Research on the Measurement and Spatial Difference Analysis of the Equalization of Urban Basic Public Services in Zhejiang Province

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Abstract. With the accelerated process of urbanization, the increasing demands of the population and the imbalance in the provision of basic public services among regions have become key factors constraining regional development. This study establishes a measurement index system for the equalization level of basic public services, and combines the subjective and objective weighting method with the Gini coefficient method to measure the comprehensive development level of basic public service equalization in 11 cities in Zhejiang Province and the developmental differences across various dimensions. Additionally, ArcGIS and GeoDa software are utilized to analyze the spatial disparities of these cities in terms of the dimensions of basic public services. The study reveals that the comprehensive development level of basic public services in Zhejiang Province is generally uneven, with most cities experiencing shortages in basic public services. While there are no significant disparities among dimensions, there are relatively large gaps in the development levels of basic education, public culture, and ecological environment among cities. Furthermore, several dimensions and the comprehensive development level exhibit localized spatial agglomeration characteristics, particularly in Jinhua and Jiaxing, where improvements in the equalization of basic public service development are urgently needed.

Keywords: Equalization of public services; subjective and objective weight method; Gini coefficient method; spatial difference.

1 Introduction

In recent years, with the rapid growth of urban population and continuous expansion of urban areas in China, issues such as difficult access to education, healthcare, and elderly care have been somewhat alleviated [1]. However, the provision of basic public services still struggles to meet the increasing demands of the population, becoming a significant factor constraining urban development. Zhejiang Province, as a model for high-quality development and shared prosperity, continues to face considerable disparities among its cities in areas such as basic education, public culture, and ecological environment. The serious issue of imbalanced provision of basic public services hinders the progress of Zhejiang Province in its pursuit of high-quality development and the establishment of a model area for shared prosperity. Therefore, this study aims to analyze the current status of equalization in basic public services in Zhejiang Province and its spatial disparities, which holds significant implications for

narrowing the gaps between urban and rural areas, regions, and population groups within the province. Currently, scholarly research on the equalization of basic public services primarily focuses on the comparison among different provinces across the country, with limited studies examining the equalization within the same province among different regions. Building upon existing academic achievements [2-6], this study selects statistical data from 2020 for 11 cities in Zhejiang Province as the research objects. In this study, an innovative approach combining the subjective and objective weighting method with the Gini coefficient method [7] is adopted to measure the comprehensive development level of equalization in basic public services and the developmental differences across various dimensions in these cities. Moreover, ArcGIS and GeoDa software tools are utilized to conduct detailed analysis and visualization of the spatial disparities in different dimensions of basic public service equalization among the cities in Zhejiang Province. This research aims to provide a solid theoretical foundation and practical guidance for the development of equalization in basic public services in Zhejiang Province.

2 Materials and methodology

2.1 Data source

Basic public services typically encompass eight major areas that meet essential livelihood needs: public education, labor employment and entrepreneurship, social insurance, medical health, social services, housing security, public culture and sports, and disability services. The data of this study mainly come from the statistical yearbooks of 11 cities in Zhejiang Province in 2021, the statistical bulletins of each city in 2020 and the statistical data of the official websites of relevant departments [8-11].

2.2 Construction of an index system for measuring the equalization level of basic public services

This study has extensively drawn upon existing research achievements and adhered to the fundamental principles of scientific rigor, representativeness, and operational feasibility. As a result, a measurement indicator system for evaluating the equalization level of basic public services has been constructed, as presented in Table 1 below.

Table 1. Measurement index system of equalization level of basic public services.

Dimension	Index	Subjective weight	Objective weight	combination weight	Index attribute
Basic education	Average number of schools per 10,000 pupils (per 10,000 pupils)	0.0316	0.0385	0.0351	Positive
	Average number of schools per 10,000 ordinary middle school students (institutes / 10,000)	0.0392	0.0423	0.0408	Positive
	Primary school teacher ratio (%)	0.0306	0.0289	0.0298	Negative
	Teacher ratio of middle school students (%)	0.0353	0.0414	0.0384	Negative
	Number of health institutions per 10,000 people (per 10,000 persons)	0.433	0.0222	0.2276	Positive

Health care	Number of beds per 10,000 people in health institutions (per 10,000 people)	0.021	0.0537	0.0374	Positive
	Number of health technicians per 10,000 people (per 10,000 persons)	0.0595	0.0693	0.0644	Positive
	Number of practising (assistant) doctors per 10,000 persons (per 10,000 persons)	0.0724	0.0693	0.0709	Positive
Social security employment	Registered unemployment rate in cities and towns (%)	0.0441	0.0226	0.0334	Negative
	Proportion of basic Endowment Insurance (%)	0.032	0.0315	0.0318	Positive
	Proportion of basic medical insurance (%)	0.0829	0.0258	0.0544	Positive
	Proportion of basic unemployment insurance in cities and towns (%)	0.0786	0.0530	0.0658	Positive
Public culture	Number of libraries and museums per 10,000 people	0.0359	0.0385	0.0372	Positive
	Number of books collected in public libraries per capita (volumes per person)	0.0224	0.0332	0.0278	Positive
	Number of cultural centers and cultural stations per 10,000 people (per 10,000 people)	0.0556	0.0899	0.0728	Positive
Ecological environment.	Green coverage in built-up areas (%)	0.0362	0.0209	0.0286	Positive
	Urban per capita park green space (square meters per person)	0.0370	0.0452	0.0411	Positive
	Centralized treatment rate of municipal sewage (%)	0.0504	0.0252	0.0378	Positive
	Proportion of days with good air quality (%)	0.0541	0.0380	0.0461	Positive
Infrastructure	Per capita water supply (tons per person)	0.0373	0.1030	0.0702	Positive
	Annual per capita electricity consumption of urban and rural residents (kilowatt-hours per person)	0.0229	0.0293	0.0261	Positive
	Per capita road area (square meters per person).	0.0247	0.0432	0.0340	Positive
	Number of mobile fixed telephone subscribers per 10,000 people (households / 10,000)	0.0532	0.0350	0.0441	Positive

2.3 Data standardization processing

Since the units of measurement of the indicators are not the same, it is impossible to measure and compare them directly, so it is necessary to carry out the dimensionless processing first. In this study, the extreme value method is used to carry out the standardisation process, and the data set consisting of n evaluation index values from m samples is set to be $(X_{ij})m \times n$. Then for positive indicators, the normalisation formula is equation (1), while for negative indicators, the normalisation formula is equation (2). where X_{ij} denotes the statistics of the ith city for the

jth indicator, j =1,2,3,... , m; i =1,2,3,... ,n. X_{max} denotes the maximum value in the statistical data of the cities of the jth indicator, X_{min} denotes the minimum value in the statistical data of the cities of the ith indicator, and X_{ij}' is the standardised value, which takes the value of [0,1].

$$X_{ij}' = \frac{X_{ij} - X_{min}}{X_{max} - X_{min}} . \tag{1}$$

$$X_{ij}' = \frac{X_{max} - X_{ij}}{X_{max} - X_{min}} . \tag{2}$$

2.4 Combination weighting and calculation of comprehensive evaluation index

The determination methods of index weights are generally divided into subjective and objective assignment methods. In order to make the determination of index weights more objective and accurate, this study adopts the combined weight method combining the hierarchical analysis method (AHP) and entropy value method (EVM) to determine the index weights. By calculating the arithmetic average of the weight scores of both the entropy value method and the hierarchical analysis method to the final weights (equation (3)), the combined score is calculated based on the final weights (equation (4)).

$$W_j = \frac{W_j^1 + W_j^2}{2} . \tag{3}$$

$$S_i = \sum_{j=1}^{m} W_j X_{ij}' . \tag{4}$$

2.5 Classification method of basic standard deviation

Taking the mean value of the comprehensive score of basic public services of each city in Zhejiang Province as the benchmark, the relative development difference index of basic public services is defined as $\bar{S}$ (equation (5)), where D is the relative development difference index and σ is the standard deviation. The relative development difference index D is divided into four levels, which are relative rich area (D ≥ 1), relative balanced area (0 ≤ D < 1), relative shortage area (1 ≤ D < 0) and serious shortage area (D < −1), so as to reflect the difference of basic public services in each city.

$$D = \frac{S_i - \bar{S}}{\sigma} . \tag{5}$$

2.6 Measurement of development balance of different dimensions of basic public services

This study adopts the Gini coefficient method to objectively and meticulously reflect the overall degree of balance of the dimensions of basic public services and the gap between the dimensions in the cities of Zhejiang Province (equation (6)).The value of G ranges from 0-1, and the larger its value, the larger the gap is. G < 0.2 indicates that the development is relatively balanced; 0.2 ≤ G < 0.4 indicates that it is in a normal state; 0.4 ≤ G ≤ 0.6 indicates that the gap in the development is large; and G > 0.6 indicates that the gap in the development is is too wide. In equation (6), G is the Gini coefficient, Y_i is the proportion of the number of people in each city, X_i is the proportion of the value of the basic public service

dimension in each city to the total dimension, n is the number of cities studied, and V_i is the cumulative number of cities sorted by per capita indicators from X_1 to X_i.

$$G = \sum_{i=1}^{n} Y_i X_i + 2 \sum_{i=1}^{n-1} Y_i (1 - V_i) - 1 \tag{6}$$

2.7 Measurement of spatial correlation and difference of basic public services

This study analyses the autocorrelation of the comprehensive development level of basic public services and the spatial distribution of the development level of each dimension in the cities of Zhejiang Province by using Global Moran's I and Local Moran's I. Global Moran's I is a kind of Global Moran's I is a global statistical indicator, which indicates whether there is spatial agglomeration in areas with similar measurements and whether it reflects the overall spatial distribution differences; Local Moran's I represents local spatial autocorrelation, which vividly demonstrates the correlation between the measurement results of each area and its neighbouring measurements with the LISA clustering diagram, thus reflecting the significance and differences of local spatial relationships. The expressions of Global Moran's I and Local Moran's I are shown in equation (7) and equation (8), respectively. Where n is the number of cities studied; W_{ij} is the spatial weight matrix; S_0 is the sum of spatial weights of each dimension indicator; I takes the value of [-1,1], I is greater than 0 indicates the existence of spatial positive correlation, I is less than 0 indicates the existence of spatial negative correlation, and I is equal to 0 indicates that there is no spatial correlation.

$$I = \frac{n}{S_0} \times \frac{\sum_{i=1}^{n} \sum_{j=1, j \neq i}^{n} W_{ij}(X_i - \overline{X})(X_j - \overline{X})}{\sum_{i=1}^{n}(X_i - \overline{X})^2} . \tag{7}$$

$$I_i = \frac{X_i - \overline{X}}{S_i^2} \times \sum_{j=1, j \neq i}^{n} W_{ij}(X_j - \overline{X}) . \tag{8}$$

3 Results analysis

3.1 Development level of equalization of basic public services in Zhejiang Province

The comprehensive development level and the development level of each dimension of basic public services in Zhejiang cities can be obtained and ranked through the utilization of a subjective and objective analysis method based on combinatorial weighting. The results of this analysis, which are displayed in Table 2, provide scores and rankings for each city.

Table 2. Score and ranking of equalization measurement of basic public services.

City	Comprehensive development		Basic education		Medical and health work		Social security employment		Public culture		Ecological environment		Infrastructure	
	score	ranking	score	ranking	score	ranking	score	ranking	score	ranking	score	ranking	score	ranking
Hang zhou	0.703 6	1	0.0699	5	0.2662	2	0.124 5	1	0.0456	5	0.06 08	9	0.1 365	1

Ning Po	0.4899	7	0.0524	8	0.1580	8	0.0812	8	0.0328	9	0.0555	11	0.1101	2
Wenzhou	0.4874	8	0.0769	4	0.2028	5	0.0527	10	0.0325	10	0.0811	6	0.0414	9
Jiaxing	0.3165	11	0.0451	9	0.0126	11	0.0773	9	0.0411	8	0.0745	8	0.0657	6
Huzhou	0.4936	6	0.0561	6	0.1050	10	0.0989	6	0.0528	2	0.1094	2	0.0714	4
shaoshing	0.6024	5	0.0812	2	0.1880	6	0.1064	3	0.0454	6	0.0828	5	0.0987	3
Jinhua	0.3940	10	0.0429	10	0.1832	7	0.0339	11	0.0150	11	0.0586	10	0.0605	7
Quzhou	0.6330	4	0.0801	3	0.2587	3	0.0923	7	0.0492	4	0.1159	1	0.0369	10
Zhoushan	0.6771	2	0.1286	1	0.2463	4	0.1035	5	0.0521	3	0.0808	7	0.0657	5
Taizhou	0.4769	9	0.0286	11	0.1567	9	0.1050	4	0.0431	7	0.0844	4	0.0592	8
Lishui	0.6727	3	0.0542	7	0.2699	1	0.1101	2	0.1145	1	0.1026	3	0.0215	11

Furthermore, based on the calculation and grading results of the Relative Development Difference Index (*D*) [12], the spatial orientations of different-level regions were displayed using ArcGIS software. This approach effectively showcases the extent of spatial differentiation in the comprehensive level of equalization in basic public services across Zhejiang Province. The spatial distribution of these disparities is depicted in Fig. 1. Fig. 1 reveals that the comprehensive development level of equalization in basic public services in Zhejiang Province remains uneven. Specifically, the relatively affluent areas encompass solely the central city of Hangzhou, along with the municipalities of Lishui and Zhoushan. The relatively balanced areas comprise only the municipalities of Shaoxing and Quzhou. In contrast, the majority of other cities are classified as experiencing a scarcity of basic public services. Furthermore, there is a concentration of severely underserved areas primarily located along the coastal regions. These findings clearly indicate that the objective of equalizing basic public services in Zhejiang Province faces significant challenges. To address this issue, continued efforts are necessary to improve the resource allocation model and enhance policy support and guidance. Through these measures, the province can gradually achieve coordinated development and further advance the equalization of basic public services.
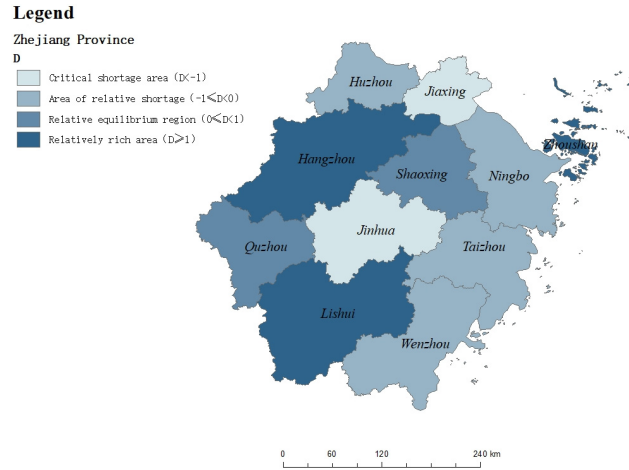
Fig. 1. Spatial Distribution of Comprehensive Development level of Equalization of basic Public Services in Zhejiang Province.

3.2 The balance of each Dimension Index of the Equalization of basic Public Services in Zhejiang Province

The Gini coefficient method was employed to measure the equity of development across various dimensions of basic public services equalization in Zhejiang Province. The results are presented in Table 4. Analyzing the outcomes in Table 3, it is evident that several dimensions of basic public services equalization in Zhejiang Province, namely basic education, public culture, and ecological environment, exhibit Gini coefficients greater than 0.3. This indicates significant disparities in the development of these dimensions among different cities, highlighting a substantial gap in equalization progress. Therefore, it is imperative to continue implementing educational and cultural support measures for relatively underdeveloped areas within the province. This can be achieved through the promotion of scientific and cultural knowledge and the enhancement of the population's overall quality, ultimately improving the sense of well-being and happiness among the general public. Additionally, greater emphasis should be placed on ecological civilization construction in several cities. For the remaining dimensions, their Gini coefficients are all below 0.3, indicating a relatively normal or balanced state of development.

Table 3. Measurement results of the equilibrium of each dimension of the equalization of basic public services.

Index	Basic education	Healthc are	Social security employment	Public culture	Ecological environment	Infrastru cture
Gini coefficient	0.3164	0.2456	0.1679	0.4271	0.3323	0.0978

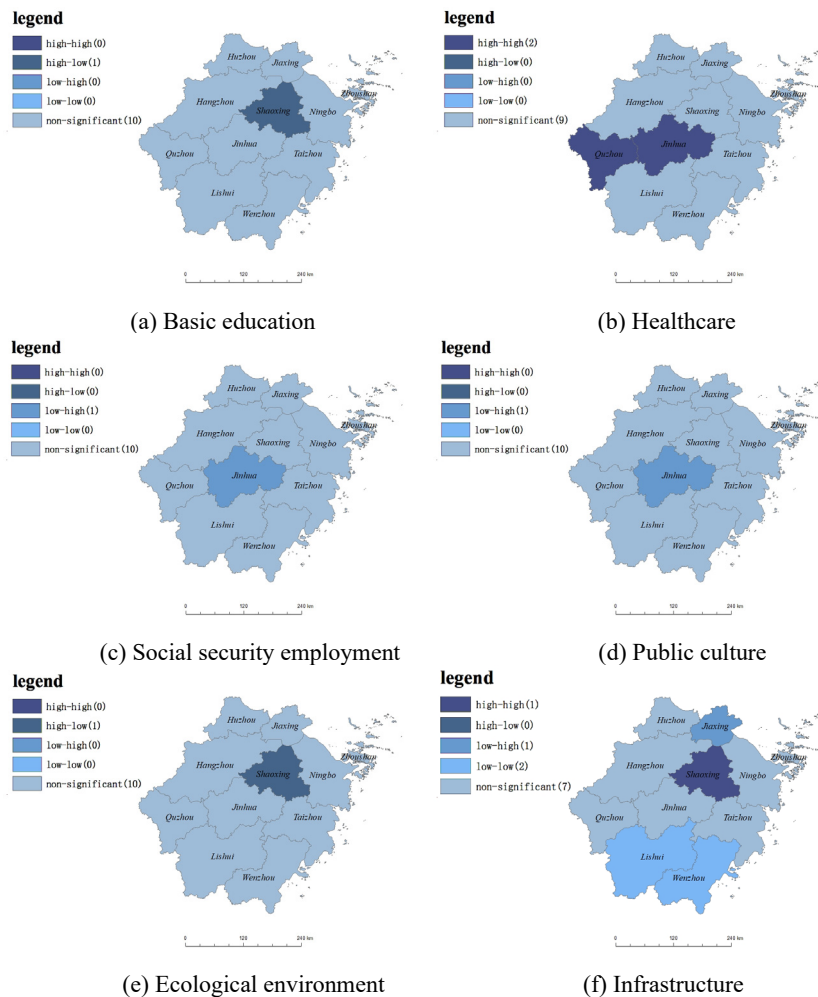## 3.3 Spatial correlation and difference of basic Public Services in Zhejiang Province

The comprehensive level of equalization in basic public services across 11 cities in Zhejiang Province, as well as the spatial clustering patterns of each dimension, were measured using Moran's I index. The measurement analysis and visualization of results were accomplished using ArcGIS and GeoDa software. The Global Moran's I was employed to assess the overall spatial correlation, and the results are presented in Table 4. Upon reviewing Table 4, it is observed that, with the exception of the social security and employment dimension, the Global Moran's I measurements of various dimensions reflecting the equalization of basic public services in Zhejiang Province, as well as the comprehensive development level, exhibit |Moran's I| values below 0.3, and |Z| values below 1.96. This suggests a lack of significant global spatial correlation. In other words, there is no overall spatial clustering trend in the development level of basic public services across cities in Zhejiang Province.
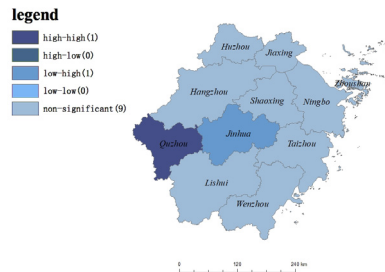
Table 4. Spatial calculation results of each dimension of equalization of basic public services.

Index	Basic education	Health care	Social security employment	Public culture	Ecological environment	Infrastructure	Comprehensive development
Global Moran's I	-0.2750	0.1520	-0.3890	-0.2600	-0.2100	0.1850	-0.2110
P price	0.2160	0.0780	0.0310	0.0910	0.3410	0.0660	0.3610
Z price	-0.8654	1.5774	-1.5497	-1.3607	-0.5163	1.6926	-0.4809

In addition, the Local Moran's I index was used to measure the local correlation between regional observations of each dimension and their surrounding areas. The significance level of spatial clustering (P-value) was set at 0.05. The measurement results of each dimension and the composite scores are presented in the LISA cluster maps shown in Fig. 2. Analysis of Fig. 2 reveals the following patterns. (1) Basic education: Shaoxing City demonstrates a higher level of basic education compared to its surrounding cities, exhibiting a "high-low" spatial clustering characteristic. This can serve as a model for educational development in neighboring cities. (2) Healthcare: Quzhou City and Jinhua City exhibit a "high-high" spatial clustering characteristic in healthcare. Not only do these cities have higher levels of healthcare development, but their surrounding cities also demonstrate relatively high levels of healthcare development. (3) Social security employment: Jinhua City falls into the category of a heterogeneous area with a "low-high" development pattern. This indicates that its level of social security and employment development is significantly lower than that of surrounding cities. The government should increase attention and policy support for social security and employment in Jinhua City. (4) Public culture: Jinhua City falls into the category of a heterogeneous area with a "low-high" development pattern. Its level of public culture development is noticeably lower than that of surrounding cities, indicating insufficient investment in public cultural development. (5) Ecological environment: Shaoxing City demonstrates a higher level of ecological environment compared to its surrounding cities, displaying a "high-low" spatial clustering characteristic. This can serve as a model for ecological civilization construction in neighboring cities. (6) Infrastructure: Lishui City and Wenzhou City exhibit a "low-low" localized spatial cold spot phenomenon in terms of infrastructure. The government needs to actively promote infrastructure development in these cities and their surrounding areas. Jiaxing City falls into the category of a heterogeneous area

with a "low-high" development pattern in infrastructure. Its level of infrastructure development is significantly lower than that of surrounding cities. The city should actively seek help from surrounding cities and learn from their development experiences. Shaoxing City demonstrates a "high-high" spatial clustering characteristic in infrastructure, indicating that not only does it have a higher level of infrastructure construction, but its surrounding cities also exhibit relatively high levels of infrastructure development. (7) Comprehensive development: Jinhua City falls into the category of a heterogeneous area with a "low-high" development pattern. Its overall level is noticeably lower than that of surrounding cities, which aligns with the measurement results of the Relative Development Difference Index (D). The city should actively seek help from surrounding cities and learn from their development experiences. Quzhou City exhibits a "high-high" spatial clustering characteristic in comprehensive development. Not only does it have a higher level of overall development, but its surrounding cities also demonstrate relatively high levels of comprehensive development.

(a) Basic education

(b) Healthcare

(c) Social security employment

(d) Public culture

(e) Ecological environment

(f) Infrastructure

(f) Comprehensive development

Fig. 2. LISA Cluster Diagram of each Index level in Zhejiang Province.

4 Conclusions

In this study, a comprehensive evaluation index system for equalization of basic public services was constructed using data from 11 cities in Zhejiang Province. The study employed a combination of subjective-objective weighting method and Gini coefficient method to measure the overall development level of cities in terms of equalization of basic public services, as well as the development disparities across different dimensions. The main findings are as follows. (1) Regarding the comprehensive evaluation results of each city, the equalization of basic public services in Zhejiang Province is still unbalanced. Specifically, the relatively affluent areas only include Hangzhou (the central city of Zhejiang Province), as well as the prefecture-level cities of Lishui and Zhoushan. The relatively balanced areas consist of the prefecture-level cities of Shaoxing and Quzhou. On the other hand, most other cities are characterized as deficient in basic public services, and there is a concentration of severe deficiencies in basic public services in the coastal areas. (2) Analyzing the balance measurement of different dimensions of basic public services and the disparities between dimensions, it is evident that there are relatively large development gaps among cities in Zhejiang Province in the dimensions of basic education, public culture, and ecological environment. These gaps indicate a considerable distance from achieving equalization of development in these dimensions. However, the Gini coefficients for the remaining dimensions are all below 0.3, indicating a relatively balanced development in those areas. (3) Examining the spatial agglomeration and disparities analysis of basic public services, it is observed that there is no overall spatial clustering trend in the development level of basic public services across cities in Zhejiang Province. However, there is localized spatial clustering in the dimensions of basic education, healthcare, social security and employment, public culture, ecological environment, infrastructure, and comprehensive development. The analysis of spatial disparities in different dimensions further underscores the urgent need to enhance the equalization of basic public services development in Jinhua City and Jiaxing City.

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