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Modeling and Analysis of the Sustainable Development of Chinese Archival Work in the Past Four Years

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Abstract: People used physical or pictorial note-taking methods to record and memorize in ancient times. With the development of productive forces, the emergence of classes, the formation of the state, and the invention of writing, many official documents appeared and were sorted, which then became archives. The natural attributes of archives are closely related to the development of human society. On the one hand, archival work develops with the development of human society. On the other hand, the status of archival work will affect the development of civilization as well. To fill the gap in the research on the sustainable development of archival work, we established a comprehensive evaluation model to analyze the development of Chinese archival work from 2018 to 2021. We found that the overall level was gradually flourishing and was less affected by the COVID-19 pandemic, but there is still a lot of room for improvement in some aspects. This study provides valuable insights for formulating targeting strategies to improve the development of archives.

Keywords: archival work; comprehensive evaluation; sustainability; China

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1. Introduction

Archives are accumulations of historical records or materials, which can be of various forms and mediums [1]. Archival careers are rich in criteria, including consent, power, inclusivity, transparency, ethics, and privacy [2]. On the one hand, the idea of archives as a collective memory is sometimes used as a metaphor for social and cultural roles. The collections of words and objects are regarded as means of extending the temporal and spatial scope of communication, helping to transmit information from generation to generation, and thereby maintaining memory. On the other hand, archives are created by powerful people. Therefore, they are not passive repositories of old materials, but rather are active places where social power is negotiated, contested, and affirmed [3]. It is generally believed that archival work is produced along with archives, including business, administrative, publicity, communication work, etc. It is constantly adjusted with the changes in the national management system, cultural level, and degree of democracy [4].

The study of archives has a long history and broad coverage. Bingham [5] examined the opportunities and challenges historians face with the digitization of newspaper archives. Jimerson [6] explained how archivists can better fulfill their responsibilities and obligations regarding decisions about which records will be kept for future generations. Flinn [7] investigated the potential impact of community archival materials on the national archival heritage. Netshakhuma [8] conducted an analysis on the archival management infrastructure in Mpumalanga, South Africa. Lv and Shi [9] explored the improvement in university archive management in the information age. Oyelude [10] provided strategies for archives to tide over difficulties under the epidemic. Lian and Oliver [11] analyzed the sustainability of independent community archives in China based on an independent community archive focusing on migrant workers. These studies mainly focus on archival philosophy, archival sociology, archival economics, archival classification, etc. Additionally, most of the methods they used were enumerated and qualitative. To the best of our knowledge, few of the

studies used hierarchical and quantitative methods to evaluate the development of archival work, either comparing the development across countries (regions) or comparing trends in different years within the same country (region). However, the evaluation of archival work development forms the basic research on the cause of archives—this will undoubtedly help optimize research on all aspects of archives.

The comprehensive evaluation method compares the advantages and disadvantages of different schemes or subjects by selecting certain evaluation indicators and establishing a mathematical model. Because of its rationality and simplicity, it has been widely used in various fields. Zeng et al. [12] proposed a comprehensive evaluation framework based on entropy and Complex Proportional Assessment to evaluate the logistic development status of Ningbo-Zhoushan Port from a dual-cycle perspective. Jiao et al. [13] used the TOPSIS method to assess the coupling between the urban rail transit system and the city's sustainable development. Lu et al. [14] used a composite weighting method to evaluate the dual innovation capabilities of 65 national innovation systems. Zhang et al. [15] proposed a strategy for the selection of landfill-cover materials based on a data envelopment analysis model where an analytic hierarchical process preference cone is included. Guo et al. [16] established a framework based on the fuzzy comprehensive evaluation method to help design a community museum.

This study aimed to introduce quantitative methods into archival research. Considering the objective and effectiveness of a comprehensive evaluation, we constructed a model based on comprehensive evaluation methods to assess the development of archival work. Considering the representativeness and data availability, we focused on the development of Chinese archival work from 2018 to 2021. We intended to objectively judge the development of Chinese archival work, especially to explore whether the COVID-19 pandemic had affected the field. The article was structured as follows: In Section 2, we introduce the indicators and data used to judge the development of Chinese archival work and build a comprehensive evaluation model, drawing on our previous work [17] which focused on the development of different schools within a university. In Section 3, we elaborate and discuss the model results. In Section 4, conclusions, suggestions, research limitations, and future research are put forward.

2. Data and Methods

2.1. Data

Every year, the National Archives Administration of China issues notices to the provincial archive bureaus to report regional archive statistics. Based on the data, the national institution publishes the "Summary of the Basic Situation of the National Archives Administration and Management Departments and Archives" every year. The main contents include six aspects: the number of institutions, full-time employees, collection, opening and utilization of archives, the floor space of archives, and digital archives certified by the competent archives department at or above the provincial level (Table 1). Since some key data were incomplete before 2018, in this study, we focused on the development of Chinese archival work during the period of 2018 and 2021.

Table 1. Indicators to assess the development of Chinese archival work.

Primary Index	Indicators	Abbreviation	Weight (%)
Number of institutions (10%)	Archive management department	AMD	4.60
	Archives	ARC	5.40
Full-time employees (15%)	Full-time employees	FTE	15.00

Table 1. *Cont.*

Primary Index	Indicators	Abbreviation	Weight (%)
Collection (25%)	Files	FIL	5.13
	Data	DAT	2.56
	Photos	PHO	3.85
	Audio tapes, video tapes, and film files	AVF	3.85
	Electronic archives	ELE	5.13
	Digital copy of library archives	DIG	4.49
Opening and utilization of archives (offline) (25%)	Open archives	OPE	1.67
	Reception file users	RFU	3.33
	Number of archives provided	NAP	3.33
	Reception users of government public information/current documents	RUG	2.67
	Number of government public information/current documents provided	NGP	2.67
	Reception data user	RDU	1.00
	Quantity of data used	QDU	1.00
	Number of public access places for government information in archives	PAG	1.33
	Number of patriotism education base in archives	PEB	2.00
	Number of archival exhibitions held	AEH	2.00
	Reception of exhibition	REE	2.00
	Publicly published materials	PPM	2.00
Floor space of archives (10%)	Total	TOT	2.80
	Storage Room	STR	3.20
	External service room	ESR	4.00
Digital archives certified by the competent archives department at or above the provincial level (15%)	Digital archives certified by the competent archives department at or above the provincial level	DAC	15.00

2.2. Methods

In this section, we introduce a comprehensive model to evaluate the development of archival work in different years. The main body of the framework is the combination of two widely used comprehensive evaluation methods: the Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) [18,19] and Grey Relational Analysis (GRA) [20,21]. This can contribute to the robustness and stability of the framework. The main idea was to compare the combination of indicators in a particular object (year in this study) with other objects. The framework is similar to that in our previous work [17], but was modified according to the needs of this study. More specific modeling details can be found in our previous article [17].

2.2.1. Data Processing and Weight Decision

The original data were first constructed into matrix $A = [a_{ij}](i = 1, 2, 3, 4, j = 1, 2, \cdots, 25)$. Then, we standardized it to matrix $B = [b_{ij}](i = 1, 2, 3, 4, j = 1, 2, \cdots, 25)$, which was used in the subsequent analysis.

Different indicators play different roles in the total performance. The weights are determined by experts in the field. They were selected from Hubei Provincial Archives, Wuhan University Archives, School of Information Management at Wuhan University, National Archives Administration of China, School of Humanities at Nanchang University, and School of Information Resources Management in Renmin University of China. The results were obtained by Delphi analysis. The weight of the primary index was directly determined by the experts, while those of particular indicators were determined by AHP [22,23]. AHP is a

widely used multi-attribute decision-making method [24–28] that contains a judgment matrix $W = [w_{ij}]$ $(i, j = 1, 2, \cdots, 25)$, where w_{ij} describes the importance of the ith indicator compared with the jth indicator. Theoretically, the matrix can be derived from a certain weight vector and satisfies $w_{ij} = w_{ik} \times w_{kj}$. However, the matrix determined by experts is often not completely self-consistent. Hence, we can get a none-zero value CI (consistency index), which can be expressed as follows:

$$CI = \frac{\lambda_{max} - n}{n - 1}, \tag{1}$$

where λ_{max} and $n = 25$ are the highest eigenvalue and dimension of the matrix W, respectively. We can claim that the consistency is acceptable if $CI/RI < 0.1$, where RI is a given index related to n and can be obtained by the random simulation of Saaty pair-wise comparison matrices [29]. The obtained weights are shown in Table 1.

2.2.2. Measurement

In this study, we combined TOPSIS and GRA methods, both of which are commonly used comprehensive evaluation methods. In evaluating the performance, TOPSIS [18,19] calculates the distance between a vector and the positive (negative) ideal vector, while GRA [20,21] assesses the similarity of the curve shape between them. We first introduced them in a self-consistent system:

The TOPSIS method focuses on the relative proximity between the ideal solution and a particular vector [18,19]. For each indicator, the maximum (best) and minimum (worst) vectors are defined as:

$$\begin{cases} B^+ = \left\{B_i^+, i = 1, 2, 3, 4\right\} = \left\{max\left\{b_{ji}, j = 1, 2, \cdots, 25\right\}, i = 1, 2, 3, 4\right\} \\ B^- = \left\{B_i^-, i = 1, 2, 3, 4\right\} = \left\{min\left\{b_{ji}, j = 1, 2, \cdots, 25\right\}, i = 1, 2, 3, 4\right\} \end{cases}, \tag{2}$$

For each year, its gap from the maximum (minimum) is defined as the Euclidean Distance D_i^+ (D_i^-):

$$\begin{cases} D_i^+ = \sqrt{\sum_{j=1}^{n} \omega_j \left(B_j^+ - b_{ij}\right)^2} \\ D_i^- = \sqrt{\sum_{j=1}^{n} \omega_j \left(B_j^- - b_{ij}\right)^2} \end{cases}, \tag{3}$$

where ω_j is the weight of the jth indicator. A lager D_i^- or a smaller D_i^+ represents a smaller distance from B^+ or a larger distance from B^-, that is, a better performance.

The principle of GRA is to use the similarity between sequences as the standard of a comprehensive evaluation [20,21]. We first calculated the absolute difference $\left|B_j^+ - b_{ij}\right|$ and $\left|B_j^- - b_{ij}\right|$, which describe the gaps between the evaluated vector and the reference (best or worst) vector. Then, we defined the minimum difference $\min\limits_i \min\limits_j \left|B_j^+ - b_{ij}\right|$, $\min\limits_i \min\limits_j \left|B_j^- - b_{ij}\right|$ and the maximum difference $\max\limits_i \max\limits_j \left|B_j^+ - b_{ij}\right|$, $\max\limits_i \max\limits_j \left|B_j^- - b_{ij}\right|$. Next, we calculated the correlation coefficient of the obtained sequences, as follows:

$$\begin{cases} \zeta_{ij}^+ = \dfrac{\min\limits_i \min\limits_j \left|B_j^+ - b_{ij}\right| + \rho \cdot \max\limits_i \max\limits_j \left|B_j^+ - b_{ij}\right|}{\left|B_j^+ - b_{ij}\right| + \rho \cdot \max\limits_i \max\limits_j \left|B_j^+ - b_{ij}\right|} \\ \zeta_{ij}^- = \dfrac{\min\limits_i \min\limits_j \left|B_j^- - b_{ij}\right| + \rho \cdot \max\limits_i \max\limits_j \left|B_j^- - b_{ij}\right|}{\left|B_j^- - b_{ij}\right| + \rho \cdot \max\limits_i \max\limits_j \left|B_j^- - b_{ij}\right|} \end{cases}, \tag{4}$$

where ρ represents the resolution coefficient, and was set to 0.5 in this study.

The Grey Correlation Degree can be calculated according to the above correlation coefficient:

$$\begin{cases} r_i^+ = \sum_{j=1}^{n} \omega_j \cdot \zeta_{ij}^+ \\ r_i^- = \sum_{j=1}^{n} \omega_j \cdot \zeta_{ij}^- \end{cases}, \tag{5}$$

where ω_j is the weight of the jth indicator. A lager r_i^+ or a smaller r_i^- represents a similar shape in relation to B^+, that is, a better performance.

2.2.3. Evaluation and Explanation

We defined:

$$\eta_{ij} = \frac{\zeta_{ij}^+}{\zeta_{ij}^+ + \zeta_{ij}^-}. \tag{6}$$

Hence, we can depict the annual trend under different indicators by comparing $\overline{\eta_{ij}} = \frac{\eta_{ij}}{\sum_{i=1}^{4} \eta_{ij}}$. Alternatively, we can evaluate the development under primary index (Table 1) by defining a parameter $\chi_{ik} = \frac{\sum \omega_i \overline{\eta_{ij}}}{\sum \omega_i} (k = 1, 2, \cdots 6)$.

We, furthermore, defined a parameter as:

$$\sigma_j = \frac{\sum_{i=1}^{4} \eta_{ij}}{4}. \tag{7}$$

This can help us evaluate the amplitude of a gap among different years from different perspectives. If the σ_j is small, the average level of all schools is far from the highest level, the gap among different years is significant, and vice versa.

By combining the Euclidean Distance and Grey Correlation Degree, we defined a couple of parameters:

$$\begin{cases} \gamma_i^+ = \varepsilon \psi\left(D_i^-\right) + (1-\varepsilon)\psi\left(r_i^+\right) \\ \gamma_i^- = \varepsilon \psi\left(D_i^+\right) + (1-\varepsilon)\psi\left(r_i^-\right) \end{cases}, \tag{8}$$

where $\psi(x) = \frac{x - min(x)}{max(x) - min(x)}$, $\varepsilon \in [0, 1]$ describes the weight between the distance (TOPSIS) and curve shape (GRA). In this study, we set $\varepsilon = 0.5$.

Finally, we can obtain the comprehensive performance score for each year as:

$$P_i = \psi\left(\frac{\gamma_i^+}{\gamma_i^+ + \gamma_i^-}\right) \times 40 + 60. \tag{9}$$

A higher score indicates a better performance.

2.2.4. Stability Analysis

The selection of indicators is crucial for a comprehensive evaluation. In extreme cases, one particular indicator may control the final score completely. However, previous studies have paid little attention to this aspect. Here, we proposed a strategy to test the stability of the model. We deleted each indicator and calculated the mean absolute error of the score before and after subtracting the indicator for each year. Then, we calculated an average of the mean absolute error of these four years, which represents a certain indicator's influence on the final result. Indicators that have greater impacts on the results may be related to their importance (weights) or extreme data (some samples perform extremely well or poorly).

3. Results and Discussion

We first assessed the development of Chinese archival work in six areas including the number of institutions, full-time employees, collection, opening and utilization of archives, the floor space of archives, and digital archives in the past four years, as shown in Figure 1.

The number of institutions peaked in 2019 and 2020. The number of practitioners dropped significantly between 2018 and 2019. It may be the result of the institutional reform in 2018, in which only the national and provincial archive management agencies are retained, and the prefecture-level agencies have been canceled. Generally, the collection and utilization of archives have increased slightly over time. In the past four years, China went through poverty alleviation, the Winter Olympic Games, and the COVID-19 pandemic; a large number of archives has been produced during these large events and emergencies. At the same time, the floor space of archives has grown steadily and substantially every year. Moreover, the number of digital archives has stalled after a significant increase in 2019.

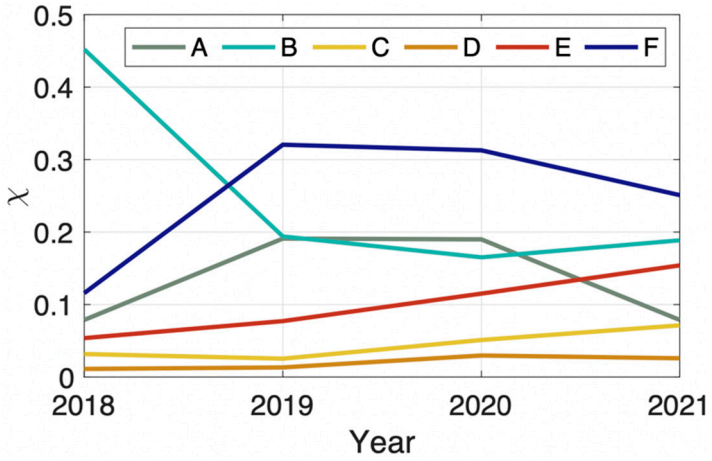

Figure 1. Development trend under different primary indexes. A, B, C, D, E, and F represent the number of institutions, full-time employees, collection, opening and utilization of archives, the floor space of archives, and digital archives certified by the competent archives department at or above the provincial level, respectively.

Next, we calculated the overall scores to evaluate the performance across the years (Figure 2). In general, the development of Chinese archival work has been improving yearly, implying that the field has been paid more and more attention, the government's investment has increased, and the management system has become more scientific. We found that the score in 2021 is significantly higher than in other years, which may be related to the newly revised archives law on 1 January 2021. The law aims to promote the archive's governance, utilization, and security system, encourage the high-quality development of the field, and contribute to the modernization of the governance system and capacity. It provides a strong legal guarantee for the sustainable and high-quality development of the archival work. An interesting phenomenon is that we did not observe a significant impact of COVID-19. This indicates that the archival work is necessary for people's lives, and even though the epidemic has caused various restrictions and inconveniences, the development of the field has not been hindered.

We analyzed the gaps in different years under the 25 indicators (Figure 3). We found some conclusions that were consistent with those in Figure 1, such as significant differences in the number of employees across years (corresponding to the substantial decline in 2018–2019). In addition, we obtained some new conclusions, for example: (1) The number of archive institutions and government information open access sites are relatively stable. The opening of archives has always been a difficult problem in archival work, so it is unlikely to make significant progress in a short period. (2) Affected by the COVID-19 pandemic, the number of archives and materials used, the number of users, and the number of exhibitions all show downward trends. (3) The number of people who need to use archives is relatively stable, and is not affected by the COVID-19 pandemic. This indicates that more people turned to digital archives.

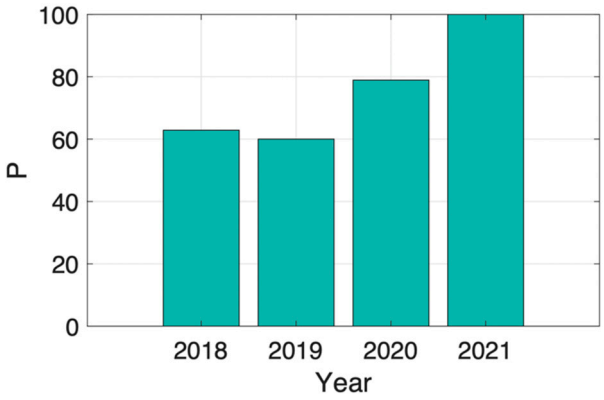

Figure 2. Performance (total score) for the development of each year.

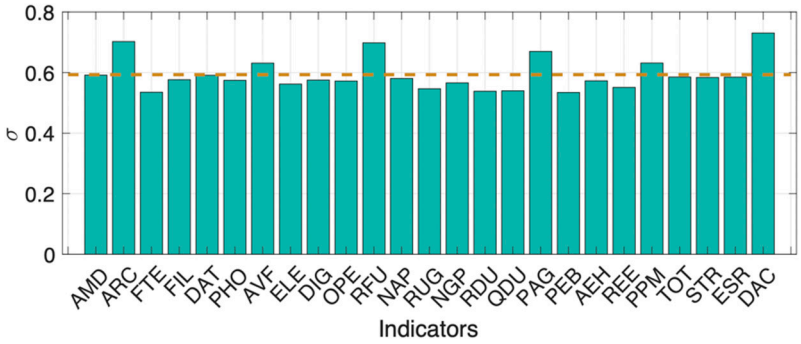

Figure 3. Gaps among different years under different indicators. The red line represents the mean value.

We further analyzed the robustness of the model (Figure 4). We found that by removing any indicator, the impact on the total score should be less than four and, in most cases, less than two. Therefore, we believe that the results obtained by replacing the indicators in a limited range should all conform to the trend in Figure 2.

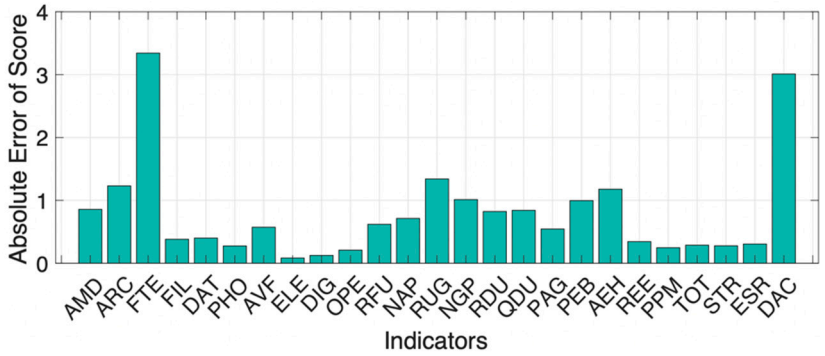

Figure 4. The average absolute difference in performance (scores) caused by the deletion of a particular indicator.

4. Concluding Remarks

Archives are involved in all levels of national economic and social development. At present, most of the research on archives is qualitative, and we unfortunately failed to find studies quantitatively by evaluating the development of archival work. In this study, we tried to introduce a quantitative method to this field and established a comprehensive evaluation model to investigate the development of Chinese archival work in the past four years. We found that Chinese archival work generally showed a positive trend and was less affected by the COVID-19 pandemic. However, the development level became better or

worse over time from different aspects (primary index). This shows the tortuousness and complexity of the development of the field, which also allows us to put forward feasible and targeted suggestions.

Based on our results, we make the following suggestions for the development of Chinese archival work:

- Speed up the construction of digital archives. Digital archives are essential to realizing the continuous accumulation, complete collection, long-term preservation, centralized management, security control, and the effective utilization of human digital memory. Due to the COVID-19 pandemic, the availability of offline archives is reduced, and the importance of digital archives is particularly prominent. Provinces, cities, and regions across the country have made some explorations in the construction of digital archives. They have achieved initial results and gained some successful experience. However, the progress is relatively slow. We suggest that governments at all levels should increase investment, formulate goals and plans, and regard the construction of digital archives as the general blueprint and principle of the archival work.
- Promote the construction of archives resource system deeply. Archive information resources are the foundation of the field. Archives of all levels and types should fully expand the scope of archival resource collection, strengthen the collection of major events and emergencies, and extend storage forms (paper, electronic, photo, film, etc.). At the same time, it is necessary to optimize the collection structure and realize the digital transformation of archival resources.
- Cultivate archival professionals vigorously. Professionals guarantee the steady development of the field. Due to the staff reduction, future practitioners will face more challenges. The government should deepen cooperation with colleges and universities, build archival talent training bases, and speed up the cultivation of archival professionals. Moreover, it is essential to improve the talent evaluation system.
- Improve file utilization service capabilities. The use of archives is the way to realize the value of archival work. Archives at all levels should continue to optimize the utilization environment, simplify the utilization procedures, and meet public needs. It is necessary to develop Internet/mobile terminal query and utilization services, especially in this period when COVID-19 is sweeping the world.

The model used in this study combined two widely used approaches (TOPSIS and GRA). These two methods assess the development of objects from different aspects. The integration of them can improve the stability and reliability of the results. In addition, compared with previous comprehensive evaluation models that only provide the overall scores, we proposed methods to evaluate the development under a specific indicator and to evaluate the balance of different objects under a certain indicator. This can provide a theoretical reference for future comprehensive evaluation models.

However, our work is still a preliminary attempt, and the model can be further improved from several perspectives. The main problem is the selection of indicators and weights. Here, we have used all available indicators and obtained weights based on expert experiences. The focus of future research is to compare the impact of different indicators and weights on the results, similar to our work in Figures 3 and 4. In addition, the applicability of this model should also be tested over a wider range, including the application over a longer time range and the comparison among different countries.

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