Humanistic demand and spatiotemporal perspective in the evaluation of urban life quality—A case study of Shandong Province in China

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Abstract. The study of the quality of life needs to be guided by theoretical basis, especially the theory embodying humanism, because the fundamental significance of the study of quality of life is to improve human happiness. A brand-new evaluation system is creatively established in this article based on people-environment relationship by combining Maslow's Hierarchy of Needs with urban development. Geographical analysis is also conducted to figure out the evolution of the spatiotemporal dynamics of quality of life, with the results indicating that urban life quality in Shandong Province have remarkable differences between areas are illustrated in the spatiotemporal evolution pattern. The growth rate of safety factors, social factors, and respect factors has differences between cities and regions, while the changes in survival factors and potential development factors are smaller, that reflecting different degrees of urban supply and demand in different periods and the real reason for the uneven life quality. In this article, the feasibility of the research method is confirmed, and a new research perspective for the evaluation of quality of life is provided.

1. Introduction

At present, China’s urbanization has gradually shifted from one focused on quantitative growth to one aimed at qualitative improvement [1]. The new urbanization directs its efforts toward the general improvement of the quality of life of all residents, promotes the development of the regional economy through the overall improvement of urbanization quality, and thereby seeks to achieve a comprehensive, coordinated, and sustainable development of the economy, society and ecology [2]. Relevant research indicates that a good quality of urban life can not only improve the happiness of the local people, but also aids in attracting a large number of innovative talents and high-tech industries to settle. Hence, it improves overall urban competitiveness and promotes a successful development of the regions. Therefore, the improvement of the quality of urban life has become an important trend of new urbanization, especially in developing countries [3,4].

The focus on urban quality of life can be traced back to Engels’s study of the working conditions of the British working class, while modern research on the quality of life is inextricably linked to the social-indicators movement emerging in the Western World in the 1960s. The “Social indicators and sample surveys”-essay, edited by American sociologist Bauer, focused on the impact of the US National Space Program on social development, and thus promoted study of the quality of life as an independent research field [5]. Before the 1990s, Western geographers mainly used social and economic data to compare and analyze the quality of urban life. For example, Smith first introduced
regional social indicators into the geographical analysis of quality of life and conducted a systematic study on the quality of life in America, including different levels such as regions and cities [6]. Similarly, Bederman et al. used census data to evaluate the quality of life in Georgia [7]; American scholars Lo et al. employed remote sensing image data as well as socio-economic data to analyze the quality of life in Assens-Clark County, USA [8]. The research proves a significant correlation between the physical environment quality of the city and the socio-economic environment; Węziak-Białowolska studied the opinions of 41,000 residents in 79 cities in Europe and analyzed various dimensions affecting urban life satisfaction [9]. Cabrera-Barona et al. selected 10 indicators of quality of life to establish deprivation coefficients and used four different spatial analysis scales in the capital of Ecuador to conduct a comparative analysis of urban quality of life [10]; Kaklauskas et al. analyzed various scales of research on quality of life. In his study, he concentrated on the QLI method and the INVAR method [11]. In addition, the smart city approach has also been used to study the development of urban quality of life [12-15].

Researches on the quality of life started late in China. Professor Lin first studied the quality of life in the late 1980s with the method of questionnaires [16]. Since the beginning of this century, studies focused on China have increased drastically [17-19]. Chinese scholars have given more priority to the studies on the quality of urban life by adopting different research methods. Su Zhang et al. used the geo-informatic Tupu to express the quality of urban space life by carrying out geospatial analysis of big data and GIS [20]; Weili Yang et al. explored the difference between the quality of life in the human society and that in urban space from different perspectives [21]. For different research areas, Liang Zhang et al. evaluated the quality of life in Anhui Province, China, through conducting principal component analysis, adopting TOPSIS and LISA research methods, they found that the impact of urban social problems on the quality of life is much more important than that on the economic as well as ecological environment [22]; Zheye Wang et al. evaluated the quality of life in 34 urban areas in Northeast China based on human values [23]; Ruirui Zhou et al. selected 6 factors affecting the quality of urban life and studied the quality of life in 19 cities in Ningxia Province [24]; Guohua Zhou et al. explored the spatial differentiation pattern and factors influencing rural life quality in Hunan Province through adopting Entropy method and ESDA spatial data analysis [25]; As to special groups, Dongqian Xue et al. conducted researches on poverty population in Xi'an through new questionnaires and interviews, finding that working conditions and salary levels are important factors affecting the satisfaction of urban poverty group in urban life, and the life satisfaction of poverty population is also affected by factors, such as community location, community function, and neighborhood relationships [26].

As can be seen from all the above, former studies have conducted fruitful explorations on the quality of urban life and obtained valuable results. From the perspective of research methods, however, the study of the spatial and temporal evolution of urban life quality over a long period of time, using spatial analysis, is still relatively rare. At the same time, the study of urban quality of life at regional scales is mostly conducted based on empirical analysis, while less relevant theories are examined from the perspective of residents’ needs. In particular, the implementation of human-centered humanistic theory into the field has been neglected for a longer time. Hence, this paper introduces Maslow’s Hierarchical Demand Theory into the study of regional urban life quality which aims to bridge the gaps in the current study of urban life quality that ignores the combination of humanism theory and positivism. Furthermore, this paper constructs a research framework for the spatiotemporal evolution of regional urban life quality based on the Maslow’s Hierarchy of Needs. And this study selects the development data of 17 cities in Shandong Province during the 12 years from 2005 to 2016 as an empirical object. With mathematical statistics and spatial analysis, the paper examines the spatial and temporal evolution pattern of urban life quality in Shandong Province at two levels: overall quality life and each level of demand.
2. Materials and Methods

2.1. Maslow’s Hierarchy of Needs and the Study of Regional Urban Quality of Life

The Theory of Demand Hierarchy was proposed by American psychologist Abraham Harold Maslow in the book “Human Motivation Theory” in 1943. The pyramidal demand model represented a groundbreaking approach to human behavior study and is divided into five levels; The ‘physiological needs’ are the most basic substances needed for people’s survival, while the ‘safety needs’ comprise people’s desire for security and protection. The next level represents the ‘social needs’ of friendship and love. It is followed by the ‘need for esteem’, including the self-confidence and self-esteem of individuals, and, lastly, the ‘need for self-actualization’, namely the need of realizing one’s value and fulfilling one’s purpose [27,28]. Among them, the physiological, safety, and social needs are classified as low-level needs, while he needs of esteem and self-actualization are classified as high-level needs. Maslow’s Hierarchical Demand Theory can provide a new perspective on the study of urban life quality. On the one hand, the city, as the basic site of human survival and development, provides differing material conditions for the satisfaction of human needs. On the other hand, the satisfaction of human needs is the driving force and ultimate goal of urban development. The differences in urban material conditions distinguishes the material and environmental basis for the realization of human individual needs. From the perspective of geography, the development of urban quality of life and the satisfaction of human needs constitute a people-environment relationship based on supply and demand. Based on the five requirements of Maslow’s Hierarchy of Needs, this paper proposes five supply conditions necessary for urban development, combines the supply conditions of cities with the needs of individual levels, and constructs a research framework for regional urban life quality study based on the Theory of Demand Hierarchy.

Figure 1. The research framework of quality of areas urban life based on Maslow’s Hierarchy of Needs.

2.1.1. Determination of indicator weights

The common methods of determining the weight of each indicator of the quality of life can be divided into equal-weight and different-weight methods. The former treats each indicator constituting a composite index as equally important whereas the latter treats each indicator differently applying subjective or objective weighting methods [29]. At present, the issue of determination of weights for
the quality of life indicators is still controversial [30]. In this paper, two methods are combined. Under the premise that the five first-level indicators are equally important, they are measured with the same weight. Conversely, in consideration of the degree of reflection of each data on the people’s life index and the differences among the data, the second-level indicators are given different weights, assigned by the CRITIC method. The CRITIC method is a differential weighting method proposed by Diakoulaki [31]. The method determines the weight of the indicator by comparing the strength of the contrasting within the indicator with the conflict among the indicators. Based on the differences in the number of secondary indicators in the primary indicator, the contrast intensity can reflect the difference between the internal data of each indicator, and the conflict avoids the information redundancy caused by the high correlation among the indicators. The standard deviation within the indicator reflects the contrast strength of the group's indicators, and the conflict among the indicators is reflected on the basis of this relevance.

\[ h_j = v_j \sum_{i=1}^{n} (1 - r_{ij}), (j=1,2,\ldots,n) \]  

In the formula, \( h_j \) is the amount of information and the degree of independence is reflected by the indicator \( j \). \( v_j \) is the standard deviation of the indicator \( j \) while \( r_{ij} \) is the correlation coefficient between the indicators \( i \) and \( j \). \( \sum_{i=1}^{n} (1 - r_{ij}) \) reflects the conflict between indicators \( i \) and \( j \). The greater the amount of information and the degree of independence of the indicators are, the more obvious the problems reflected by the indicators are. Thus the weight of the indicators should be raised accordingly. The weight of the indicator \( j \) should be: \( e_j = h_j / \sum_{i=1}^{n} h_i, (j=1,2,\ldots,n) \). The different weight of each secondary indicator is calculated by the CRITIC method. Then, it is normalized in the corresponding first-level indicator and multiplied by the weight of the first-level indicator by 0.2, the total weight of each secondary indicator is calculated in the end.

| Primary indicators | Secondary indicators | Different weight (%) | Total weight (%) |
|--------------------|----------------------|----------------------|------------------|
| Q1 fators | Q11 Disposable income per capita | 2.5220 | 1.5612 |
| | Q12 Proportion of living expenses per capita in disposable income | 2.4252 | 1.5013 |
| | Q13 Engel coefficient | 4.7561 | 2.9442 |
| | Q14 Living area per capita | 3.0910 | 1.9134 |
| | Q15 Consumer price index | 3.1657 | 1.9597 |
| | Q16 Rate of sewage treatment | 2.3659 | 1.4646 |
| | Q17 Popularization rate of domestic water | 1.5582 | 0.9646 |
| | Q18 Popularization rate of domestic gas | 1.7299 | 1.0709 |
| | Q19 Rate of industrial solid waste treatment | 1.9148 | 1.1853 |
| | Q20 Harmful gas emissions per square kilometer | 3.1917 | 1.9148 |
| | Q21 Average temperature in July and August | 3.1107 | 1.8750 |
| Q2 factors | Q21 Number of hospital beds per 10000 people | 2.4082 | 2.6884 |
| | Q22 Number of medical staff per 10000 people | 2.1023 | 2.3469 |
| | Q23 Density of drainage pipeline | 2.9495 | 3.2927 |
| | Q24 Expenditure of public security per capita | 1.8324 | 2.0457 |
| | Q25 Expenditure of public security and employment per capita | 2.5741 | 2.8737 |
| | Q26 Pension per capita | 2.5817 | 2.8821 |
| | Q27 Deposit-loan ratio in the financial institutions | 3.4671 | 3.8706 |
2.1.2. Calculation of indicator scores

(1) Calculation of scores of each indicator in each city

For the positive indicator (i.e., the optimal value is the maximum value), the following rule applies: If the maximum value \( m \) should be 100 points, the normalization coefficient \( x = \frac{100}{m} \) is calculated, and the other data in the indicator is multiplied by the normalization coefficient \( x \) to calculate the score. For the negative indicator (that is, the optimal value is the minimum value), the reciprocal of the data in the indicator is first calculated to form a new data group. Then the new data group is calculated the score according to the method of the positive indicator. Some special cases shall be addressed in the following study.

The indicator Q15 (the consumer price index expressed as a percentage) is based on 100 and scored according to the distance between the actual value and 100. Based on previous studies, the most suitable standard temperature selected for this paper is 21±3°C [32]. The temperature data collected in this paper consists of the average temperature of July and August in each city. Therefore, the standardization of the index Q112 is according to the distance from 24, the greater the distance, the lower the score of quality of life. The value of the financial loan-to-deposit ratio (%) of the indicator Q27 is greater than 50 % (bank breakeven point) [33]. The higher the deposit-to-deposit ratio is, the higher the risk is. Therefore, the indicator Q27 is standardized with the minimum value as the optimal value.

Calculating the final score of each city

After the calculation of scores of each secondary indicator in each city, according to the final weight of each secondary indicator in Table 1, the final score of quality of life for each city in 2005-2016 can be obtained.

2.2. Research methods, study area and data sources

2.2.1. Research methods

After calculating the final scores of urban life quality in each city, the scores of the different cities in different years are combined with the vector map of Shandong Province employing the color grading method. Thus the spatial evolution pattern of urban life quality in Shandong Province is obtained. At the same time, the following statistical methods are used to analyze the regional differences in urban life quality in Shandong Province.

(1) Coefficient of variation:
\[
V_t = \sqrt{\frac{1}{n} \sum_{i=1}^{n} (Y_{ti} - \bar{Y}_t)^2}
\]  (2)

In the formula, \(Y_{ti}\) is the quality of life score of the city \(i\) in the year \(t\), \(\bar{Y}_t\) is the average value of the quality of life scores of \(n\) cities in the year \(t\), and \(n\) is the number of cities.

(2) Theil coefficient:

- Differences in the eastern region, the central region, and the western region:

\[
T_{WR} = \sum_i \frac{Y_{ij}}{Y_i} \ln\left( \frac{Y_{ij}/N_{ij}}{Y_i/N_i} \right)
\]  (3)

In the formula, \(Y_{ij}\) is the quality of life score calculated by weighting the urban population by the city \(j\) of the region \(i\), and \(N_{ij}\) is the population of the city \(j\) of the region \(i\). \(Y_i\) means the total quality of life score calculated by weighting the proportion of the population in the region \(i\). \(N_i\) means the population of the region \(i\).

- Differences between the three regions:

\[
T_{BR} = \sum_i \frac{Y_i}{Y} \ln\left( \frac{Y_i/N_i}{Y/N} \right)
\]  (4)

In the formula, \(Y_i\) is the total quality of life score for the region \(i\). \(N_i\) means the total population of the region \(i\) while \(Y\) refer to the total score of urban life quality in Shandong Province. \(N\) is the total population of Shandong Province.

- Differences by city:

\[
T_p = \sum_i \sum_j \frac{Y_{ij}}{Y_i} \ln\left( \frac{Y_{ij}/N_{ij}}{Y_i/N_i} \right)
\]  (5)

In the formula, each symbol has the same meaning as above. According to the formula (5), the regional differences in urban quality of life in Shandong Province can be decomposed into the sum of intra-regional \(T_{WR}\) and inter-regional \(T_{BR}\) differences:

\[
T_p = \sum_i \sum_j \frac{Y_{ij}}{Y_i} \ln\left( \frac{Y_{ij}/N_{ij}}{Y_i/N_i} \right) = \sum_i \frac{Y_i}{Y} T_{pi} + T_{BR} = T_{WR} + T_{BR}
\]  (6)

2.2.2. Study area
Shandong Province (114°47.5’–122°42.3’ E, 34°22.9’–38°24.01’ N) is located in the east of China, with an area of 157,900 square kilometers. As of December 2017, there are 17 cities and 100.04 million people in Shandong Province (Shandong Statistical Yearbook, 2018). With the continuous development of the economy, Shandong Province has become one of the most important Provinces in China. In 2018, Shandong's regional GDP reached 7646.97 billion yuan ($1109.97 billion). This study examined the quality of urban life in 17 cities in Shandong Province, including Jinan, Qingdao, Zibo, Zaozhuang, Dongying, Yantai, Weifang, Jining, Tai'an, Weihai, Rizhao, Binzhou, Dezhou, Liaocheng, Linyi, Heze, and Laiwu. (In January 2019, Laiwu was included in Jinan. Since then, Shandong Province includes 16 cities.)
2.2.3. Data sources
The vector data of the administrative boundary of the area under the study is derived from the Atlas of Shandong Province while the administrative division map with a scale of 1:1600000 is obtained by vectorization after computer scanning. The statistical data of the cities in Shandong Province is gathered from the Shandong Statistical Yearbook 2006-2017, compiled by the Statistical Bureau of Shandong Province and published by China Statistics Press. Part of the data also comes from the China City Statistical Yearbook 2006-2017 and annual statistical yearbook of each city.

3. Results

3.1. The overall evolution pattern of urban living quality in Shandong Province
The next steps of the study include of finding the quality of life scores of each city and calculating the average of the quality of life scores of all cities in each year to reflect the overall pattern of urban life quality development in Shandong Province. According to previous studies, Shandong Province is divided into three regions: eastern region, the central region, and the western region. The eastern region includes the five cities: Qingdao, Yantai, Weihai, Rizhao, and Weifang while the central region comprises the six cities: Jinan, Zibo, Laiwu, Linyi, Tai’an, Dongying. The western region includes another six cities: Jining, Binzhou, Dezhou, Liaocheng, Zaozhuang, and Heze.

The results show that the average score of urban quality of life in Shandong Province ranged between 58 and 60 points from 2005 to 2007 and then rose to 60-65 points from 2008 to 2012 in figure 3. From 2013 to 2016 (except for 63 points in 2014), the scores continued to rise to 65-70 points. These results prove that, with the advancement of time, the quality of urban life in Shandong Province has wholly improved. From the average annual scores of life quality in each city, Weihai (77.27 points), Dongying (76.10 points), and Qingdao (75.40 points) represent the top three, while the three western cities Jining (55.94 points), Liaocheng (52.97 points), and Heze (49.99) scored the lowest.

Compared with the average city quality of life (63 points) in the past 12 years, the seven cities of Jinan, Qingdao, Zibo, Dongying, Yantai, Weihai, and Laiwu exceeded the provincial average value, thus being leaders in the quality of life in the Province. The average scores of the remaining 10 cities are lower than the provincial average, indicating that they still have great development potential in terms of urban life quality.
Figure 3. The changes of average score of quality of urban life in Shandong Province in 2005-2016.

Through Arcgis 10.2, the quality of life scores of each city are connected to the administrative division vector data of Shandong Province in figure 4. The scores of all cities and counties are graded by the equal interval method. Ultimate spatial differentiation of urban quality of life in Shandong Province in the 12 years from 2005 to 2016 is generated. The results are converted into figures to show the overall evolution of urban life quality in Shandong Province during the chosen period.

The spatial and temporal evolution patterns of the quality of life in cities in Shandong Province differ significantly. The scores of the eastern region, represented by Qingdao, Yantai, and Weihai, resemble those of the central region, represented by Jinan, Zibo, Laiwu and Tai'an, as well as Dongying. At the same time, except for Yantai, the quality of life in cities in the eastern region has been at a medium and high level of 65 points and above, especially in Qingdao and Weihai, which have been scoring 70 points or more. In the central region, with enhanced volatility of the previous period, Jinan and Zibo entered the ranks of cities with 70 or more points in 2012 and 2009 respectively. They then remained stable at 70 points or more. Laiwu and Tai'an both ranged at 63-69 points. Interestingly, Dongying in the central region has been showing volatility of more than 70 points in the past 12 years. In contrast, the quality of life in the western region represented by Liaocheng, Dezhou, Binzhou, and Heze, as well as the western region, represented by Jining, Zaozhuang, and Rizhao, ranked generally at a medium or lower level. The urban quality of life scores in the western were all below 65 points, especially in Heze in 2003, which scored a meagre 43 points, the lowest score for the quality of life in all 17 cities in the Province in the past 12 years.
3.2. Evolution pattern of various demand levels of urban life quality in Shandong Province

In order to intensify the study of the spatial and temporal evolution of urban life quality in Shandong Province, it is necessary to discuss each factor separately according to Maslow’s Hierarchy of Needs. By calculating the annual average scores of the five major indicators, we can derive the developmental status of each indicator over the 12 years selected in figure 5. By additionally calculating the average annual growth rate of these five indicators, we can identify each indicator’s trend in the research period. Following the standard classification method of the chart, the average annual score and the average annual growth rate of the five major indicators calculated by the equal interval method provide helpful tools for comparison.

The physiological demand represented by the Q1 survival factor indicator is overall stable in the evolution of Shandong Province despite some fluctuation over the years. By calculating the average annual growth rate of the Q1 indicator over the past 12 years, it is found that its average annual growth rate amounts to less than 2.5% in the whole Province over the study period. This is only an average value compared with most other first-level indicators. In terms of rate, the average annual growth rate of the Q1 indicator is relatively low, with the change among the five major indicators being relatively small. In the 12-year average of the scores, the eastern and central regions achieve generally higher scores than the western region. Cities with average scores exceeding 15 points, such as Qingdao, Yantai, Weihai, Dongying, and Linyi, are located in the eastern and central regions, and then an obvious different pattern of high East and low West is formed obviously.

The Q2 safety factor indicator represents the safety factors, including medical conditions, government security expenditures, employment security, and per capita pensions. This indicator is closely related to the soundness of social laws and systems, as well as the stability of the social order. Among the Q2 indicators, the average annual growth rate of cities in the western region of Shandong
Province surpasses those in the central and eastern regions. For example, the average annual growth rate of Heze (5.1 %) and Binzhou (3.08 %) in the western region ranked first and second in the Province. Dezhou and Liaocheng scored also higher above 2%, while Qingdao (0.31 %), Rizhao (0.9 %), Weihai (1.19%), and Yantai (1.75 %) display relatively low average annual growth rates. On the contrary, the average scores of urban indicators in the central and eastern regions are higher, indicating that the relatively developing cities in the western part of Shandong Province are growing faster than the developed central and eastern regions in meeting the safety needs of its residents. Thus, the gap between them and the central and eastern regions is gradually shrinking.

The Q3 social factors correspond to Maslow’s category of social needs. They are located in the middle of the demand hierarchy and addressed after the two basic needs of survival and security are sufficiently met. Social demand is greatly affected by urban infrastructure construction, so this indicator is relatively large and varies greatly among cities. Compared with the eastern region, some central and western cities display notably large annual growth rates in this sector. However, on the average score, most of the leading cities are located in the east and central, while the western cities significantly lag behind.

The Q4 respect factors represent people’s need for esteem. Its fulfillment is second only to the need for self-actualization and greatly affected by factors, such as the wage gap of social workers. The average annual growth rate of index scores in the western region is relatively high whereas the central and eastern regions score notably lower. Interestingly, among these, the cities with higher average scores are specifically concentrated in the central eastern part, while the southern part of the western region performs not as good as the rest of the region. Again, the same pattern is reflected in the Q4 indicator: the southern parts of the western region is catching up with the central and eastern regions.

The Q5 potential development factor equals the highest level of the need hierarchy, self-actualization. Compared to the other four first-level indicators, the score difference between the cities in Shandong Province on this indicator shows only small disparities. Except for Dongying in the central region with negative growth rates, the average annual growth rate of index scores in other regions show a small increase. The cities with higher average scores are fewer and exclusively located in the eastern and central regions. The rest of the cities score at medium levels, with small gaps between them. However, the western region remains in the last place.

Figure 5. The evolution pattern of sub-indicators of quality of urban life in Shandong Province
3.3. Regional differences in urban quality of life in Shandong Province

To examine the urban living quality and the evolution pattern of each demand level in Shandong Province more comprehensively. It is required to make an analysis of the evolutionary characteristics of the differences in the quality of life and various demand indicators. The coefficient of variation is used to reflect the relative differences between the urban quality of life and the indicators of demand in each year in Shandong Province. For this purpose, the Theil coefficient is applied to reflect the differences in quality of life in the three regions: eastern region, the central region, and the western region. This paper follows the clustering principles of geographical proximity [34,35], natural resources, economic development, and other geographical regions. The eastern region includes Qingdao, Yantai, Weihai, Rizhao and Weifang. The central region includes Jinan, Zibo, Laiwu, Linyi, Tai’an and Dongying. The western region includes Jining, Binzhou, Dezhou, Liaocheng, Zaozhuang and Heze.

By calculating each city’s quality of life scores, as well as the coefficient of variation of each indicator’s scores in each year, we can see that the coefficient of variation of the urban quality of life scores in Shandong Province has decreased each year in figure 6, indicating that the overall gap in the urban quality of life in Shandong Province has been shrinking over time.

Although the growth of the coefficient of variation of Q3 social factors has slowed down slightly, it has continued to rise nevertheless. It remained above 0.3 except for 2014, indicating that there still exists a large gap in the social factors related to the development of different cities in Shandong Province. Q2 safety factors, Q4 respect factors, and Q5 potential development factors show a significant decline in the coefficient of variation, of which Q4 respect factors decreased most significantly: It ranged from 0.2592 in 2005 to 0.2564 in 2014 and then suddenly fell to 0.1294 in 2016. This suggests that the gap between Q2 security factors, Q4 respect factors, and Q5 potential development factors in the cities in Shandong Province has decreased in significance since 2005, meaning that the distribution among different cities is more balanced. The coefficient of variation of Q1 survival factors remained relatively stable with only small fluctuations. Slightly varying from 2005 to 2014, Q1 decreased from 0.0711 in 2014 to 0.0421 in 2016, indicating a leveling among cities.

![Figure 6. The coefficient of variation of sub-indicators of quality of urban life in Shandong Province](image)

Calculating the Theil coefficient reveals that the regional difference index (TP) of the Province in the 12 years displays a general downward trend, indicating that the gap in the urban living quality in Shandong Province has been shrinking in figure 7. Similarly, the TWR index of the three major
regions in the east, central, and west of Shandong Province respectively, as well as the TBR index of the three major regions, showed an overall downward trend in the past 12 years, suggesting that the differences between the three major regions are also decreasing each year.

The TWR index is consistently higher than the TBR, indicating that regional discrepancies is composed of intra-regional differences. Before 2012, the internal differences in the eastern region of Shandong Province exceeded those in the central and western regions. The quality of life scores in Qingdao and Weihai were significantly higher during this period that in Rizhao and Weifang. Simultaneously, the eastern region, formed by the Qingdao-Yantai High Zone with Weifang, displayed a different pattern of Rizhao and low partition Between 2005 and 2012, the quality of life in Dongying in the central region rose rapidly, while the quality of life in other cities did not change significantly. Therefore, since 2012, internal differences in the central region began to gain more concerns, and this trend spread further to the eastern region.

Conversely, the quality of urban life in the western region has increased steadily over the past 12 years. The cities score at a low level, with little to no fluctuations. Therefore, the regional differences in the western region are accordingly insignificant. In general, the TP curve has remained at a low level, while the TWR and TBR were simultaneously fluctuating, which indicates that the difference in the quality of life in Shandong Province shows an overall decline in spatial and temporal evolution during the 12 years.

![Figure 7. The evolution of difference of quality of urban life in Shandong Province, inter-regions and intra-regions.](image)

**4. Discussion**

In the demand hierarchy, survival needs are the lowest and most easily met, while self-actualization needs are the most advanced and, hence, most difficult to meet. The study at hand found that the average annual growth rate of the Q1 survival factor indicator and the Q5 potential development factor indicator scored the lowest in the 12 years researched, indicating that the two indicators did not change significantly in this period. The position of these two needs in Maslow’s hierarchy and their difficulty to be satisfied pose the question of whether the cities in Shandong Province have already sufficiently met the basic needs of survival and, therefore, shifted their developmental focus toward meeting the needs of higher levels. At the same time, the results suggest that the satisfaction of the highest level of needs in cities in Shandong Province remains still mostly unmet. This means that the supply of external conditions for people to achieve self-actualization is relatively scarce.

Regardless of the overall change in the past 12 years or the difference in scores between cities, the differentiation of is the most significant. Similarly, the level of social and economic construction, caused by the disparities in developmental strength among the cities in Shandong Province, leads to
differences in infrastructure construction, public security situation, and employment rate. This implies that the cities in Shandong Province are currently maintaining a moderate yet uneven developmental stage. Especially the development of eastern cities surpasses that of western cities. The low-level requirements in the demand hierarchy have mostly been met and the focus has shifted towards the medium and high-level needs. However, the satisfaction of the highest-level requirements is still out of reach. This result caters to the current development status of cities in Shandong Province: all cities have solved the problem of food and clothing, and are currently maintaining different levels of wealth while striving to become a prosperous city.

The analysis of the regional urban life quality from the perspective of residents’ needs can provide more targeted policy recommendations. Regarding its future urban development, the government of Shandong Province should focus on narrowing regional development differences and strive to meet the medium-to-high-level needs of each city. This lays the foundation for moving to higher levels of demand. The factors influencing the quality of urban life in Shandong Province are more widely reflected in the level of social development and medical education, rather than the natural environment, housing facilities, and residents’ income. The government should balance the local fiscal expenditures, infrastructure construction, social security, medical standards, and teacher education levels caused by different levels of social and economic development in different cities. Since different cities follow different developmental paths, their corresponding countermeasures have to be differentiated accordingly. Eastern cities can increase their investment in education and careers while maintaining the overall quality of life. Improving the quality of supplies for middle and high-level needs will hence encourage people to pursue higher levels of demand. The Province’s preferential policies (such as tax reduction and exemption, simplified approval process) can be tilted to the west to promote the economic development of local cities, change the demand situation of the local population, improve the satisfaction rates of the low and medium needs, and thereby cause a shift in people’s needs. At a high level, the quality of urban life can be improved in many ways, thus narrowing the regional development gap.

5. Conclusions
Based on Maslow’s Hierarchy of Needs, this paper took a preliminary attempt to construct a research framework of the spatiotemporal evolution of the regional urban life quality. Emphasis was specifically placed on the relationship between humans and environment which leads to the introduction of previous humanism studies on the urban quality of life often neglected before. At the same time, this study compensates for the limitations of previous research on the evaluation of the urban life quality based on the theory of hierarchical demand. With this framework, we can have a deeper understanding of people’s needs distributed on the five levels, and can hence build a more comprehensive evaluation system of urban life quality according to the characteristics of each level of demand. With Shandong Province in China as a case study, the spatial and temporal evolution of the urban quality of life in region from 2005 to 2016 was examined. The following conclusions were obtained:

In the past 12 years, the quality of urban life in Shandong Province has shown an upward trend. At the same time, the spatial and temporal evolution patterns of urban life quality are significantly different. The eastern and central regions display a better urban life quality than the western region do.

The cities differ significantly with regard to the various indicators of the quality of life. The annual average of the indicators in the eastern and central regions is relatively high, whereas the average annual growth rate of the indicators in the western region is relatively high. However, the gap between the two regions is narrowing gradually.

The changes in the quality of life indicators are also notably different. Although the survival factors and potential development factors vary less in the whole Province, the safety, social, and respect factors have changed greatly in the past 12 years, reflecting the regional cities’ supply discrepancies on different needs.
The research framework of regional urban life quality based on Maslow’s Hierarchy of Needs constructed in this paper can provide a reference for the study on the evaluation of social development in other regions. Concerning future urban as well as rural development, local governments should narrow the regional development gap employing balanced financial input, rational resource allocation, and coordinated policy support. Implementing these measures will comprehensively improve the quality of urban life in developing areas and compensate for regional gaps.

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