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# GeoDetector Based Research on Spatial Differentiation and Influencing Factors on China Urban Exhibition Development

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# GeoDetector Based Research on Spatial Differentiation and Influencing Factors on China Urban Exhibition Development

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**Abstract.** The author constructed index system, including 4 factors, namely Regional environment, related supporting industries, market openness, urban hierarchy and 17 sub-variables with 69 cities as sample, to analyze the spatial differentiation and factors influencing China urban exhibition development based on Natural Breaking Point and Geographic Detector. The research results show that there is significant spatial differentiation for China urban exhibition development; Factors that have a significant impact on the development of urban exhibition include Related supporting industries, open market ,Urban hierachy and two variables of Regional environment, namely ,the Regional GDP and GDP Proportion of Tertiary Industry. The interactions between factors is more influential than factors alone.

**Keywords:** Urban exhibition development; Geoetector; Related supporting industry; Open market; Urban hierarchy.

## 1. Introduction

Exhibition is economic activity that people gathered for specific theme at specific venue [1], what originated in Europe in 19th century, and defined by American comprehensive scholars as MICE and late Events had been added to extend the definition of MICE as MICEE[2]. In this paper, exhibition is an alternative term of MICE.

In recent years, the exhibition industry of China has developed rapidly, and the scale and exhibition area of the exhibition industry have reached the first place in the world. In 2018, the number of cities undertaking exhibition activities in China reached 181, and the total number of exhibition venues in the whole year reached 10,889, and the total exhibition area increased by 1.2% compared with 2017. Although affected by the macro economy, the growth rate of exhibition development has declined, but the overall exhibition industry has developed smoothly, especially the holding of the first China International Import Exhibition in 2018, which shows that China has moved from a large country of exhibition industry to a powerful country of exhibition industry.

However, the exhibition industry of China presents the phenomenon of imbalance and great differentiation in different cities, accurately grasping the reasons for the spatial differentiation of the development status of the exhibition industry in various cities in the country, it is of great significance for different cities to find a suitable exhibition development road and promote the local exhibition competitiveness. The author determines the influence factors of spatial differentiation of convention and exhibition development status of cities and their interrelationships through geographical detectors to provide feasible suggestions for the healthy development of convention and exhibition industry in China.

## 2. Literature Review

### 2.1. Literature Review for Exhibition Spatial Distribution

Zhu H. (2004) found that economic strength is the main factor affecting the industrial layout of convention and exhibition center city[3]. Wang Y. (2005) found that the spatial movement of exhibition economy mainly originates from discrete force and attraction[4]. Ju H. et al (2006) pointed out that the lack of accurate market positioning and investment leads to the imbalance of regional layout of China's urban exhibition industry [5]. Tian T. et al (2006) demonstrated that The characteristics of spatial distribution of exhibition industry and its influencing factors include social factors, natural factors, scientific and technological factors and economic factors[6]. Fu H. (2006) puts forward the location decision theory of exhibition industry layout[7]. Ju S. et al (2006) puts forward some ideas about constructing the spatial economic structure of exhibition economy in Beijing, Yangtze River Delta, Pearl River Delta and Exhibition City Belt[8].

Yang X., et al (2014) study the spatial agglomeration and time distribution characteristics of exhibition industry in China[9]. Fang Z. et al (2013) utilize Kernel Density Estimation and GIS technology, finding that the development of characteristic industrial clusters, market demand, government policy and environmental factors of exhibition facilities affect the spatial pattern of exhibition enterprises in the Pearl River Delta [10]. Ren G. (2014) [11]and Fang W. (2018)[12]studied distribution and spatial agglomeration characteristics of exhibition venues. Yang G. et al (2016) improved gravity model to measure the mutual attraction between cities in the middle and lower reaches of Yangtze River[13]. Sun Z. et al (2019) makes an interactive study on the spatial layout and function orientation of exhibition venues[14].

Current studies focus on exhibition industry development, economic or social impact, while the empirical literature is rare on the spatial and temporal distribution in China exhibition industry.

### 2.2. Literature on Factors Influencing Exhibition Development

SWOT analysis[15], Diamond Model[16], Factor analysis[17], Non-linear Model[18]and coordinated development model [19] have been utilized to study the development of exhibition industry level what focus on exhibition industry competitiveness, evaluation index system and effects. Qu H., et al (2000)[20],Weber K et al(2003) [21],Karin W. (2003)[22],Tay L(2006) ,Linda T. (2006)[23], Wang S., et al(2009)[24], Lee H.(2008)[25],Lee H.(2016)[26],Su J., et al(2018)[27], Liu J., et al(2019)[28]have constructed exhibition competitiveness index systems. Meng F. et al (2012) found the principal factor influencing exhibition industry by means of Interaction Mechanism Model of the Development of Exhibition Industry and Urban Economic Growth. Some researchers demonstrate that regional economy affect exhibition industry[31[30][31].

At present, there are few researches on the spatial differences and the influencing factors of urban exhibition development in China based on large scale sample, Geographical Detectors has not been utilized for exhibition industry. Based on the spatial differences of the development of China's urban convention and exhibition, the author tries to provide empirical reference for the healthy development of China's urban exhibition by using Geographical Detectors to study the related factors affecting the development of urban exhibition.

## 3. Research Design

### 3.1. Selection of Variables Influencing Exhibition Industry Development

Selecting the measureable, quantifiable and accessible data according to literature[24]( Lee H.,2008;Lee H.,2016;Wu Q., et al,2018;Zhao L., 2006;Zhao Q.,2014;Zhou I.,2015;Zhan D.,2017, the author constructed an index system to evaluate the urban exhibition industry development what include 4 factors ,Regional environment (X1-X7), Related supporting industry(X8-X12) , Open market(X13-X16), Urban hierarchy(X17)  and 17 influencing variables (Table1).

**Table 1.** Index system of impact factors for the development of urban exhibition.

| Research factor | Variable definition and its  unit | Literature source |
|---|---|---|
| Regional environment | X1: Regional GDP//billion | Lee H.,2008[24], Wang  Q., et al,2018[29] |
| | X2: Economy increase percent //% | Wang S., et al,2009[24] |
| | X3:  the ratio between added value of the Secondary Industry and GDP of the city//% | Lee  H.,2016[25] |
| | X4:  GDP  Proportion  of  Tertiary Industry //% | Wang  S.,  et  al,2009[24],  Lee H.,2016[25] |
| | X5:  Average  walking  distance  from public transportation stops //m* | The author |
| | X6: Per capita park green space //m²* | |
| | X7: Green overage of Built Areas//% | Zhou L.,2015 |
| | X8:Number  of  scenic  spot  A  and above// | Lee H.,2008[24] , Zhou I.,2015 |
| | X9:4A Number of scenic spot4 A and above// | Lee H.,2008[24] |
| Related  supporting industry | X10: number of visitors //10 thousand person-times of 2018 of the city | Wang S., et al,2009[24], Wang  Q., et al,2018[29] |
| | X11: annual tourism earnings of the city //100 million Yuan | |
| | X12:  number  of  Star-rated  hotels  of  2018// | Wang S., et al,2009[24], Wang  Q., et al,2018[29], Zhao L.,2006[31] |
| Open market | X13:  foreign  exchange  earnings  from international tourists //$ 100 million | Zhou L.,2015[32] |
| | X14: number of international tourists //  10 thousand person-times | Zhou L.,2015[32] |
| | X15: total value of export goods// 100 million Yuan | Zhan D.,2017[33] |
| | X16:  total  value  of  import  goods  //100 million Yuan | |
| Urban hierarchy | X17: urban hierarchy//* | Lee   F.,2014[36] |

 * selected by the author

## 3.2. Research Method

*3.2.1 Urban exhibition industry development index.* Urban exhibition industry development index is from "Statistics report of China exhibition industry 2018", the formulae of Urban exhibition industry development   index is :

$$Y_{\mathrm{n}} = 0.1\left(A_n + B_n + C_n + D_n + E_n + F_n + G_n + H_{\mathrm{n}}\right) + I_n + J_n + K_n$$
$$+ L_n + M_{\mathrm{n}} + 0.3R_n + 0.2P_n + 3Q_n + 2O_n \tag{1}$$

$Y_n$, Urban exhibition industry development of city n;

$A_n$, number of exhibition of city n;

$B_n$, urban exhibition area of city n(10 thousand $m^2$) ;

$C_n$, domestic dependent exhibition number of city n;

$D_n$, number of overseas independent exhibition projects of city n;

$E_n$, number of exhibition hall of city n;

$F_n$, area available at city exhibition venues of city n(10 thousand $m^2$) ;

$G_n$, Number of government departments and agencies involved in urban exhibition industry of city n;

$H_n$, number of members of IAEE of city n;

$I_n$, Number of autonomous exhibitions outside cities of city n;

$J_n$, number of UFI member and number of certified exhibition projects of city n;
$K_n$, number of urban IAEE member of city n;
$L_n$, Number of urban exhibition projects included in TOP100 2018 of city n;
$M_n$, Number of urban exhibition projects included in the 2018 TOP3 by industry breakdown in city n;
$R_n$, Number of Exhibition Specialty of Undergraduate Colleges of city n;
$P_n$, Number of Exhibition Specialty of Colleges of city n;
$Q_n$, convention and exhibition A listed companies of city n;
$O_n$, exhibition industry New Third Board Listed companies

*3.2.2 Natural breakpoint method for city classification.* The core idea for Natural Breakpoint Method is clustering, taking into account the range and number of elements between each group as close as possible, the discontinuity of the data set as the basis for classification of the data set, so that each group of internal similarity the largest, and the difference between the external group and the group is the largest[34].

*3.2.3 Geographical detector.* Geodetector is a set of statistical methods to detect spatial heterogeneity and its driving force. It is assumed that if an independent variable has an important influence on a dependent variable, then the spatial distribution of the independent variable and the dependent variable should be similar. Geographic detectors mainly include factor detection, risk detection, ecological detection and interactive detection[35]. In this study, factor detectors and interactive detectors are used to detect the influence factors of spatial differentiation and the interaction between them. The mathematical expression of a geographical detector is as follows:

$$q = 1 - \frac{1}{n\delta^2}\sum_{i=1}^{r}n_i\delta_i^2$$

(2)

Among them:
q is the explanatory power of detection factor to the development of city exhibition;
n is the sample size of the whole region;
$\delta^2$ is the discrete variance of the Urban exhibition industry development index;
$n_i$ is the sample size of sub-level area;
$\delta_i^2$ is the variance of sub-level area;
r is the number of sub-level area;
$\delta^2 \neq 0$, then the model holds[14]
The value range of q is [0,1], the larger the value, the more significant the spatial differentiation of the dependent   variable Y, the level of urban exhibition development .When the stratification is cause by independent variable X, the larger the value of q indicates X the stronger the explanatory power for the level of urban exhibition development. When q=1, it means that the $\delta_{i2}$ approaches to 0, which indicated that the independent variable   X completely control the spatial distribution of the development of Y , urban exhibition development; when q=0, it shows that the influence factor X has no relationship with Y. The principle of the factor detector is to judge whether the detection factor has influence on a dependent variable Y by the value of q.
The q value of two factor X1and X2 pairs of Y are calculated separately: q(X1) and q(X2), and the value of q when the interact with them (i.e., the new polygon distribution formed by the tangent of the two layers of superimposed variables X1and X2): q(X1∩X2). Q (X1), q(X2) and q(X1∩X2) are then compared, the relationship between the two factors can be divided into the following five categories [35] (Fig. 1), which is the principle of the interactive detector.
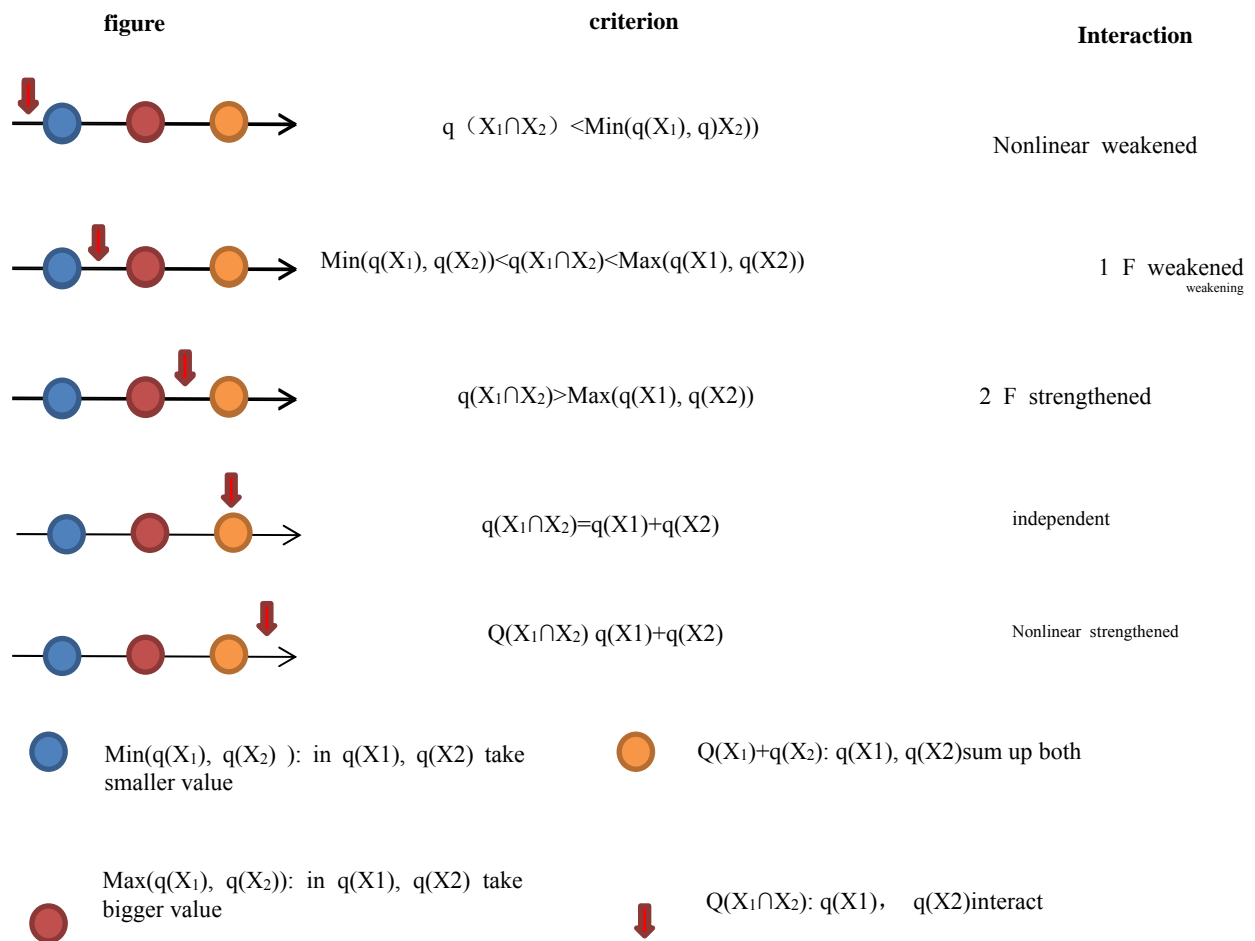
| figure | criterion | Interaction |
|--------|-----------|-------------|



| | $q（X_1 \cap X_2）<Min(q(X_1), q)X_2))$ | Nonlinear weakened |
| | $Min(q(X_1), q(X_2))<q(X_1 \cap X_2)<Max(q(X1), q(X2))$ | 1 F weakened weakening |
| | $q(X_1 \cap X_2)>Max(q(X1), q(X2))$ | 2 F strengthened |
| | $q(X_1 \cap X_2)=q(X1)+q(X2)$ | independent |
| | $Q(X_1 \cap X_2)\ q(x1)+q(X2)$ | Nonlinear strengthened |

$Min(q(X_1), q(X_2) )$: in $q(X1)$, $q(X2)$ take smaller value

$Q(X_1)+q(X_2)$: $q(X1)$, $q(X2)$sum up both

$Max(q(X_1), q(X_2))$: in $q(X1)$, $q(X2)$ take bigger value

$Q(X_1 \cap X_2)$: $q(X1)$, $q(X2)$interact

**Figure 1.** Five types of interaction between two independent variable factors and dependent variables.

*3.3. Sample*

According to the research result of Lee F.(2014)[36] and The Statistics Report of China Exhibition Industry 2018, the author selected top 183 cities with the highest value of Urban Exhibition Industry development Index as intended sample, because of the availability of data, only 69 cities have been selected as research sample(Table 2).

**Table 2.** Research sample cities.

| City hierarchy | Cities |
|----------------|--------|
| National center(6) | Beijing, Shanghai, Chongqing, Shenzhen, Guangzhou, Tianjin |
| Provincial center(19) | Wuhan, Dongguan, Foshan, Chengdu, Nanjing, Shenyang, Xi'an, Hangzhou, Harbin, Dalian, Jinan, Qingdao, Changchun, Suzhou, Xiamen, Changsha, Urumqi, Fuzhou, Zhengzhou |
| Metropolis(27) | Guiyang, Zhongshan, Ningbo, Nanchang, Nanning, Wuxi, Lanzhou, Haikou, Wenzhou, Hohhot, Yinchuan, Xuzhou, Datong, Nantong, Zibo, Zhuhai, Luoyang, Changzhou, Yangzhou, Huizhou, Taizhou, Liuzhou, Tai'An, Quanzhou, Jiangmen, Handan, Baoding |
| Medium –size(16) | Guilin, Jiaxing, Mianyang, Shaoxing, Lianyungang, Xingtai, Leshan, Qinhuangdao, Jining, Zhenjiang, Ganzhou, Zhangjiakou, Yibin, Nanchong, Dezhou, Zhaoqing |
| Small size(1) | Lhasa City |

## 4. Data Sources and Processing

### 4.1. Data Sources
The original data for this research is from China Statistical Yearbook (2019) , Statistical Yearbooks 2019 of concerning cities and provinces,  Bulletin of Statistics of National Economic and Social Development 2018 of concerning cities, City Statistics Bureau Public Report, City Tourism Bureau Website, and China Exhibition Data Statistics Report (China Convention and Exhibition Economic Research Association ,2018,http://www.cces2006.org/), Baidu Map: China City Traffic Report of 2018.

### 4.2. Data Processing
Because of the unavailability of data ,Kunming, Shijiazhuang, Hefei, Taiyuan, Weifang, Linyi, Yancheng, Yantai ,Xining, Tangshan, Langfang, Yiwu, Kunshan have been removed from the sample ,69 cities have been retained as subject(Table2).

The data of independents of Geodetector is nominal, for the original data of the remaining 69 cities, cluster analysis was performed using the K-mean value in SPSS25.0. Each detector factor cluster was divided into 5 categories, of which 1-5 represented the progression of its data development (proportion) degree, 1 represented the development (proportion) worst (less), and 5 represented the development (proportion) best (more).

## 5. Findings

### 5.1. Spatial Differentiation of China Exhibition Industry Development
By introducing the data of 69 cities in 2018 into the formula (1), the development of 69 cities was obtained. The natural breakpoints of 69 cities were classified 5 levels as highest level (128.300004-478.480011), higher level (65.099999-128.300003), medium level (36.200002-65.09998), lower level (10.970001 - 36.200001) and lowest level(0.15 - 10.97) (Table 3).

**Table 3.** Study on the spatial distribution of regional cities exhibition development[*.]

| City hierarchy | Number of cities | | | | | Average value of exhibition development |
|---|---|---|---|---|---|---|
| | Lowest | lower | medium | higher | highest | |
| National center | 0 | 0 | 1 | 2 | 3 | 212.15 |
| Provincial center | 0 | 7 | 5 | 7 | 0 | 52.32 |
| metropolis | 17 | 9 | 1 | 0 | 0 | 12.24 |
| Medium -size | 16 | 0 | 0 | 0 | 0 | 3.55 |
| Small size | 1 | 0 | 0 | 0 | 0 | 1.30 |

● From the ArcGIS 10.2 calculation result

Table 3 shows:

1) The top 69 cities in the report, the development of exhibition industry is generally in the middle level, and the average level of exhibition development in 69 cities is 38.48.

2) There are significant spatial differentiation for China city exhibition development.

3) The difference between number one city Shanghai (478.48) and the 176th city Zhaoqing (0.15), 49, is more than 3189 times. Only 3 national cities' exhibition industry level is highest among which Tianjin's exhibition industry development is medium; provincial center cities include 7 higher, 5 medium and 7 lower exhibition industry development cities.

### 5.2. Factor Finding Influencing China Urban Exhibition Development

5.2.1. *Results of factor detector.* Factor detectors are utilized to detect the influence of influence factors on the development of urban exhibition. By introducing the independent variables and dependent variables into the geographical detector, the results of the detection of the explanatory power of the influencing factors of the development are shown in Table 4.

**Table 4.** Detecting results of impact factors of China's urban convention and exhibition development [*].

| Factor | Variable definition and its unit | q | p |
|---|---|---|---|
| Regional environment | X1: Regional GDP//billion | 0.844 | 0.000 |
| | X2: Economy increase percent //% | 0.033 | 0.705 |
| | X3: the ratio between added value of the Secondary Industry and GDP of the city//% | 0.182 | 0.152 |
| | X4: GDP Proportion of Tertiary Industry //% | 0.387 | 0.005 |
| | X5: average walking distance from public transportation stops //m* | 0.094 | 0.184 |
| | X6: per capita park green space //m²* | 0.093 | 0.287 |
| | X7: Green overage of Built Areas//% | 0.034 | 0.732 |
| | X8:Number of scenic spot A and above// | 0.270 | 0.065 |
| | X9:4A Number of scenic spot4 A and above// | 0.785 | 0.000 |
| Related supporting industry | X10: number of visitors //10 thousand person-times of 2018 of the city | 0.554 | 0.000 |
| | X11: annual tourism earnings of the city //100 million Yuan | 0.845 | 0.000 |
| | X12: number of Star-rated hotels of 2018// | 0.612 | 0.000 |
| | X13: foreign exchange earnings from international tourists //$ 100 million | 0.781 | 0.000 |
| Open market | X114: number of international tourists // 10 thousand person-times | 0.492 | 0.000 |
| | X15: total value of export goods// 100 million Yuan | 0.481 | 0.003 |
| | X16: total value of import goods //100 million Yuan | 0.803 | 0.000 |
| Urban hierarchy | X17: urban hierarchy//* | 0.603 | 0.000 |

*V stands for variable, q for the value of q, p for the significant level

**Table 5.** Descending significant impact factors of China's urban convention and exhibition development

| Variables | | q statistic | p value |
|---|---|---|---|
| X11 | Annual tourism earnings of the city | 0.845 | 0.000 |
| X1 | Urban GDP | 0.844 | 0.000 |
| X16 | Total value of import goods | 0.803 | 0.000 |
| X9 | total number of attractions 4A and above | 0.785 | 0.000 |
| X13 | foreign exchange earnings from international tourists | 0.781 | 0.000 |
| X12 | number of star-rated hotels | 0.612 | 0.000 |
| X17 | urban hierarchy | 0.603 | 0.000 |
| X10 | Number of Visitors | 0.554 | 0.000 |
| X14 | number of international tourists | 0.492 | 0.000 |
| X15 | Total value of export goods | 0.481 | 0.003 |
| X4 | the ratio between value of the tertiary Industry and GDP of the city | 0.387 | 0.005 |

The value of q of core factor is above 0.5, and the value of q of important factor in [0.4, 0.5], the value of q of weak factor is below 0.4 [37].

Table 4 and 5 shows that the q values of Annual tourism earnings of the city, Urban GDP, Total value of import goods, total number of attractions 4A and above, foreign exchange earnings from international tourists, Urban GDP, number of star-rated hotels, urban hierarchy and Number of Visitors are all above 0.5, indicating that these factors have a great influence on the level of urban exhibition development and are the core influencing factors. The q value of X14 (number of international tourists)

and X15(total value of export goods) is between 0.4 and 0.5, which is an important factor affecting the development of China exhibition. The influence of independent variable X4 on the development of urban exhibition is weak, which belongs to general factor.

The research findings show that some variables of Regional Environment (Regional GDP, ratio between value of the tertiary industry and GDP of the city), related supporting industries, open market and urban hierarchy significantly affect the urban exhibition development.

*5.2.2. Detection results of interactive detectors.* 17 factors are detected interactively to determine the interaction between two different detection factors enhance, weaken or maintain the influence on the dependent variables Y (the level of urban exhibition development). The interactive detection results of these 11 detection factors are shown in tables 6, and the values in the tables represent the influence of the two factors acting together on the level of urban exhibition development.

From further observation, we can see :①the influence of two factors acting together is greater than the influence of two factors acting alone. such as q (X1∩X4)=0.954>0.844 of X1 and 0.387 of X4.② 1 +1> 2. That is, when two factors act together, its influence on the city exhibition industry development is greater than that of the previous single core influence factor alone. Such as X4(the ratio between value of the tertiary    Industry and GDP of the city) and X15(Total value of export goods) acting alone is weak, but when the two factors work together, its influence on the level of urban exhibition development(0.927) is actually greater than the sum(0.868) of influence of X15(0.481) and X4(0.387).

**Table 6.** Detection results of interaction between influence factors.

|     | X1 | X4 | X9 | X10 | X11 | X12 | X13 | X14 | X15 | X16 | X17 |
|-----|------|------|------|------|------|------|------|------|------|------|------|
| X1  | 0.844 |      |      |      |      |      |      |      |      |      |      |
| X4  | 0.954 | 0.387 |     |      |      |      |      |      |      |      |      |
| X9  | 0.889 | 0.909 | 0.785 |    |      |      |      |      |      |      |      |
| X10 | 0.913 | 0.835 | 0.838 | 0.554 |   |      |      |      |      |      |      |
| X11 | 0.899 | 0.937 | 0.853 | 0.893 | 0.845 |  |      |      |      |      |      |
| X12 | 0.942 | 0.910 | 0.838 | 0.905 | 0.887 | 0.612 |  |      |      |      |      |
| X13 | 0.962 | 0.853 | 0.931 | 0.942 | 0.945 | 0.930 | 0.781 |  |      |      |      |
| X14 | 0.964 | 0.856 | 0.927 | 0.945 | 0.948 | 0.921 | 0.833 | 0.492 |  |      |      |
| X15 | 0.956 | 0.927 | 0.870 | 0.886 | 0.946 | 0.918 | 0.915 | 0.917 | 0.481 |  |     |
| X16 | 0.866 | 0.934 | 0.854 | 0.859 | 0.892 | 0.874 | 0.930 | 0.932 | 0.854 | 0.803 |  |
| X17 | 0.887 | 0.879 | 0.918 | 0.915 | 0.924 | 0.746 | 0.839 | 0.819 | 0.955 | 0.873 | 0.603 |

## 6. Research Findings and Suggestions

*6.1. Findings*

*6.1.1. On the whole, there are significant spatial differentiation for urban exhibition development in China.* The development of exhibition industry in national central cities is generally high, especially in Shanghai, Beijing and Guangzhou, which is much higher than that in other cities. The development of the exhibition industry in the provincial central cities basically belongs to the middle level, and the development gap between different cities is also large, and the development of the exhibition industry in the same grade cities is about 6 times different. The development of exhibition industry in big cities and middle cities is low, and the development of exhibition industry is not high.

*6.1.2. Factors that have a significant impact on the development of urban exhibition include Related supporting industries, open market, Urban hierarchy and two variables of Regional environment, namely, the Regional GDP and GDP Proportion of Tertiary Industry.*

*6.1.3. The interaction between the detection factors which significantly affect the development of urban exhibition enhances the influence on the development of urban exhibition.* In the interaction, the influence on the development of urban exhibition is stronger than that of core elements alone. This also shows that the development of urban exhibition needs to be supported by the environment and

conditions of the region.

This piece of research introduce Geodetector into exhibition industry study and reach an exploratory empirical findings that affect urban exhibition development factors which contributes to the knowledge.

*6.2. Suggestion for the Public Service Provider or MICE Organizers*

Based on the findings , it is suggested to keep improving the regional economic level because of   the significant impact of Regional GDP; to promote the healthy and sustainable development of urban tourism related supporting industries and interaction; to create a good environment and enhance the support of related industries for exhibition; to stick to the open policy for that the development of urban inbound tourism, import and export can promote the development of urban convention and exhibition industry and the regional competitiveness .

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