Competitive Ecological Niche of Archival Data and Its Optimization Strategies

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Abstract

【Purpose/Significance】 In the era of big data, the value and significance of archival data are increasingly prominent. However, the explicit or implicit competition among different types of archival data is detrimental to the maximum realization of archival data' s value as a production factor. 【Method/Process】 Based on niche theory, and proceeding from the three fundamental dimensions of resources, function, and spatiotemporal aspects, the "state," "potential," and "energy" of archival data competition can be understood and the comprehensive situation of archival data's competitive ecological niche can be examined through two core indicators: breadth and overlap. 【Results/Conclusion】 In response to existing issues such as the need for expansion of archival data resources, high overlap in interdisciplinary talent resources, weak production factor value, unbalanced regional development, and barriers in digital space, this paper proposes that, led by archival departments, the ecological niche occupation of archival data in the three dimensions of resources, function, and spatiotemporal aspects be systematically adjusted, the competitive synergy of archival data populations be enhanced, and consequently the adaptation and evolution of archival data species be promoted at a higher level.

Full Text

Competitive Niche of Archival Data and Its Optimization Strategies

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Abstract

[**Purpose/Significance**] In the era of big data, the value and importance of archival data are becoming increasingly apparent. However, explicit or implicit competition among different types of archival data hinders the full realization of archival data element value. [**Method/Process**] Based on niche theory, this study examines the competitive "state," "trend," and "potential" of archival data by analyzing three fundamental dimensions—resources, functions, and spatio-temporal characteristics—using two core indicators: breadth and overlap. This approach enables a comprehensive assessment of the competitive ecological niche of archival data. [**Results/Conclusions**] Addressing current issues such as the need to expand archival data resources, high overlap in composite talent resources, weak value of production factors, uneven regional development, and barriers in digital space, this study proposes that archival departments take the lead in systematically adjusting the ecological niche positioning of archival data across the three dimensions of resources, functions, and spatio-temporal factors. This will enhance the competitive and cooperative capabilities of archival data populations, thereby promoting the adaptation and evolution of archival data species at a higher level.

Keywords: Archival Data; Archival Data Niche; Co-opetitive Capacity; Niche Optimization

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Archival data, as a crucial component of the national public data resource system, possesses both archival attributes and data characteristics. Its development trajectory directly influences the positioning and goal attainment of archival undertakings. The 2025 Government Work Report positions data work as a core element for developing new productive forces and promoting the digital economy, while archival work is incorporated into the frameworks of social governance, livelihood security, and spiritual civilization construction [1]. This highlights the dual role and potential tension of archival data within the macro policy framework. Specifically, within the archival data ecosystem, different populations compete for resources while ecological factors remain insufficiently coordinated; externally, archival data must compete for survival space with other "data species" in the broader data resource system. Against this backdrop, introducing niche theory demonstrates significant relevance—the theory emphasizes achieving coexistence and development through continuous adjustment and optimization of interactions with the environment. Embedding it in the competitive analysis of archival data helps explore the dynamic adaptation mechanisms and co-evolutionary pathways of archival data in complex data environments.

[Figure 1: see original paper]

Niche theory and data ecology first emerged in foreign research, with applications in competitive analysis across education, business, and other fields [2], yet

rarely connected to archival studies. Scholar Brett Aho notes that China' s treatment of data as a new production factor increasingly orients data toward public goods, creating a unique data ecology distinct from other countries [3], with archival data forming an indispensable part of China' s public data resource system.

A CNKI database search using the keywords "archives" AND "niche" reveals relevant research dating back to 2003 (Figure 1). Archives-related themes represent a hotspot in academic research, with scholars such as Kang Li conducting early explorations in this domain. They examined fundamental principles of archives niches, including state, dimensions, breadth, overlap, and dynamics [4], and designed indicators to measure comprehensive national archives in China [5][6]. Information niche has also attracted scholarly attention; for instance, Nie Yunxia et al. explored archival resource security issues from the perspective of information producers, information service institutions, and information user niches, proposing corresponding construction measures [7]. Yu Yingxiang et al. mentioned the need for archival departments to address the information niche breadth and competitiveness of archival data management in their discussion of archival data operation ecology [8].

Overall, both foreign theoretical discussions on niche theory and domestic archival scholars' explorations based on niche theory provide important references for this study. However, existing research has not taken archival data as the core object under niche theory, and most studies merely interpret the meaning and composition of archival data ecology. The integration of archival data and niche theory requires further expansion and deepening. Therefore, this paper examines archival data in competitive environments from multiple levels and dimensions based on niche theory, aiming to clarify the internal and external development situation of archival data, explore future footholds for archival work, and facilitate high-quality development of archival undertakings in the new era and environment.

1.1 Archival Data and Its Niche

Archival data refers to "digitized archival information and data records with archival characteristics" [9]. It carries the authenticity and integrity core functions of historical memory while possessing data features of shareability, analyzability, and value-added potential, making it an important component in the national data ecology with dual functions of cultural inheritance and element circulation.

Niche refers to the temporal and spatial position of a biological unit (species, population, or individual) in a specific ecosystem and its functional relationships with related biological units [10]. Biological units undergo long-term changes and development through competition and cooperation, adapting to the environment to gain survival advantages; thus, niche represents a combination of absolute dynamics and relative stability. Fundamental niche theories include

niche overlap and separation theory, niche expansion and compression theory, and niche state-potential theory [11].

The archival data niche constitutes the dynamic position and functional relationships that archival data occupies in a specific ecosystem. Its connotation manifests at two levels: externally, archival data interacts with ecological factors such as politics, economy, and technology to form a dynamic balance of "environmental adaptation—resource acquisition—value release" ; internally, it comprises basic factors including archival data ontology (e.g., documents, audiovisual materials), archival data subjects (e.g., archival departments, enterprises, public actors), archival data technologies (e.g., storage and analysis tools), and archival data institutions (e.g., policies and standards) that collaboratively construct a multi-dimensional ecological space. Through value realization activities driven by archival data subjects and technologies, this forms resource positioning and functional orientation. This niche exhibits hierarchical characteristics (individual, population, and community-level nesting), multi-dimensionality (encompassing spatio-temporal, resource, and functional niches), and relative stability. Its extension can reach specific branches such as network archival information resource niches, archival metadata niches, and archival management data niches, reflecting the differentiated positioning and systematic connections of archival data across various ecological scenarios.

1.2 Competitive Niche of Archival Data

Due to resource scarcity, biological units continuously face multiple forms of competition—internal and external, explicit and implicit. Competition represents both an interrelationship among biological units and a fundamental state for achieving ecological positioning. The competitive niche emphasizes niche breadth, niche overlap, competitive roles, and core resource capabilities of biological units during competition [12].

In the archival data domain, inter-population competition manifests as differentiated competition among archives at different levels and regions in building characteristic resources, while competition for high-quality archival data talent also exists between archival departments and data management departments. The resulting competitive niche of archival data does not passively accept environmental selection. Instead, it is influenced by the "human" factor (including organizations and individuals) as archival data subjects who adapt to environmental changes, make active choices, and participate in competition, leading to continuous dynamic evolution. Specifically, the competitive niche of archival data refers to the survival and development pattern formed through dynamic competition by proactive archival data subjects (including organizations and individuals) during niche evolution in archival science. Its core connotation manifests as: three-dimensional competitive elements of "state" (resource input and accumulation status), "potential" (environmental influence and resource utilization outcomes), and "capacity"(initiative and ability for resource acquisition); diversified competition patterns formed through interference competition (where

stronger parties directly squeeze weaker parties' niches) and resource utilization competition (where archival data subjects compete for limited resources); complementary and cooperative "co-opetitive" relationships built at the population level; dynamic adaptation with the external environment through "balance–imbalance–new balance" at the species level; and ultimately forming an ecosystem evolution mechanism with survival, competitive, and developmental capabilities.

It should be noted that in the ecological pattern with multiple archival data subjects, archival departments must occupy a dominant position due to their irreplaceable role in maintaining data authority and public interest. However, emphasizing the leading position of archival departments does not exclude multi-subject participation; rather, it advocates ensuring their "gatekeeper" role in the ecology through institutional design to ultimately achieve the unity of publicness, security, and innovation in archival data governance. This ecological pattern construction represents both an inevitable requirement for national governance modernization and a critical defense for safeguarding collective human memory in the digital age. Therefore, in constructing the competitive niche of archival data, archival departments should actively participate in competition and, through coordination, division of labor, and resource optimization, react upon the data ecosystem to promote the optimization and upgrading of the competitive niche of archival data.

2 Underlying Framework of Archival Data Niche

Drawing on biological research approaches to the measurability of biological unit niches, this paper aims to construct a methodological-level underlying analytical framework for archival data niches. Every archival data population must assess its spatio-temporal conditions, acquire certain resources, and develop distinctive functions to occupy an ideal niche [13]. Evidently, the three dimensions of spatio-temporal, resource, and function constitute the fundamental entry points for interpreting the essence and components of archival data niches. Given that niche separation and expansion form the basic driving forces for subject evolution and intensify competitive states, this paper selects niche overlap (reflecting competition intensity) and breadth (reflecting resource utilization scope) as core measurement indicators for archival data to quantitatively characterize its competitive and adaptive capabilities. This ultimately forms the underlying framework of archival data niche shown in Figure 2 [Figure 2: see original paper], where core indicators examine fundamental dimensions to help understand the performance of "state," "potential," and "capacity" competitive elements, thereby revealing the survival status of archival data populations and species and providing a foundation for in-depth understanding of the competitive niche of archival data.

[Figure 2: see original paper]

2.1.1 Resource Dimension of Archival Data Niche

The resource dimension forms the foundation of other dimensions. For archival data, resources are prerequisites for survival and development; the abundance, breadth, and adaptation to all resources measure archival data' s comprehensive capabilities relative to competitors. Various resources available for archival data value realization activities include archival data ontology, archival data subjects, and archival data technical equipment. Among these, archival data ontology is the basis for all related activities and the source of nutrients for archival data to exert evidentiary, historical-cultural, and production factor values. The possession of archival data ontology measures the scope of activities that archival departments can undertake, while the quality of archival data directly affects the effectiveness of value realization activities. Archival data subjects, as key resources in the archival data niche, refer to various talents in enterprises, public institutions, or among the public who participate in archival data value realization activities. Archival data technical equipment comprises the technical means and supporting devices that archival data subjects can utilize, primarily involving databases, artificial intelligence, blockchain, and other technologies. The cognitive, activity, and decision-making capabilities and initiative of archival departments influence the action orientations of diverse subjects such as enterprises and the public, which in turn determine the mastery of other resources like data acquisition and technology utilization. Meanwhile, social, economic, political, institutional, and cultural environments closely related to archival data value realization activities, as well as social demands and evaluations of archival departments, also constitute important factors affecting the archival data resource niche, relating to the potential resources of archival data.

2.1.2 Functional Dimension of Archival Data Niche

The functional dimension represents the core dimension of archival data niche, referring to the diverse roles, service functions, and synergistic empowerment value that archival data undertakes in the data ecosystem for both archival undertakings and the data ecosystem. This dimension manifests both as diversified functional forms such as cultural inheritance, policy decision-making support, public services, and data element circulation formed through resource development, and as support effectiveness for macro objectives like data sovereignty maintenance, data governance optimization, and digital memory construction through functional output. Its functional boundary expansion is influenced by dual factors—subject capabilities (driven by "capacity") and social demand orientation (driven by environmental tendencies)—presenting dynamic adaptation characteristics.

At the species level, the archival data functional niche is rooted in the core responsibility positioning of archival institutions. The *Archives Law of the People' s Republic of China* (2020 Revision, hereinafter "New Archives Law") comprehensively and systematically outlines the strategic planning for China' s archival undertakings development and future direction, explicitly stating the need to

"uphold the leadership of the Communist Party of China" in archival work, adhere to the political positioning of archival work, and establish and strengthen the political attribute that "archival work bears the Party' s name" and the sacred duty of "managing archives for the Party, preserving history for the nation, and serving the people" [14]. This directly maps to archival data' s evidentiary guarantee function in government data ecology, memory inheritance function in cultural data ecology, and knowledge service function in public data ecology. At the population level, differentiation of archival data functional niches is shaped by differences in data attributes and subject role coordination: first, different categories of archival data (e.g., government archives, livelihood archives, cultural heritage archives) focus on segmented functions such as administrative supervision support, livelihood rights protection, and cultural IP development due to content characteristics and value density differences; second, diverse actors (e.g., archives, data management institutions, enterprises, the public) undertake complementary functions like data aggregation, intelligent analysis application, and scenario-based service supply based on resource endowment differences. This functional layering and cooperation mechanism both avoids resource depletion caused by excessive niche overlap and forms systematic service capabilities through functional network weaving.

2.1.3 Spatio-Temporal Dimension of Archival Data Niche

The archival data spatio-temporal niche comprises temporal and spatial dimensions, with resource and functional dimension construction requiring consideration of spatio-temporal factors. The temporal dimension of archival data niche refers to the time periods occupied by multiple subjects in archival data value realization activities. From the internal environment perspective, the richer the resources such as relevant technologies, talents, and funds, the more frequent the activities of subjects across time periods; from the external environment perspective, the clearer the data governance responsibilities of archival departments and the greater the recognition of archival data element value, the more active the performance in the temporal dimension. The spatial dimension of archival data niche refers to the space involved in archival data value realization activities. In big data environments, archival data becomes increasingly active in digital space: on one hand, the archival work environment extends from physical space to digital space, with digital archives (rooms) continuously emerging, placing the formation, management, and utilization of archival data in virtual environments; on the other hand, as archival information resources transform from digital state to data state, the digital space occupied by archival data storage continues to grow rapidly.

2.2 Core Indicators of Archival Data Niche

The big data era increasingly demands data aggregation effects. Therefore, optimizing archival data niches cannot rely solely on enhancing the competitiveness of single-type subjects (or "species"); more critically, it requires promoting

co-opetitive relationships of mutual constraint, coordination, and integration among different archival data populations to enhance overall co-opetitive capacity. This necessitates that indicators for assessing archival data niche breadth and overlap more comprehensively consider the complexity of such co-opetitive interactions.

2.2.1 Archival Data Niche Breadth

In the biological world, niche breadth manifests as the adaptation range of biological units to ecological factors or the diversification degree of environmental resource utilization. Accordingly, archival data niche breadth represents the scope and quantity of archival data' s adaptation, occupation, and utilization of ecological factors across resource, functional, and spatio-temporal dimensions [15]. Archival data niche breadth must first be appropriate; excessive expansion may cause spatio-temporal compression, resource grabbing, and functional overlap, reducing distinctive advantages and intensifying population competition. The measurement of archival data niche breadth also implies equilibrium requirements—balanced breadth across different archival data niches leads to internal coordination. Taking the archival data resource niche as an example, breadth equilibrium manifests as: first, diverse, rich, and sufficient sources and types of archival data ontology; second, archival data subjects encompassing multi-disciplinary professionals in data, computer science, law, etc., meeting population survival and development needs; third, complete technologies and supporting equipment for data collection, processing, and mining, providing strong support for value realization; and finally, comprehensive legal regulations covering the entire archival data lifecycle and broad social support.

2.2.2 Archival Data Niche Overlap

Niche overlap measures the similarity between two different biological units and their ecological factors [16]. Different biological units' niches may overlap in one or multiple dimensions; the more overlapping dimensions and the closer the breadth on overlapping dimensions, the higher the niche overlap, and vice versa. Niche overlap can be roughly categorized into overlap and separation, with overlap further comprising three situations: coincidence, inclusion, and intersection. As shown in Figure 3 [Figure 3: see original paper], as the niches of different archival data populations A and B shift from overlap to separation, their dimensional performance trends diverge, reducing similarity in survival and development dependence and consequently weakening inter-population competition.

[Figure 3: see original paper]

Niche overlap may lead to functional duplication and resource grabbing, weakening co-opetitive capacity. Therefore, biological units generally seek niche separation. However, in the big data era' s context of data aggregation and sharing, blindly pursuing low niche overlap in archival data is not entirely suit-

able. Archival data possesses long-term preservation value with symbiotic and cumulative characteristics [17]; aggregating archival data to achieve scale and aggregation effects is essential for excavating and enhancing archival data value. Overlap caused by shared data resources and open spaces among archival departments, data departments, and the public is unavoidable. Under these circumstances, the focus on archival data niche overlap concerns how archival departments coordinate division of labor among archival data subjects and allocate and supplement overlapping resources.

3 Current Issues in the Competitive Niche of Archival Data

On one hand, competition among archival data populations may achieve healthy development and promote adaptation and evolution; on the other hand, it may lead to negative consequences such as reduced population numbers. To steer archival data niche competition toward benign development, this section reveals the current state of co-opetitive capacity among archival data populations and summarizes existing problems in internal and external symbiotic development based on the underlying framework, providing references for timely adjustment of archival data ecological structure and future archival work. Issues across dimensions differ: resource and spatio-temporal dimensions face both breadth and overlap challenges; while the functional dimension' s segmented cooperation mechanism helps enhance archival data' s diverse value and social benefits in the big data era, avoiding overlapping competition, it primarily suffers from bottlenecks of unbalanced functional breadth.

3.1 Resource Dimension: Ontology Breadth Requires Expansion, Talent Resources Highly Overlapped

Currently, the actual breadth of archival data ontology resource niche is far smaller than its fundamental breadth. Regarding forms of archival data ontology, traditional archival data digitized from existing stock remains constrained by original forms, exhibiting a structural problem of more intra-system and less extra-system resources. Real-time collected archival data on the incremental basis features broader sources and forms, more comprehensively reflecting national landscapes and preserving social memory with long-term value and competitive potential. However, new archival data also poses identification and collection challenges: on one hand, real-time archival data generates and changes rapidly, disappearing without timely preservation and accumulation; on the other hand, source and form diversity leaves archiving and preservation scopes for new archival data without unified standards, creating inter-unit differences. Regarding archival data quality, high-quality archival data is the prerequisite for actually increasing ontology resource niche breadth. Currently, unclear rights and responsibilities and inconsistent business standards among archival departments and between archival and other departments lead to uneven archival data quality, hindering resource integration among different archival data subjects and constraining ontology resource increase and co-opetitive capacity for-

mation. For example, during the "Maximum One Visit" reform in Rui' an City, unclear authority between archival and business departments on business archives management led to incomplete collection, making it difficult to increase actual resource breadth [18].

Different archival data share similarities in resource types, sources, and usage, with current competition primarily reflected in talent resource contention. Archival data possesses both archival nature and data characteristics, and ultimately, different archival data populations all require composite talents with both archival expertise and data literacy. However, archival talent overall remains scarce. According to 2023 national statistics on archival administrative departments and archives, among existing full-time personnel in archival administrative departments and archives at all levels, the proportion of personnel with corresponding academic degrees in archival specialties is 17.57% and 18.38%, respectively [19]. During the 13th Five-Year Plan period, national archival administrative departments and archives of all types and levels had only 1.35 archival specialty graduates supplied over five years [20]. With such professional levels and supply in archival institutions, enterprises and other archival data subjects inevitably face development bottlenecks of lagging talent teams. Meanwhile, archival education struggles to meet data capability cultivation needs. In 2021, China approved 57 archival specialty education reform research projects, with one focus being curriculum system construction and talent training model innovation in the digital intelligence era; however, only 3.13% of archival specialty faculty have computer science backgrounds, and teaching methods lack practical training embedding, resulting in shallow technical teaching modules and difficulties in course offering and instruction [21]. Limited professional supply, insufficient data education, and highly overlapping resource demands create fierce competition among archival data subjects at the talent level.

3.2 Functional Dimension: Unbalanced Functional Breadth, Weak Production Factor Value

Archival data supports policy decision-making, public services, and cultural inheritance while carrying important value as production factors driving digital economy development. Its functional positioning affects competitiveness relative to other data species in the national resource system. Currently, the competitive niche of archival data suffers from unbalanced functional breadth constraints, primarily manifested in the relative weakness of archival data production factor value.

As an important component of China' s public data resources, archival data demonstrates prominent functions in policy decision-making and public services. For example, in highway government services, rapid access to archival data optimizes administrative approval processes and enhances project construction and management efficiency [22]. In cultural inheritance, archival data contains rich creative materials; the classic image of "Nezha" in *Nezha: The Devil' s Birth* derives not only from archival records of early story forms but also benefits from

continuous archiving and organization of its dissemination and evolution [23]. By contrast, archival data remains emerging in production factor value: first, archival departments have yet to fully recognize its enormous potential as a production factor, with archival data rarely participating in data property rights registration practices promoted across regions; second, large amounts of archival data containing personal privacy and sensitive information still circulate in gray markets, lacking unified, standardized, and controllable transaction and protection mechanisms. As the big data era increasingly emphasizes data element value, weakness in this functional dimension will reduce competitive positioning, weaken the data governance role of archival departments, and ultimately marginalize archival work in the national data governance system.

3.3 Spatio-Temporal Dimension: Uneven Regional Development, Barriers in Digital Space

In physical space, different regions exhibit varying breadth in archival data competitive niches, with this competitive strength distribution largely mirroring economic level distribution. For example, regarding regional differences in enterprise archival data, the 2024 China Archival Data Innovation Index (ADIA) Development Report shows that the Yangtze River Delta and East China regions lead in enterprise archival data innovation scores, demonstrating high-quality development and strong competitiveness [24], while Northwest China shows weaker archival data innovation with obvious deficiencies in technological and management innovation competitiveness. Regional differences in competitive niches stem from uneven regional development, fundamentally reflecting unbalanced regional resources. Regions with weaker competitiveness may have shortcomings in archival data work, such as talent cultivation, R&D investment, and technology transformation. From a population perspective, differences in competitive strength across archival data niches inevitably exist; however, at the species level, regional breadth imbalance may weaken overall development potential and affect archival data value realization in broader fields.

In digital space, China' s archival data competitive niche demonstrates constraints of low overlap in management service space: at the species level, archival management and data management currently constitute two relatively independent and isolated systems [25], with archival departments yet to initiate in-depth cooperation with data departments in resource sharing and business coordination; at the population level, large amounts of archival data remain scattered across various business systems, fragmented and not comprehensively aggregated. Taking archives as an example, China' s existing archive network system is criss-crossed, including comprehensive archives at all levels built according to administrative sequences, archives (rooms) established within enterprises and institutions, and archives (rooms) constructed within various professional systems, with fragmentation having become the basic pattern of different archival management [26]. Sharing archival data among different archival departments lacks unified top-level design. While this distribution pattern reduces direct

spatial competition to some extent, it also creates "data barriers" that not only constrain unified management and overall planning of archival data but also fail to meet big data era demands for data aggregation, sharing, and deep utilization, hindering the full release of archival data element value. Primary reasons include concerns among archival data subjects about losing characteristic resource advantages, security and accountability pressures, and insufficient technical capabilities of archival departments in system interfaces and identity authentication.

4 Optimization Strategies for the Competitive Niche of Archival Data

To address challenges facing the competitive niche of archival data, optimization strategies led by archival departments are required. Archival departments should coordinate diverse subjects including data departments, enterprises, and the public, optimize the allocation of limited resources such as archival data, talent, and technology, and systematically adjust ecological niche positioning across resource, functional, and spatio-temporal dimensions. The aims are: resource dimension enrichment and orderly governance, functional dimension potential stimulation, spatio-temporal dimension regional coordination and integration empowerment, ultimately systematically enhancing the co-opetitive effectiveness of archival data niches.

4.1 Resource Dimension Optimization Strategies

Resources are essential for population survival, competition, and development; adjustments to functional and spatio-temporal dimensions of the archival data competitive niche must build upon resource dimension optimization. Specific strategies include: first, gradually expanding resource breadth by increasing sources and forms of archival data ontology and ensuring high quality and reliability through orderly governance; second, strengthening talent supply-side reform through structural overlap reduction to alleviate talent competition dilemmas among government departments, enterprises, and other diverse subjects, ensuring optimized talent supply.

4.1.1 Deeply Practice the "Grand Archives" Concept to Expand Archival Data Resource Collection In the big data era, the "data is king" concept has gained widespread recognition. Under governance contexts of intensifying data sovereignty competition, archival departments must both respond to the institutional development of new data governance agencies like big data bureaus and strengthen strategic layout of native data sovereignty. This requires reconstructing the archival data resource niche, expanding endowment-quality data resources to strengthen archival departments' leading position and thereby gain more institutional discourse power.

The January 2025 National Archives Bureau Directors and Archives Directors

Meeting emphasized the need to focus on archival resource collection work and study incorporating documents and materials formed by new businesses, fields, and platforms into collection scopes [27]. The essence of "Grand Archives" is to expand archives and archival departments [28]; under this concept, archival data subjects' enthusiasm increases and archival resource collection scope expands. Therefore, deeply practicing the "Grand Archives" concept aligns with the goal of expanding archival data resources. Archival departments must recognize the broad sources of archival data, not limiting collection to digitization of existing archives but emphasizing collection of data records with archival characteristics and actively optimizing archiving scopes. Archival departments need to focus on bottom-level, fragmented, and complex archival data, such as public network data and public livelihood data. Such archival data truly covers the populace, providing more possibilities for broadening archival data ontology resources and exploring social space for archival undertakings, helping cultivate core competitiveness of archival data species.

Regarding collection methods, archival departments can leverage WeChat public accounts, social media, thematic websites, and other platforms to solicit archival data. For example, State Grid developed a WeChat mini-program based on its "State Grid Archives" public account for collecting COVID-19 thematic archives, enabling frontline workers to upload photos and videos from work sites, thereby promoting collection of public health emergency thematic archival resources [29]. Regarding collection technologies, archival departments can utilize artificial intelligence to capture and process data from different channels and integrate resources through big data technologies such as integration, exchange, and warehousing. For instance, Baidu uses intelligent agents to crawl information from web pages, analyze it, and form structured data [30].

4.1.2 Establish and Improve Regulations and Standards to Ensure Orderly Archival Data Governance Regulations and standards are resources with both guiding and safeguarding functions in the archival data ecology. To promote archival data quality improvement and ensure authentic broadening of archival data ontology resources, the national level should first issue targeted policies in a timely manner to clarify archival data governance goals and development plans, guiding legislative departments and archival departments at all levels to prioritize archival data regulation and standard formulation. Government departments need to continuously adjust policy texts based on practical experience in establishing and improving archival data regulations and standards to promote ecological balance [31]. Experiences formed by various regions and departments in archival data governance practice should be both publicized as exemplary cases and elevated to institutional norms according to relevant regulations.

As subjects with data governance obligations, archival departments should actively participate in archival data legislation and standard formulation. Specifically, at the regulatory level, they can propose that the National Archives Bu-

reau formulate departmental rules such as the *Archival Data Governance Measures* to clarify responsibilities, rights, and obligations of archival departments, data departments, enterprises, and the public in archival data governance. At the standard level, archival departments should seize opportunities in archival industry standard formulation and revision plans, such as supplementing the *Basic Terminology of Archival Work* (DA/T 1-2000) with general concepts like "archival data" and "archival metadata." Archival departments can also lead the formulation of standards and norms based on full lifecycle archival data management, regulating different stages of archival data collection, organization, storage, development, and utilization. Additionally, they can design evaluation standards examining archival data form, content, and utility by referencing the *Information Technology—Data Quality Evaluation Indicators* to respond to policies and regulations and ensure archival data integrity, accuracy, availability, and security.

4.1.3 Rationally Complete the Education Chain to Optimize Archival Data Talent Supply "Capacity" represents the most active component of archival data niches, with the most rapid and obvious impact. Adequate and rational talent supply can quickly provide momentum for optimizing the competitive niche of archival data. The *Education Powerhouse Construction Outline (2024-2035)* requires comprehensively building a vocational education system integrating industry and education and a self-improving and excellent higher education system [32]. Addressing overlapping competition for archival data talent resources can be approached through supply-side reforms in vocational and higher education.

In vocational education, archival departments can jointly organize professional literacy lectures with data departments and enterprises to deepen practitioners' understanding of industry development trends and professional responsibilities, guiding them to enhance understanding of archival data and develop lifelong learning awareness and habits. Meanwhile, continuing education thematic training and technical upgrading should be conducted according to the composition of archival data-related staff and actual work needs to meet evolving job requirements. On-the-job archival staff can fully utilize online education resources, particularly massive open online courses (MOOCs) such as national 精品 courses in *Archival Management*, *Electronic Records Management*, and *Database Technology and Application*.

In higher education, archival data education requires multi-disciplinary faculty: first, "maintaining orthodoxy" —archival science specialty teachers should continuously upgrade core curriculum systems, preserve archival science characteristics, and incorporate practical modules in courses like electronic records management; second, "innovating" —leveraging faculty from computer science, data science, and other fields to add data management and archival data resource development courses such as database principles and applications, data mining, and data visualization. Wuhan University' s archival science program actively

seeks transformation, emphasizing data literacy education. Taking undergraduate archival education as an example, based on foundational and core archival courses, it has added innovative courses like "Big Data and Culture," "Computational Archival Science," and "Data Analysis and Visualization," and created the "Smart Archives Full Lifecycle Management Virtual Simulation Training Platform" to ensure students can integrate professional knowledge with core activities of archival data formation, management, and utilization across industries through practical scenarios [33]. Additionally, higher education archival programs can specialize in directions like intelligent archives, data governance, and digital humanities to correspond with talent demands in different fields such as enterprises, government departments, and cultural industries, achieving structural optimization of talent supply.

4.2 Functional Dimension Optimization Strategies

Stimulating archival data' s function as a production factor relates to developing new productive forces in the archival field and closely associates with the role positioning of archival departments in data governance responsibilities. Enhancing the breadth of archival data competitive niche' s production factor function requires a dual-drive approach of institutional guarantee and scenario application.

First, archival departments should participate in legislative bodies and data governance institutions' work to accelerate exploration of incorporating archival data into institutional frameworks for data rights confirmation, transaction, and supervision, providing legal foundations and market environments for production factor value realization. Archival departments should strengthen their positioning as professional data management departments, actively participate in institutional design, promote inclusion of archival data in data element market construction and trusted data space development policies and regulations, and clarify archival data ownership, usage rights, and supervision responsibilities. They should also accelerate formulation of archival data-specific rights confirmation standards and operational procedures, exploring actionable pathways for on-chain registration and compliant usage.

Second, archival institutions should actively explore archival data collection, circulation, production, and service links, forming exemplary scenario construction through typical case promotion to attract more units to participate in archival data element development. Taking local archival department exploration practices as examples: at the resource construction stage, Henan Changyuan City Archives targeted characteristic industries like lifting equipment, medical devices, and culinary arts, collaborating with industrial chain lead departments, responsible units, and industry associations to solicit and build characteristic archival databases, classifying and integrating modules like technological iteration and enterprise growth to lay foundations for subsequent utilization [34]. At the capitalization stage, Hubei Xiaogan City Archives, as a pilot unit for municipal public data resource capitalization reform, used 60,000 livelihood archives

as an entry point to conduct data inventory, rights and value confirmation, and accounting entry, promoting data resource development and utilization and creating exemplary scenarios with leading and promotional effects [35].

4.3 Spatio-Temporal Dimension Optimization Strategies

Spatio-temporal dimension optimization strategies for archival data competitive niches require overall breadth equilibrium and overlap coordination [36]. On one hand, exchange and cooperation should achieve regional coordinated development as an optimization goal; on the other hand, under data aggregation requirements, collaborative mechanisms led by archival departments should integrate data space to enhance archival data co-opetitive capacity.

4.3.1 Actively Conduct Exchange and Cooperation to Promote Regional Coordinated Development The competitive strength of archival data depends not only on resource endowment and technical levels but also closely relates to data circulation environments and cooperation mechanisms in physical regions. The strong competitive niche of archival data in the Yangtze River Delta region benefits from high-quality and close cooperation, where sharing archival data resources and utilization experiences provides a favorable ecological environment. Evidently, exchange and cooperation among archival data subjects constitute important strategies for optimizing niche structure and narrowing regional development gaps.

Regional archival departments, enterprises, and data departments should actively seek exchange and cooperation through mutual assistance agreements and collaborative memoranda. For example, Beijing-Tianjin-Hebei archival departments jointly signed a cooperation agreement for cross-regional sharing and utilization of livelihood archives, advancing platform construction, data access, system testing, and formal operation in phases to gradually realize a new service model of "cross-archive inquiry and remote certification" for livelihood archives, significantly enhancing coordination and effectiveness in livelihood services [37]. Another example is Yangzhou Baoying County Archives, which leveraged its collection resources and jointly signed the *Archival Inquiry Convenience Service Agreement* with the county data bureau based on practical experience in data services and utilization, collaboratively building a convenient archival inquiry service platform to promote local archival data public service efficiency [38]. Archival departments should summarize and promote these excellent experiences in regional coordinated development to provide reference models for other regions and further encourage the formation of archival data co-opetitive capacity.

4.3.2 Build Shared Service Platforms to Integrate Archival Data Governance Space Article 41 of the New Archives Law indicates that promoting archival information resource sharing service platform construction and facilitating cross-regional and cross-departmental sharing and utilization of archival

digital resources represents both the basic requirement of the Party and state for archival undertakings development and the inevitable requirement for advancing the national big data development strategy [39]. Addressing current issues of dispersed archival data management service spaces requires unified technical infrastructure support. Building archival data sharing service platforms can improve management efficiency of cross-regional, cross-departmental, and cross-industry archival data and enhance archival data resource utilization rates, thereby strengthening archival data co-opetitive capacity.

In technology-driven contexts, archival departments should 善用技术赋能 (skillfully utilize technology empowerment) to optimize the archival data competitive niche. For instance, by learning and utilizing cloud computing, blockchain, artificial intelligence, and other technologies, they can further construct and optimize archival data sharing platforms, achieving four-in-one construction of archival data sharing and interaction, processing, cloud storage, and operation and maintenance [40]. Additionally, to break "data barriers" with other enterprises and institutions, archival departments should actively access regional and national public data sharing service platforms. For example, to achieve interconnection with provincial public data resource registration platforms and promote registration information connectivity, the National Public Data Resource Registration Platform launched operation on March 1, 2025, aiming to achieve electronic certificate "one certificate, one code" nationwide and support registration information inquiry and sharing. The platform not only requires Party and government organs and public institutions to register public data resources included in authorized operation scopes but also encourages registration of resources not included. As an important component of national public data resources, archival data should be fully pursued and actively integrated into public data resource registration management by archival departments to enhance archival data' s niche advantages at the same species level.

Archival data constitutes a strategic resource driving China' s economic and social progress, and archival data elements are indispensable for developing new productive forces. As the data era advances and data competition intensifies, archival departments should leverage archival data element value realization to promote adaptation and evolution, further enhancing core competitiveness. Using breadth and overlap indicators to examine existing problems in the competitive niche of archival data from the three fundamental dimensions of resources, functions, and spatio-temporal factors and proposing corresponding optimization strategies represents an inevitable requirement for high-quality development of archival undertakings in the big data era. In the future, archival departments should continue to deeply explore the "capacity" of archival institution coordination, drive complementary "state" and "potential" in archival data, and continuously advance overall optimization of the archival data competitive niche.

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Note: Figure translations are in progress. See original paper for figures.