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The Customized Measurement System of Urban Quality of Life for Chinese Cities

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Abstract: *Quality of Life (QOL) is a multi-faceted and complex concept. Urban Quality of Life (UQOL), as a kind of QOL at the urban level, is of such a nature. The value of UQOL is hard to measure, yet it serves as a significant concept for the management and promotion of sustainable urban environments. This paper delineates the definition of UQOL and elaborates on its measurement approaches in detail. Incorporating the existing systems in developed countries and the actual circumstances of China, a measurement system encompassing 5 domains and 44 indicators is presented. By employing the customized linear relationship model of UQOL with housing prices and income, empirical tests were carried out with a sample of 35 cities in China. The test outcomes were discussed, and the model was optimized. According to the optimized model, the total UQOL value of each city in particular year can be computed. The development of this measurement system aims to offer an alternative foundation for estimating UQOL in Chinese cities, enabling the authorities to establish and implement a superior set of urban policies to achieve sustainable urban management.*

Keywords: *Urban Quality of Life; Chinese Cities; Measurement System*

1. Introduction

Recently the study of quality of life (QOL) has been given an increasing worldwide attention among global cities, especially those in the developing countries. The outputs from QOL study are usually used to rate the quality of life in different places or cities, such as annual rankings of top urban quality of life (UQOL) in Chinese cities. Such ranking to a certain extent is very helpful for policy makers, urban planners, and sustainability researchers. As Seik said, "It is inevitable that as cities move forward into the 21st century, urban QOL studies will increasingly become important tools for planning and managing livable, viable and sustainable cities." [1] Rapid urbanization over past few decades has brought a series of social and environmental problems in China. If neglected, they would harm our living conditions and threaten urban sustainable development in future.

Quality of life is a multi-faceted and complex concept. People from economics, planning, political science, sociology, psychology, geography, medicine, management and marketing have been joining in the discussion of QOL since 1930s. In China, the study of QOL began in 1980s and concentrated in the areas of sociology, demographic, economics and medicine[2]. This paper focuses on QOL at the urban level. Some concepts in specific disciplines, for example, in medical science[1] or other micro subdivision, that serve specific groups only would be excluded from this study. Given the concepts of QOL may differ from personal experiences, a definition of QOL would be given first.

2. Definition of Urban Quality of Life

There are a lot of researchers from various areas studying QOL since the 1930s. More than 100 definitions of QOL have been proposed from different perspectives[3]. These definitions include such elements as good life, subjective well-being, happiness, life satisfaction, and amenities [4-7].

From literatures, QOL has been defined in three main ways:

[1] The research of QOL in medical area often aims at patients with specific diseases, such as QOL in the paper "Dual diagnosis and quality of life in patients in treatment for opioid dependence" and "Chronic cough and QOL in allergic and respiratory diseases measured by a new specific validated tool-CCIQ".

(a) The concept of QOL is shown in terms of objective and subjective characteristics, such as the QOL Research Centre in Denmark which defines subjective quality of life as "feeling good and being satisfied with things in general" and objective quality of life as "fulfilling the societal and cultural demands for material wealth, social status and physical well-being" [8].

(b) The elements of QOL are set by tangible and intangible components. The tangible components represent those material measurable goods and services from the environment or the society. The intangible components means those intangible elements such as "privileges, rights and decision-making role" [9].

(c) UOL is defined at both the external macro-level and the individual level. For instance, Grayson [10] concluded that any assessment of QOL in the cities had to be conducted at two levels: first, at a personal level where each person assessed their own level of satisfaction with life within their life sphere and, second, an evaluation of the components of the city environments which helped to create the sense of satisfaction (or dissatisfaction).

Although these three approaches have always been competing to gain final political and philosophical consensus, they are helpful for us to have a more comprehensive view of what QOL is. Diener[11] indicated that "despite the conceptual and methodological differences between social indicators and SWB[2], scientific approaches to well-being need to take a comprehensive view of the phenomenon by incorporating the strengths of each perspective". So, we hope to suggest whether these three strands could be joined into a comprehensive framework.

It is hard to search a universally accepted definition of QOL, but it is possible to reach certain agreement. A consensus of defining a concept says that there are usually two fundamental sets of components and processes operating in a definition. It was noted that QOL included those internal psychological-physiological feelings which produced a sense of satisfaction or gratification with life either at the individual level or within communities and social group, and those external conditions which acted as a trigger to the internal mechanism [12]. In this way, the definition and the assessment of QOL can be conducted at two levels: internal personal life and external life conditions which act as a trigger to the internal individual mechanism. A QOL definition of this kind is from Ontario Social Development Council [13]:

Quality of Life is the product of the interplay among social, health, economic and environmental conditions which affect human and social development.

According to the above (a) and (b) classification approaches, attributes in (c)'s classification at both personal and external levels could be divided into "objective" or "subjective" and "tangible" or "intangible". We give a correlated concept of QOL combining these three main approaches as the following Figure 1.

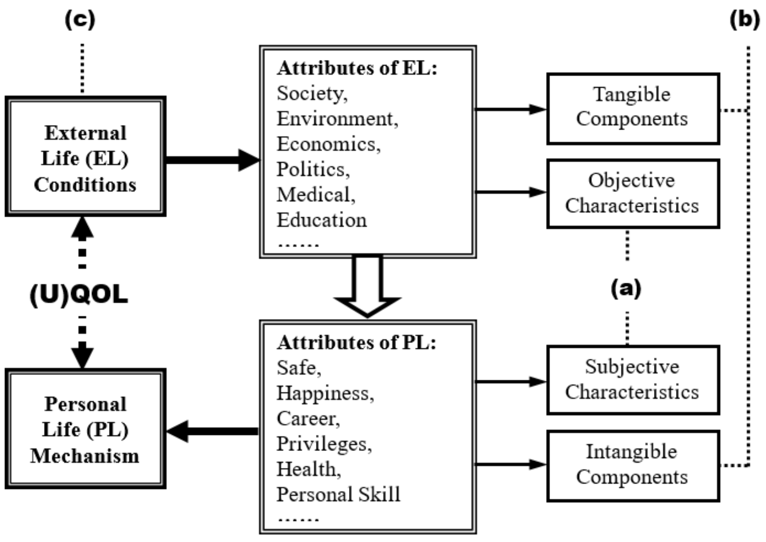

Figure1. *A Correlated Conceptual View of QOL*

[2] SWB is short for "subjective well being" which was a term proposed by Diener in 1984. SWB is consisted of three components: life satisfaction, positive effect, and negative effect. It's defined that a person with high life satisfaction, high positive effect, but low negative effect has high SWB (Diener 1984).

The personal life level means how individuals in the cities assess their own satisfaction with life within his life sphere. This kind of concepts is the motivation of QOL study on how to improve people's feeling and living in their life. Campbell et al. [14] summarized "Quality of life has been defined as the degree of well-being, satisfaction and standard of living". Liu [15] made QOL as "the status of human happiness and satisfaction at a particular time for the given physical and psychological conditions with which the individual in question is confronted". Liu's more applied definition of QOL indicated "that each individual (i) attempts to maximize may be expressed as an output function with two factor inputs as arguments — the physical (PH) and the psychological (PS)—a portion of which he owns and a portion of which he shares with other people in the community at any given point of (t): $QOL_{it} = f(PH_{it}, PS_{it})$".

Hereafter more and more researchers went further along this line. Szalai [16] rethought about the scope of "personal" and viewed QOL as a "collective attribute that adheres to groups or categories of people, not to individuals". Besides, in addition to the tangible living conditions, personal value, career development and other human rights were also considered. The quality of a person's life was directly related to its capability which was defined as the potential or ability to do or to be something. Technically that person's QOL level depended on a certain level of functioning such as health and education [17]. QOL of a society included basic elements like privileges, rights and decision-making role, especially the status of women in societies [9]. Therefore, beyond the initial research on generally-defined satisfaction or happiness, the content of personal QOL has been constantly expanded by researchers with new keywords in changing periods or places. For instance, Senasu and Singhapakdi [18] contend that at least some forms of QOL can exert a positive influence on an individual's well-being and have been verified in the context of developing economies in Asia.

QOL at external level represents the quality provided by external conditions which then stimulate the sense of satisfaction (or dissatisfaction) in the personal life. Attributes of external conditions described by Liu [19] consisted of over 120 indicators from different aspects. They included economics, politics, environment, health, education, and social indicators. All of these indicators were divided into community and individual datasets. From this data collection, Liu [15] developed an index of QOL for metropolitan regions in the United States. Mouratidis [20] investigated how the urban environment affects residents' subjective well-being through QOL via other approaches. Scholars such as He and Miao et al. [21] examined the influence of the urban environment on residents' QOL in the context of Chinese cities.

In Figure 1, three approaches are put together trying to realize an integrated comprehensive definition. Because urban quality of life (UQOL) is one kind of QOL in most cities, our definition of UQOL is mainly following this two-level concept: one level is the "external life conditions" and the other is the "personal life". Attributes of these two levels are listed and corresponded side by side in Figure 1. Usually, indicators of external life conditions are mostly objective and tangible compared with those of personal life which are mostly subjective and intangible. But there are also some exceptions. For examples, "public policies" as one attribute of external life conditions is an intangible factor with subjective characteristic; the factors of "living quality" such as location and living area are tangible with objective characteristic. Thus this correlative concept stands on a common but not absolute view to explain the characteristics of UQOL factors. Finally borrowing the definition of QOL from Ontario Social Development Council which is mostly consistent with our analysis, UQOL for our own research can be defined as follows.

Urban Quality of Life is the product of the interplay among the external conditions in society, environment, economics, politics, healthcare, education and housing which affect both individual development and sense of well-being in the urban.

3. THE CUSTOMIZED MEASUREMENT SYSTEM OF UQOL

There is no agreement on the definition or a set of indicators to describe UQOL. This makes our research need our own judgment for suitable indicators. Besides, technical difficulties have also limited the measurements of UQOL. This stems from the problems that there are too many variables involved; cultural and political differences among cities and countries, incomplete statistical data or time series, as well as unreliability of survey data. So we would need to follow a certain set of guidelines to develop our own indicators to do the measurement of UQOL. How can we guarantee that the indicators are comprehensive enough and their data are workable to be collected? A useful set of UQOL indicators should have the following characteristics [22-24]:

- ***Measurable –*** *Quantifiable indicators are more welcomed.*
- ***Based on existing data –*** *If possible, indicators are suggested to be derived from reliable existing data base or information. That can speed their use up and reduce costs.*
- ***Affordable –*** *In order to avoid the termination of research because of financial cost or time, it's better to prescribe a conservative budget before assembling and analyzing indicators.*
- ***Based on time series –*** *Indicators should be collected by a regular interval so that changing can be compared.*
- ***Quickly observational*** *– Indicators whose data collection can be developed soon are more useful than those that require long processing.*
- ***Change-sensitive*** *– Indicators should change as conditions change so that they can accurately reflect reality.*
- ***Widely accepted*** *– Indicators must be understood and accepted by their users.*
- ***Easy to understand*** *– Indicators are better to be reported in a fashion so that a wide range of people can understand them.*
- ***Balanced*** *-- Indicators should be politically neutral and allowed for measurement of both positive and negative impacts*

The above keywords all suggest to objective indicators more than subjective ones. The main advantage of objective indicators is that they are based on quantitative statistics rather than individuals' subjective perceptions, so there is a lesser chance to be limited by their social environment or experience. Also, objective indicators are more often used in the research of QOL at the urban level [25]. So the objective indicators are preferred in this paper. Some research indicated that the level of objective conditions can represent individuals' subjective sense to some extent because both objective and subjective indicators are inter-related [26]. For example, average life expectancy, amount of hospitals and so on can be used to explain the level of health care; proportion of population with higher education, amount of libraries and schools and so on can partly reveal the level of education, etc.

Our research is underpinned by the definition of "Urban Quality of Life" as the product of the interplay among the external conditions in society, environment, economics, politics, healthcare, education and housing which affect both individual development and sense of well-being in the urban. The measurement indicators will be derived from several domains in society, environment, economics, politics, healthcare, education and housing which affect both individual development and sense of well-being in the urban as in Figure 2. At the same time, because our paper discusses about QOL at the urban level, the customized indicators will be mainly focused on the objective ones [27]. Besides, in order to choose a suitable set of indicators, we will follow Leitmann's 9 characteristics as close as possible [28]. In summary, the customized indicators are mostly objective indicators following the principles of "measurable, based on existing data, affordable, regularly collected, quickly observable, sensitive to change, widely accepted, easy to understand, and balanced or politically neutral" which are derived from domains of society, environment, economics, politics, healthcare, education and housing.

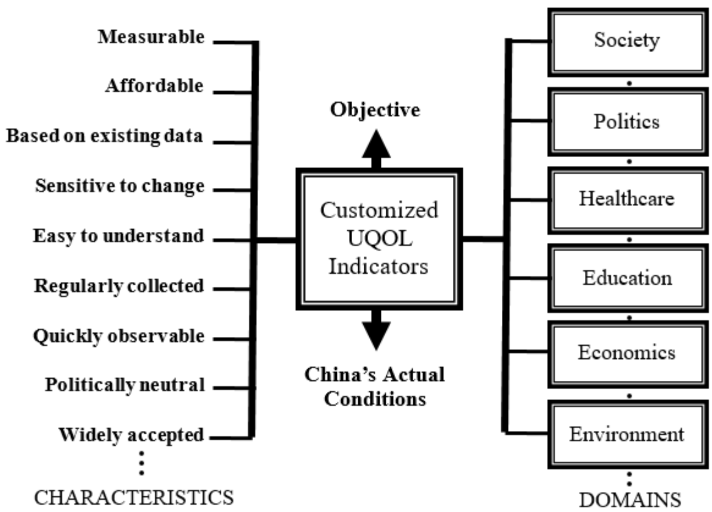

Figure2. The Framework of Customized Indicators

According to Diener's research on the differences in measuring QOL among countries[29], our indicators are also required to meet China's actual conditions. The simplest way to match the specific situation of a country is to define our indicators in the same way as the national statistical books do. That means it's better to use the indicators which could be found in authorized statistical books or websites in China so that we can collect the data easier and keep consistent sayings. On the other hand, we cannot adopt the existing popular indicators worldwide into our paper directly, without adjusting them to considerations of the country's characteristics. Table 1 shows all indicators in different domains after the adjustments. In order to keep consistent with statistical books in China, both English and Chinese names of indicators are laid for convenience to be looked up in future. We also set a number to each indicator for data analysis[3].

Table1. *Customized UQOL Indicators in China*

<table>
<tr><th colspan="2">Domains</th><th>Indicators</th><th>No.</th><th>Unit</th></tr>
<tr><td rowspan="20">Society</td><td rowspan="5">Transportation</td><td>Total urban road area</td><td>S11</td><td>m²</td></tr>
<tr><td>Total freight</td><td>S12</td><td>10,000 tons</td></tr>
<tr><td>Public traffic passengers (bus and tram)</td><td>S13</td><td>10,000 persons</td></tr>
<tr><td>Total public (electronic) Buses</td><td>S14</td><td>car</td></tr>
<tr><td>Total taxis</td><td>S15</td><td>taxi</td></tr>
<tr><td rowspan="6">Telecommunication & Cultural Service</td><td>Total post offices</td><td>S21</td><td>office</td></tr>
<tr><td>Per capita fee for telecommunication services</td><td>S22</td><td>yuan</td></tr>
<tr><td>Telephone subscribers per 10,000 urban residents</td><td>S23</td><td>person</td></tr>
<tr><td>Cell phone subscribers per 10,000 urban residents</td><td>S24</td><td>person</td></tr>
<tr><td>Collection books in public libraries for per hundred urban residents</td><td>S25</td><td>book</td></tr>
<tr><td>Theaters and cinemas for per million urban residents</td><td>S26</td><td>theater</td></tr>
<tr><td rowspan="4">Housing Condition</td><td>Per capita housing area</td><td>S31</td><td>m²</td></tr>
<tr><td>Per capita water consumption</td><td>S32</td><td>ton</td></tr>
<tr><td>Per capita electricity consumption</td><td>S33</td><td>KWh</td></tr>
<tr><td>Gas penetration rate</td><td>S34</td><td>%</td></tr>
<tr><td rowspan="5">Safety</td><td>Unemployment rate</td><td>S41</td><td>%</td></tr>
<tr><td>Incidence of criminal cases per 100,000 urban residents</td><td>S42</td><td>cases</td></tr>
<tr><td>Traffic fatalities per 100,000 urban residents</td><td>S43</td><td>person</td></tr>
<tr><td>Fire accidents per 100,000 urban residents</td><td>S44</td><td>person</td></tr>
<tr><td>Natural population growth rate</td><td>S45</td><td>%</td></tr>
<tr><td colspan="2" rowspan="2">Healthcare</td><td>Total hospitals</td><td>H1</td><td>1,000 hospitals</td></tr>
<tr><td>Total doctors</td><td>H2</td><td>1,000 doctors</td></tr>
</table>

[3] This measurement system has been used in an empirical test for 35 Chinese cities through a customized linear model linking housing prices, worker income to 44 UQOL indicators. The results of the UQOL ranking in 35 cities in 1999 and 2007 will be appended behind for reference.

	Total hospital beds	H3	1,000 beds
Education	Per capita scientific & educational expenditure	ED1	yuan
	Students at colleges per 10,000 urban residents	ED2	person
	Professional and technical workers per 10,000 urban residents	ED3	person
	Total primary schools	ED4	1,000 schools
	Total middle schools	ED5	1,000 schools
	Total colleges	ED6	1,000 colleges
	Ratio of teachers and students in primary schools	ED7	%
	Ratio of teachers and students in middle schools	ED8	%
	Ratio of teachers and students in colleges	ED9	%
Economics	Per capita GDP	EC1	Yuan
	The contribution proportion of tertiary industry in GDP	EC2	%
	Per capita public finance revenue	EC3	yuan
	Per capita public finance expenditure	EC4	yuan
	Per capita consumption expenditure	EC5	yuan
	Per capita savings' closing balance	EC6	yuan
Environment	Per capita funds for urban maintenance and construction	EN1	yuan
	Population density in urban centre	EN2	Person /km^2
	Per capita green area	EN3	m^2
	Green coverage in built-up areas	EN4	%
	Harmless treatment rate of garbage	EN5	%
	Sewage treatment rate	EN6	%

(Total: 44 indicators)

4. Result Analysis and Discussion

From previous definitions of QOL, this paper summarizes three main ways of definition methods. By combining all these three methods, our own definition of UQOL is given. This definition of UQOL comes from the concept of QOL but the subjects being measured are different. QOL relies more on individual's conditions of living and feeling, while UQOL emphasizes on the assessment of urban itself and its influence on personal life. So our definition may be useful for the area of urban studies greatly but not guaranteed to be accurate in other areas.

In this research the measurement of UQOL is limited to 44 indicators which are divided into 5 main domains (8 sub-domains). Though they cover all required UQOL domains, it will be more comprehensive if the indicators of quality of air (such as the emissions of SO_2 and CO2) can be added to the domain of environment, the crime rate can be added to the domain of safety, the total users of internet can be added to the domain of telecommunication & culture service, and so on. Some possibly helpful but missing indicators didn't be recorded in the Chinese statistical books until 2003. Given this measurement system is set up to do an empirical test which asks for a time series of more than 10 years, those indicators have to be ruled out. Thus after several years, UQOL studies in China can be improved by using data with a higher quality which has more indicators added with a longer time series.

Borrowing the measurement system of 44 UQOL indicators in this paper, an empirical test is done through a customized linear model[4] which links UQOL to housing prices and income. A data set on commodity housing prices, average income of urban workers and 44 customized UQOL indicators in 35 Chinese cities (Peking, Tianjin, Shijiazhuang, Taiyuan, Hohhot, Shenyang, Dalian, Changchun, Harbin, Shanghai, Nanjing, Hangzhou, Ningbo, Hefei, Fuzhou, Xiamen, Nanchang, Jinan, Qingdao, Zhengzhou, Wuhan, Changsha, Guangzhou, Shenzhen, Nanning, Haikou, Chongqing, Chengdu, Guiyang, Kunming, Xian, Lanchow, Xining, Yinchuan and Urumqi.) The list covers most capital cities and famous cities in China.

In this model, housing price is the dependent variable which is explained by income variable and all 44 indicators of UQOL. This customized model reflects Rosen's compensation theory as well as meets Glaeser's interpretation on urban value: the total value of urban (urban rents) are decided by urban productivity value (income) and urban amenity value (UQOL) [30]. By putting the annual data of 35 cities in 11years (1997-2007) including housing prices (35*11=385 observations), income (35*11=385), 44 UQOL indicators (44*35*11=16940) into the maximum model regression, the result can be got in Table 2.

Table2. *The Result of the Maximum Model Regression*

Dependent Variable: LOG(PRICE)				
Method: Least Squares				
Sample: 1385				
Included observations: 385				
	Coefficient	Std. Error	t-Statistic	Prob.
C	4.229498	0.565079	7.484788	0.0000
LOG(INCOME)	0.280622	0.061676	4.549920	0.0000
EC1	3.25E-06	1.76E-06	1.847877	0.0655
EC2	-0.000109	0.001500	-0.072969	0.9419
EC3	9.97E-06	8.16E-06	1.221432	0.2228
EC4	-1.53E-05	8.24E-06	-1.860803	0.0636
EC5	3.16E-05	1.14E-05	2.773022	0.0059
EC6	5.73E-06	2.12E-06	2.704182	0.0072
ED1	0.000148	6.46E-05	2.299339	0.0221
ED2	0.000124	9.00E-05	1.373627	0.1705
ED3	5.79E-05	4.98E-05	1.162227	0.2460
ED4	0.000115	0.000129	0.890425	0.3739
ED5	0.000138	0.001477	0.093608	0.9255
ED6	0.003242	0.013688	0.236833	0.8129
ED7	-0.005831	0.009098	-0.640940	0.5220
ED8	0.006550	0.011729	0.558419	0.5769
ED9	0.004191	0.004601	0.910903	0.3630
EN1	2.21E-05	1.19E-05	1.859466	0.0638
EN2	-1.21E-05	1.00E-05	-1.203415	0.2297
EN3	0.005329	0.004934	1.080052	0.2809
EN4	0.004503	0.001856	2.426834	0.0158
EN5	0.000567	0.000535	1.060678	0.2896
EN6	0.002038	0.000475	4.294075	0.0000
H1	-0.000358	0.000366	-0.979909	0.3278
H2	0.005553	0.003184	1.744201	0.0820
H3	0.000363	0.001964	0.184763	0.8535
S11	-4.06E-06	4.92E-06	-0.825122	0.4099
S12	1.58E-06	1.71E-06	0.929143	0.3535
S13	-3.91E-06	1.17E-06	-3.331454	0.0010

[4] The modeling and data analysis would be described in detail in another paper.

S14	7.49E-07	3.33E-06	0.224673	0.8224
S15	2.13E-06	2.45E-06	0.869537	0.3852
S21	-4.30E-07	1.51E-07	-2.855742	0.4546
S22	-7.93E-05	2.52E-05	-3.141548	0.5718
S23	3.31E-06	6.03E-06	0.548734	0.5835
S24	-3.01E-06	3.62E-06	-0.832445	0.4057
S25	0.000711	0.000214	3.315059	0.0010
S26	0.002831	0.000903	3.136083	0.0019
S31	-0.003651	0.003896	-0.937119	0.3494
S32	0.001603	0.000352	4.554419	0.0000
S33	7.86E-05	5.04E-05	1.560606	0.1195
S34	-0.000166	0.000764	-0.217832	0.8277
S41	-0.017926	0.009605	-1.866312	0.0629
S42	2.40E-05	2.61E-05	0.917356	0.3596
S43	0.004403	0.002943	1.496136	0.1355
S44	9.48E-05	0.000320	0.296099	0.7673
S45	-0.005765	0.004018	-1.434936	0.1522
R-squared	0.907539	Mean dependent var		7.838133
Adjusted R-squared	0.895266	S.D. dependent var		0.454221
S.E. of regression	0.146998	Akaike info criterion		-0.885079
Sum squared resid	7.325243	Schwarz criterion		-0.412743
Log likelihood	216.3777	Hannan-Quinn criter.		-0.697749
F-statistic	73.94269	Durbin-Watson stat		1.023746
Prob(F-statistic)	0.000000			

In this result, both R-squared and adjusted R-squared are close to 0.9, showing the goodness of fit of regression model. However, some variables have a high p-value, indicating that the model can be greatly reduced using backward elimination method. A reduced model can show the significant indicators of UQOL based on the data. The common choice of the threshold of p-value is 0.1 or 0.05. Considering that UQOL is a multi-faceted concept involved in various domains, so we'd like to increase the p-value a little bit to make sure that each domain has some indicators remaining. The regression model after backward elimination is shown in Table 3, where the threshold of p-value is chosen to be 0.2. Here 22 UQOL indicators remain, and we can observe a slightly improved adjusted R-squared compared to the maximum model.

Table3. *The Reduced Regression Model at p-value < 0.2*

Dependent Variable: LOG(PRICE)				
Method: Least Squares				
Sample: 1 385				
Included observations: 385				
	Coefficient	Std. Error	t-Statistic	Prob.
C	4.609237	0.433618	10.62971	0.0000
LOG(INCOME)	0.241047	0.049759	4.844258	0.0000
EC1	3.65E-06	1.49E-06	2.449056	0.0148
EC3	9.26E-06	7.29E-06	1.271249	0.1806
EC4	-1.15E-05	7.47E-06	-1.539599	0.1245
EC5	3.25E-05	1.04E-05	3.137003	0.0018
EC6	6.72E-06	1.75E-06	3.844369	0.0001
ED1	0.000114	4.98E-05	2.288473	0.0227
ED2	9.43E-05	5.80E-05	1.626102	0.1048
ED3	6.85E-05	4.31E-05	1.588116	0.1131
EN1	1.94E-05	1.06E-05	1.837929	0.0669

EN2	-1.32E-05	8.30E-06	-1.589566	0.1128
EN4	0.005562	0.001324	4.201901	0.0000
EN6	0.002019	0.000421	4.800385	0.0000
H2	0.006933	0.001872	3.702790	0.0002
S13	-3.83E-06	9.66E-07	-3.965353	0.0001
S15	2.25E-06	1.60E-06	1.411830	0.1589
S25	0.000724	0.000180	4.022311	0.0001
S26	0.002909	0.000800	3.636407	0.0003
S32	0.001721	0.000291	5.911905	0.0000
S33	7.45E-05	4.41E-05	1.689326	0.0920
S41	-0.014811	0.008612	-1.719908	0.0863
S43	0.005077	0.002413	2.103684	0.0361
S45	-0.005733	0.003684	-1.556087	0.1206
R-squared	0.904906	Mean dependent var		7.838133
Adjusted R-squared	0.898284	S.D. dependent var		0.454221
S.E. of regression	0.144864	Akaike info criterion		-0.960893
Sum squared resid	7.533864	Schwarz criterion		-0.693921
Log likelihood	210.9720	Hannan-Quinn criter.		-0.855011
F-statistic	136.6485	Durbin-Watson stat		1.017339
Prob(F-statistic)	0.000000			

In this reduced model, compared to UQOL indicators, income is a very significant factor with p-value close to 0. Here, the relationships between housing prices and most of the remaining UQOL indicators meet the conventional understanding well, except 5 negative ones and 1 unexpected indicator, including per capita public finance expenditure (EC4), population density in urban centre (EN2), public traffic passengers (S13), unemployment rate (S41) and natural population growth rate (S45) which are negative, and traffic fatalities (S43) which seems a little unexpected.

Public finance expenditure (EC4) is a type of governmental subsidies to the residents which is used in public products or service. Why does high per capita public finance expenditure correlate with low housing prices? There are two possible reasons: 1) small or less-developed cities always have smaller population than large cities, so even they have less total public finance expenditure, their per capita finance expenditure may be higher than those of large cities; 2) developed cities have better public instruments or service than those undeveloped cities, so the central government assigns more expenditure to undeveloped cities according to the demand.

The explanation on the negative impact of “population density in urban centre (EN2)” needs to track to the distribution of population in Chinese cities. In cities with low housing prices, the housing prices in urban centre are relatively affordable. Because the resources of urban center are much ampler than suburban district, more and more people move towards the urban center. But in cities with high housing prices, the housing prices in the urban centre is so high that only a small portion of people can afford it. With the transportation and public service in the suburban district rising up very quickly, more and more people feel comfortable to move out to the surrounding areas.

For the public traffic passengers (bus and tram) (S13), the main reasons may focus on other alternative traffic tools: metro, taxis, private cars, train, plane and so on which are more expensive compared with buses and trams. In fact, if we can collect the data of all other traffic tools, the results may be explainable, but it is very difficult to find all the data. Even so, from the result of taxis (S15) which is positive against housing prices, we guess whether the more public traffic passengers mean relatively less people using other expensive alternative traffic tools. If so, the negative impact of public traffic passengers can be explained.

From the regression, higher unemployment rate (S41) indicates lower housing prices. It is easy to be explained that high unemployment rate may lower housing demand. But higher natural population growth (S45) indicates lower housing prices, which is not easy to believe. Normally, higher population growth would mean higher housing demand as more families are being formed. So the only explanation may be that this kind of housing demand has a time lag not to reflect on housing market in time during our observed period.

Using the significant indicators whose P-value is under 0.2, the total value of UQOL can be calculated for each city in a specific year. The ranking results in both 1999 and 2007 are shown in Appendix 1. With this measurement mechanism, we will be able to monitor the level of sustainability for each city as far as urban quality of life is concerned.

5. Conclusion

This paper integrates the existing measurement systems of developed countries and the actual circumstances of China to construct a customized UQOL measurement system applicable to the urban background of China, encompassing 5 domains and 44 indicators. Utilizing the customized UQOL and the linear relationship model with housing prices and income, an empirical test was conducted using 35 cities in China as samples. Through the empirical study, the model was further refined, and the indicators were reduced to 22. Based on the optimized model, the total UQOL value of each city in a specific year can be computed. The appendix presents the total UQOL values of 35 Chinese cities in 1999 and 2007. The development of this measurement system aims to offer an alternative foundation for estimating the UQOL of Chinese cities, enabling authorities to establish and implement a superior set of urban policies to achieve sustainable urban governance.

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Appendix 1 Inter-urban Comparison of UQOL in 35 Chinese Cities in 1999 and 2007

City	**∑UQOL**			
	1999		2007	
	Value	Rank	Value	Rank
Shenzhen	1.56411	1	2.26178	1
Shanghai	1.12373	4	2.10093	2
Peking	1.39015	2	2.07739	3
Guangzhou	1.27865	3	1.8329	4
Xiamen	1.01535	6	1.81419	5
Hangzhou	0.93237	8	1.65484	6
Ningbo	0.78883	18	1.62461	7
Nanjing	1.07177	5	1.48629	8
Dalian	0.93579	7	1.33758	9
Qingdao	0.83912	14	1.33534	10
Tianjin	0.88985	9	1.29752	11
Shenyang	0.8349	15	1.28182	12
Wuhan	0.84922	13	1.27367	13
Fuzhou	0.88054	10	1.24198	14
Chengdu	0.6813	27	1.23853	15
Taiyuan	0.61264	30	1.21237	16
Jinan	0.74805	21	1.19595	17
Changsha	0.74037	22	1.14211	18
Changchun	0.70017	24	1.10048	19
Xian	0.76187	19	1.09618	20
Zhengzhou	0.70412	23	1.07882	21
Hefei	0.76131	20	1.06395	22
Urumqi	0.69572	26	1.03738	23
Nanchang	0.63315	29	0.99221	24
Yinchuan	0.59361	31	0.96439	25
Guiyang	0.42337	35	0.96353	26
Kunming	0.87823	11	0.96144	27
Nanning	0.79501	17	0.94872	28
Haikou	0.85195	12	0.94852	29

Harbin	0.69638	25	0.93966	30
Hohhot	0.64015	28	0.93102	31
Shijiazhuang	0.82606	16	0.89887	32
Chongqing	0.52645	33	0.82929	33
Lanchow	0.54602	32	0.81899	34
Xining	0.4458	34	0.6438	35

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