

# **The Relationship between Cultural Facilities in Tianjin and the Development of the Cultural Industry**

## **-- Based on Grey Relational Analysis**

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### **Abstract**

Driving the high-quality development of public cultural services in the new era, improving the quality and level of supply is an important task to further deepen the reform of the cultural system, develop advanced socialist culture, and meet the realistic needs of the people to enjoy a more enriched, more diversified, and higher-quality spiritual and cultural life to satisfy the people's aspirations for a better life. Urban public cultural facilities are the business cards of urban cultural display, not only satisfying the cultural needs of the people, but also contributing to a certain extent to the economic development of the cultural industry. Tianjin is a region with developed cultural industry in China, studying the public cultural facilities in Tianjin is of great significance, understanding the relationship between public cultural facilities and the cultural industry, and providing the government with a direction for cultural industry development. This article takes the data of Tianjin's public cultural facilities from 2016 to 2020. First, the comprehensive score of public cultural facilities is calculated by the entropy method to understand the situation of public cultural facilities in Tianjin. Secondly, through grey relational analysis, the correlation between public cultural facilities and the cultural industry is studied to understand the existing relationship between public cultural facilities and the cultural industry in Tianjin.

### **Keywords**

Cultural Facilities; Cultural Industry; Grey Relational Analysis.

## **1. Introduction**

In the new era, the pursuit of high-quality development of public cultural services, with the enhancement of quality and level of supply, has become an important task for deepening the reform of the cultural system and promoting the flourishing development of advanced socialist culture. This effort aims not only to offer citizens a more enriching, diverse, and high-quality cultural life but also to fulfill the genuine desire of the masses for a better life. Urban public cultural facilities are not only a good showcase of urban culture but also serve to meet the cultural needs of the population and significantly contribute to the economic growth of the cultural industry.

As a center for the development of the cultural industry in China, the study of Tianjin's public cultural facilities holds significant importance for a comprehensive understanding of their value and impact, as well as for exploring the connections between Tianjin's public cultural facilities and the development of the cultural industry, providing valuable guidance for the future development of the cultural sector. This study is based on data of Tianjin's cultural facilities from 2016 to 2020, using the entropy method to calculate the comprehensive score of public cultural facilities in order to understand the cultural landscape of Tianjin. Subsequently, through a grey relational analysis, we analyze the mutual connections between public cultural

facilities and the cultural industry, thereby evaluating the concrete situation of interactions in Tianjin.

## 2. Research Status of Cultural Facilities in Tianjin City

After entering the 21st century, the development of cultural facilities in Tianjin gradually became more diversified. By the end of 2008, Tianjin had completed 10 significant cultural facility projects, including landmarks such as the renovation of Tianjin Library, Li Shu Tong's former residence, Binhu Theater, Zhou Enlai Memorial Hall's West Floral Hall, and Xiaobailou Concert Hall, which are highly favoured and frequently used by the public. Furthermore, the pace of construction of grassroots cultural facilities in various districts and counties has been gradually accelerating. However, at the same time, in the first decade of the 21st century, Tianjin lacked modern large-scale cultural facilities reflecting the city's character, as well as large platforms for international exchanges or hosting international events. This limitation constrained Tianjin's international competitiveness significantly.

After 2010, cultural life in Tianjin became increasingly enriched, and during the period of the 12th Five-Year Plan, a basic public cultural service system was established. Cultural facilities refer to the spaces where cultural activities take place and the necessary equipment [1]. The completion of the Tianjin Cultural Center, based on the utilization and integration of existing cultural resources to meet the cultural needs of the people, embodies the city's development direction. It enhances the city's cultural function, strengthens Tianjin's comprehensive strength and influence, and fully demonstrates Tianjin's cultural functions. Public cultural facilities are first and foremost a group of buildings or architectural complexes that simultaneously possess specific cultural functions and cultural added value [2]. Cultural facilities can represent the city's culture and serve both internally and externally, playing a crucial role in the overall cultural functions of the city [3]. Cultural facilities also possess characteristics of humanization and affinity, serving as the materialization of the city's character and charm [4]. The design of public facilities that integrate regional culture can effectively present the image and spiritual essence of the regional culture, achieve harmony and unity with the spatial environment, and continue the local cultural heritage [5]. The Tianjin Cultural Center is the largest public cultural facility in Tianjin, combining public cultural venues, urban parks, citizen leisure centers, and youth activities. It is also the largest in the country, integrating cultural exhibitions, exchanges, leisure, and consumption into a cultural leisure center.

Regarding the cultural industry, designing to improve the quality of facility services, ensure service equality, and consider the life cycle of the facility [6]. Tianjin has initiated six key projects with a total investment of nearly 150 billion RMB, and the development trend of industrial agglomeration is evident. Currently, Tianjin has over 30 cultural industry parks, more than 20,000 cultural enterprises, nearly 400,000 employees, and has basically formed a cultural industry development layout of "mountains and seas, urban and rural areas, four districts, and multiple points." Achieving environmental protection and sustainable development in public facilities [7]. The city has gradually improved an eight-category cultural industry system, including cultural creativity, radio film and television, publishing, performing arts and entertainment, cultural tourism, digital content and animation, cultural exhibitions and advertising, and art trading; the cultural industry is gradually developing towards a pillar industry [8].

### 3. Research Methodology of the Relationship between Cultural Facilities and Cultural Industry in Tianjin City

#### 3.1. Entropy method

(1) To ensure that the entropy variables fall within the range of [0,1], we will normalize each indicator using the range method, resulting in a normalized matrix:

$$Y_{ij} = \frac{X_{ij} - (X_{ij})_{\min}}{(X_j)_{\max} - (X_j)_{\min}}$$

Variables in the formula:

$i$  denotes the evaluator number;

$j$  represents the index number of evaluation;

$Y_{ij}$  denotes the normalized data of the  $i$ -th evaluator for the  $j$ -th evaluation index;

$X_{ij}$  represents the data of the  $i$ -th evaluator for the  $j$ -th evaluation index in the original data;

$(X_{ij})_{\min}$  is the minimum value in the original data;

$(X_j)_{\max}$  is the maximum value in the  $j$ -th evaluation index;

$(X_j)_{\min}$  is the minimum value in the  $j$ -th evaluation index.

(2) Calculate the proportion of the  $i$ -th evaluator for the  $j$ -th index

$$P_{ij} = Y_{ij} / \sum_{i=1} Y_{ij}$$

(3) Calculate the entropy value of the indicators

$$e_j = \frac{1}{\ln n} \sum_{i=1}^n P_{ij} \ln P_{ij}$$

In the equation,  $e_j$  denotes the entropy value of the  $j$ -th evaluation index, and  $n$  represents the number of evaluators.

(4) Calculate the entropy weight of the indicators

$$S_j = \frac{1 - e_j}{\sum_{j=1}^n (1 - e_j)}$$

#### 3.2. Grey Relational Analysis

Grey Relational Theory was firstly proposed by Professor Ju-Long Deng [9] from Huazhong University of Science and Technology in 1982. After nearly 30 years of development and improvement, it has been widely applied in various fields, such as economics and society. Grey Relational Analysis is one of the main contents of grey system analysis, used to analyze the closeness of the main behavioral factors of a grey system to the related behavioral factors, and to determine the main and secondary factors influencing the development of the system. Due to the limited statistical data in China and other reasons causing uncertainty, when analyzing

system-related factors, grey relational analysis methods have certain advantages over regression analysis, variance analysis, principal component analysis, and other statistical methods. It is equally applicable to both the quantity and regularity of the samples. This method takes correlation as a relative indicator of the closeness of the relationship between factors in the system, and uses the degree of geometric similarity between the main behavior sequence and the related behavior sequences in the system to determine the degree of closeness of their connections as the basic idea. It is a grey system analysis method that takes correlation calculation as the basic means. The basic steps of grey relational analysis are as follows:

- (1) Select reference sequence (system characteristic sequence) and comparison sequence (related factor sequence);
- (2) Raw data selection: This paper uses the GDP of the cultural industry in Tianjin Municipality to reflect the economic growth situation as a system characteristic indicator value. It selects a series of related factor indicator values such as the number of public libraries, the number of archival institutions, the number of museums, the number of TV/radio program sets, the number of cinema screening units, the number of schools, the number of research projects, the number of attractions, and the number of restaurants;
- (3) Initialisation: Initialisation is taking the first number in a series to subtract it from all the numbers in the same series, resulting in an initialisation series;
- (4) Calculate relational parameters: After the transformation of the data in the previous step, the system characteristic sequence is denoted as  $X_0$ , and the related behavioral factor sequence is denoted as  $X_i$ . The relational parameters between the two sequences can be calculated using the following formula:

$$\varepsilon_{0i} = \Delta_{\min} + \rho \Delta_{\max} / \Delta_{i(t)} + \rho \Delta_{\max} \quad (1)$$

In the equation,

$$\Delta i(t) = |y_0(t) - y_i(t)|;$$

$$\Delta_{\min} = \min_{i=1,2,3,\dots,m} \Delta i(t);$$

$$\Delta_{\max} = \max_{i=1,2,3,\dots,m} \Delta i(t);$$

$$i = 1, 2, 3, \dots, m;$$

$$t = 1, 2, 3, \dots, n;$$

In the formula,  $\rho$  represents the resolution coefficient, typically taken as 0.1 to 0.5; in this analysis,  $\rho$  is taken as 0.5.

$$\gamma_{0i} = 1/n \sum_{j=0}^n j = \varepsilon_{0i}(t), i = 1, 2, 3, \dots, m \quad (2)$$

Rank the relation sequences: Rank the sequence based on the magnitude of  $\gamma_{0i}$ , distinguishing the degree of correlation. The larger the value of  $\gamma_{0i}$ , the greater the degree of correlation; conversely, the smaller the value of  $\gamma_{0i}$ , the smaller the degree of correlation.

## 4. The Study on the Correlation of Cultural Facilities in Tianjin Municipality with the Cultural Industry

### 4.1. Selection of Variables

The variables selected for this study in Tianjin municipality will be categorized into four main categories, which include cultural basic venues, entertainment industry, science and education facilities, and tourism facilities.

- (1) Cultural basic venues construction includes public libraries, archives institutions, museums;
- (2) Entertainment industry facilities construction includes television, film, and broadcasting;
- (3) Science and education facilities include schools, research projects;
- (4) Tourism facilities include attractions and catering establishments.

4.2. Establishing Indicators

This study selects the number of public libraries, the number of archives institutions, the number of museums, the number of TV/broadcast programs, the number of movie screening units, the number of schools, the number of research projects, the number of attractions, and the number of catering establishments as indicator variables, as shown in Table 1.

**Table 1.** Table for the Construction of Indicator System for Cultural Facilities in Tianjin Municipality

Primary Indicator	Secondary Indicator
Cultural Basic Venues	Public Library Quantity (A1)
	Archives Institution Quantity (A2)
	Museum Quantity (A3)
Entertainment Industry Facilities	Number of TV/Broadcast Programs (A4)
	Number of Movie Screening Units (A5)
Science and Education Facilities	Number of Schools (A6)
	Number of Research Projects (A7)
Tourism Facilities	Number of Attractions (A8)
	Number of Catering Establishments (A9)

5. Comprehensive Score of Cultural Facilities in Tianjin Municipality

5.1. Selection of Variables

This article obtained the cultural facilities data of Tianjin Municipality from the "Tianjin Statistical Yearbook" for the years 2016-2020, selected the entropy method to calculate weights, and obtained the comprehensive scores of cultural facilities in Tianjin Municipality, as well as weight distribution and comprehensive scores outlined in Table 2. According to Table 2, it can be seen that the archives institution quantity has the highest comprehensive score of 0.329 among cultural basic venues, indicating that the quantity of archives institutions has been relatively well maintained from 2016 to 2020 to meet the cultural needs of the population. In the entertainment industry facilities, the comprehensive score of the number of movie screening units is relatively good at 0.314, indicating that the supply of movies meets the cultural demands of the population. In the science and education facilities, the comprehensive score of the number of schools is relatively good, the cultural industry's contribution to the national economy ranks high among all industries [10]. In terms of tourism facilities, the number of attractions has a score of 0.261, indicating that the tourism industry in Tianjin Municipality is rich, and it reflects the advantages of tourism development and the integration of culture and tourism in Tianjin.

From the perspective of the first indicator, it can be observed that cultural basic venues have the highest score. This is partly because it is the most basic channel for urban cultural dissemination, providing a basic carrier for the development of cultural industries. Museums, cultural centers, and other cultural venues usually represent a city's distinctive cultural industry and cultural traditions. These cultural resources embody the spiritual connotation and creative source of local cultural industry development. The construction of local cultural basic venues not only preserves and inherits unique culture but also promotes cultural publicity and

exchange, creating a favorable cultural atmosphere and driving the development of the cultural industry. Furthermore, these cultural basic venues provide venues for art creation, performances, and cultural services, directly contributing to the revenue generation of the local cultural industry.

**Table 2.** Comprehensive Score of Cultural Facilities in Tianjin Municipality

Primary Indicator	Secondary Indicator	Entropy Value(e)	Weight Coefficient(w)	Integrated Score	
Cultural Basic Venues	Public Library Quantity (A1)	0.825	6.89%	0.179	0.696
	Archives Institution Quantity (A2)	0.184	32.20%	0.329	
	Museum Quantity (A3)	0.869	5.17%	0.188	
Entertainment Industry Facilities	Number of TV/Broadcast Programs (A4)	0.694	12.08%	0.196	0.510
	Number of Movie Screening Units (A5)	0.732	10.58%	0.314	
Science and Education Facilities	Number of Schools (A6)	0.767	9.19%	0.234	0.399
	Number of Research Projects (A7)	0.860	5.52%	0.165	
Tourism Facilities	Number of Attractions (A8)	0.754	9.71%	0.261	0.430
	Number of Catering Establishments (A9)	0.781	8.64%	0.169	

\*The data in Table 2 have all been processed by rounding to three decimal places.

## 5.2. Correlation Analysis of Cultural Facilities with Cultural Industry in Tianjin Municipality

This paper adopts Professor Julong Deng's Grey Relational Analysis method from Huazhong University of Science and Technology. By studying the correlation analysis of cultural facilities on the cultural industry in Tianjin City, this paper selects the following factors as pertinent index variables: the number of public libraries, archival institutions, museums, TV/radio programs, cinema units, schools, research projects, attractions, and dining establishments; deferring to the tertiary sector GDP as the characteristic index. The analysis concludes the correlation results of cultural facilities on the cultural industry in Tianjin City (as shown in Table 3), and ranks their correlation levels accordingly (as illustrated in Table 4). According to the table below, the increasing correlation between the number of museums and the cultural industry over time is driven by the growth in the number of museums, which invigorates the surrounding cultural industry. As national income levels rise and cultural consumption increases, with improved levels of collective cultural expenditure, innovation in cultural industry drives more and more innovative culture-related products. The increase in the number of museums prompts greater public consumption, includes cultural resources, cultural facilities, cultural investments, and more [11], which consequently raising the cultural industry's GDP. Over time, the majority of correlations between cultural facilities and the



cultural industry exhibit gradual decrease in their relationships due to changes in the international environment, overlaid with existing hegemony and unilateralism among various countries. Another part of the decline can be attributed to Tianjin's continued innovation in industrial transformation while facing contemporary phenomena resulting from structural fatigue.

**Table 3.** Result of the Correlation Analysis between Cultural Facilities and Cultural Industry in Tianjin Municipality

Time	2019	2020	2021	2022	2023
Public Libraries	0.385	0.440	0.655	0.485	0.333
Archival Institutions	0.333	0.582	0.432	0.349	0.336
Museums	1.000	0.526	0.700	0.985	1.000
Number of TV/Radio Programs	0.333	0.813	0.548	0.383	0.333
Cinema Units	0.335	0.464	0.597	0.349	0.341
Schools	1.000	0.699	0.597	0.510	0.909
Research Projects	1.000	0.588	0.969	0.879	0.552
Tourist Attractions	0.351	0.440	0.945	0.349	0.351
Restaurants	0.333	0.966	0.430	0.431	0.429

**Table 4.** Ranking of the correlation coefficients between cultural facilities and the cultural industry in Tianjin Municipality

Correlational Items	Correlation Coefficients	Ranking of Correlation Coefficients
Public Libraries	0.46	7
Archival Institutions	0.406	9
Museums	0.842	1
Number of TV/Radio Programs	0.482	6
Cinema Units	0.417	8
Schools	0.743	3
Research Projects	0.798	2
Tourist Attractions	0.487	5
Restaurants	0.518	4

### 5.3. Conclusions on the Development of the Cultural Industry in Tianjin Municipality based on Cultural Facilities

The cultural industry, as an emerging industry, plays an important role in promoting the transformation of urban economic structure and achieving high-quality development [12]. This study primarily focuses on the correlation between cultural facilities and the development of the cultural industry in Tianjin Municipality. Firstly, an indicator system and data sources are established and described. The comprehensive scores of various cultural facility indicators are calculated using the entropy method, and it is found that the archive institutions in the cultural foundation category, the number of cinema units in the entertainment industry facilities, and the number of tourist attractions have higher comprehensive scores. Based on the primary indicator, it is observed that cultural foundation facilities have the highest comprehensive score. Through Grey Relational Analysis, the correlation between cultural facilities in Tianjin Municipality and the cultural industry is analyzed. It is found that the correlation between the number of museums and the cultural industry has become increasingly higher over time. Additionally, it is noted that the majority of correlations between cultural facilities and the cultural industry decrease as time progresses.

## 6. Suggestions on the Development of the Culture Industry in Tianjin

The main factors influencing the development of China's cultural industry are production factors, market conditions, and government policies, including the radio and television sector [13]. Based on the results, the following recommendations are proposed for the cultural facilities in Tianjin Municipality:

In the field of cultural facilities in Tianjin, it is recommended to increase investment in educational facilities. Firstly, there should be an increase in the number and variety of educational facilities to meet the growing demand for education. Additionally, it is necessary to update and upgrade existing educational facilities to ensure the quality and efficiency of their services. Furthermore, in the planning of cultural facilities, emphasis should be placed on the rational allocation of educational resources to ensure that every community has access to quality educational facilities. By increasing investment in educational facilities, it can promote the improvement of education quality and equity, providing local residents with better learning opportunities and development spaces.

To enhance tourism-related facilities in Tianjin, it is important to focus on upgrading and expanding existing infrastructure. This could involve improving transportation networks such as roads, airports, and public transportation to enhance accessibility for tourists. Additionally, enhancing accommodation options by constructing more hotels and providing diverse lodging choices can improve the overall tourism experience for visitors. Developing entertainment and cultural venues, such as museums, theaters, and theme parks, can attract more tourists and enrich their stay in Tianjin.

Investing in tourism-related facilities not only benefits the tourism industry but also contributes to the local economy by creating job opportunities and increasing revenue. By continuously improving and expanding tourism-related facilities, Tianjin can strengthen its position as a prominent tourist destination, attracting more visitors and boosting the city's overall appeal.

Strengthen the construction of basic cultural venues and cultural entertainment facilities. Carrying out planning and design; placing emphasis on the layout planning and design of basic cultural venues and cultural entertainment facilities to ensure a balanced distribution, making it convenient for residents and visitors to engage in cultural and entertainment activities; Increasing investment in construction; enhancing financial support for the construction of cultural facilities, encouraging participation from private capital, and promoting improvements in the quality and quantity of cultural facility construction; Enhancing facility quality; focusing on construction quality to ensure that cultural venues are modern and convenient, with comprehensive and practical functions; Expanding cultural entertainment projects; diversifying cultural entertainment projects, holding various cultural exhibitions, arts performances, and shows to provide a variety of cultural and entertainment options; Strengthening management and operation; establishing a sound cultural facility management mechanism, defining responsibilities clearly, ensuring good operation and management of facilities, and enhancing service quality and efficiency; Attracting talent training; attaching importance to the construction of personnel teams in cultural venues, strengthening relevant training and education, and raising the professional level and service attitude of personnel engaged in cultural work. Through the above measures, the construction level of basic cultural venues and cultural entertainment facilities in Tianjin can be effectively improved, providing residents and visitors with a more diverse cultural experience and entertainment options.



## 7. Conclusion

The development of cultural facilities is not only a matter of urban planning but also a question of urban cultural governance. Currently, many major cities in China have entered a stage where existing resources are fully utilized. Culture serves as a significant driver for urban rejuvenation and a key growth sector for the city's economy. With both basic and diverse cultural needs coexisting, and against a backdrop of increasing flexibility in urban cultural service demands, it becomes important to explore further how to effectively utilize cultural facilities and utilize them to promote the development of cultural industries. This issue is worth further exploration to harness the full potential of culture as a force for economic and social advancement.

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