficient, and management is lacking, and there is no special National Trail management agency [49]. Existing hiking trails, forest trails, mountaineering fitness trails, and other trails are not connected, planning and development orientations are not harmonized, and allowing them to develop would have catastrophic results. Although forest trails and mountaineering fitness trails are in the process of being constructed, and the length of the routes is growing, no design standards or design principles that stand up to scrutiny have been established, resulting in a disparity in the quality of the routes. Only by conducting complex research work on natural resources, fully investigating and grasping the current situation, and comprehensively analyzing information related to National Trail can we have a basis to rely on in the subsequent planning and design stages [43]. It is necessary to establish a special management body for National Trail as soon as possible, so as to formulate legal standards pertaining to National Trail, to normalize and standardize the construction of National Trail, and to prepare adequately for the future construction of National Trail systems.

6.2. Theoretical and Practical Implications

Construction of a National Trail research framework can not only improve the nature reserve system, but also guide the overall planning and development of other types of National Trail and the direction of resolving landscape corridor construction issues that will be encountered during the development of national parks within the nature reserve system.

Responding to the strategy of rural revitalization and implementing the construction of a national ecological civilization, it will also be helpful to supplement the research system of nature reserves and national parks and to enrich the theoretical framework construction of various disciplines, such as territorial spatial planning, landscape ecology, and management.

First, the National Trails Research Framework was constructed to provide a theoretical foundation and policy basis for the formal establishment of National Trails in the future. National Trail theory, through the application of relevant technical methods, indicates the main principles of compliance in terms of economic development, social participation, the ecological aspects of the practice and guidance, and the practice level based on human and natural resource data, and the National Trail construction process involving planning, management, and laws and regulations can be organized. The ultimate objective is to attain economic growth, life optimization, cultural preservation, and ecological stability.

Second, the technical process of National Trail can provide general guidelines for the development and design of various types of trails. A scientific examination of trail resources can, to a certain extent, optimize trail development by using National Trail resources and methodological tools. Improving the standardized design of National Trail and strengthening their methodological approach is of tremendous practical importance.

Third, the planning and administration of National Trail facilitates the integration of resources across several spaces. Greenways, as a landscape resource in the form of a belt, can function independently as a provider of scenery and connect the surrounding dispersed landscape components. Building National Trail, as a novel method of utilizing ecological resources, together with the existing condition of National Trail construction in China, can lead to the development and unified construction of National Trail. It is important to adhere to the concepts of green development to create a close relationship between people and nature.

Fourth, the National Trail is one of the national park system's expansions built in the context of ecological civilization development. Currently, China's economic development and ecological civilization construction are intertwined, with natural reserves serving as the core carrier and key area of ecological civilization construction. The establishment of a National Trail adheres to the principle of harmonious coexistence between humans and nature, and a National Trail creates a wild, purely natural recreational space that satisfies people, achieves ecological restoration and protection, and creates a beautiful habitat.

6.3. Limitations and Future Research

The construction of National Trail in China is an inevitable product of economic and social development and an important part of national infrastructure construction. This study seeks to provide preliminary research preparation for National Trail construction on the basis of interNational Trail construction experience and existing research. Despite this, the creation of National Trail is a complicated and diverse undertaking that necessitates cooperation and consideration due to the several disciplines and fields involved. Due to limited knowledge and insufficient research experience throughout the writing process, the discussion on the construction of the National Trail lacks in-depth analysis, and its operability requires further demonstration and investigation.

First, building a research framework for National Trail in China is not discussed in length in this study; only a few proposals or concepts are presented. In the future, it is anticipated that a greater number of scholars will undertake more in-depth research on this topic in accordance with China's national conditions and will continue to promote the next phase in the creation of National Trail.

Second, the analysis of actual National Trails can be much more developed. Despite the fact that this work integrates and analyzes actual case studies of National Trail based on prior research, there may be many difficulties in the analysis of National Trail cases due to restricted capacity, fewer sources, and undeveloped theories. In light of this, the authors anticipate more in-depth inquiries into, and resolution of, these difficulties in upcoming practice-oriented work.

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