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Research Article

The Value Loss of Chinese Key Cities due to Traffic Noise

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Abstract: A method for analyzing value loss of Chinese key cities due to traffic noise is proposed based on the rate of pollution loss. Correlative parameter of this method is confirmed according to the national standard of environmental noise. Then the rate of pollution loss for different sound level is computed. Considering the characteristic of traffic noise of China cities, the general computational method for value loss due to traffic noise is proposed in this study. Finally, the value loss of Chinese key cities due to traffic noise are analyzed by the urban road traffic noise, per capita disposable income and metropolitan area population of Chinese key cities in last five years.

Keywords: Chinese key cities, rate of noise pollution loss, the value loss of urban road traffic noise, traffic noise

INTRODUCTION

Noise pollution has become one of the most important environmental problems in recent years. Noise affects the human health unfavorably both physically and psychologically. With the increase in the number of vehicles and population, much more people have been affected by the noise from year to year. In particular, traffic noise sounds greater than city environmental noise and has a bad influence to the residents surrounding. Therefore, the National Bureau of Statistics and the People's Republic of China State Environmental Protection Administration announces major cities urban road traffic noise in every year.

However, the traffic noise of the city is expressed as the average equivalent continuous A sound level. For urban residents, in general, it is difficult to know exactly traffic noise on the extent of the injury through the average equivalent continuous a sound level. If the level of a traffic noise can be transform to money, the urban residents will greatly enhance the perception of urban road traffic noise level and compare various cities horizontal traffic city noise, or know noise change of city road over the years.

There have been some attempts to financially quantify the cost of damages to residential areas and environment due to noise pollution. The most commonly used techniques for estimating noise damage costs are hedonic price methods (HPM) (Henrik *et al*., 2010) and contingent valuation methods (Venkatachalam, 2004). The former examines the effect of road and railway noise on property prices based on revealed behavior, while the latter is a simple, flexible nonmarket valuation method that is widely used in cost-benefit analysis and environmental impact assessment. However, contingent valuation methods are subject to severe criticism. The criticism revolves mainly around two aspects, namely, the validity and the reliability of the results and the effects of various biases and errors. So many papers combinecontingent valuation and other methods such as choice experiments (Joan *et al*., 2009). However, the above studies on the noise costs focus on the urban environmental sound. In fact, traffic noise sounds greater than urban environmental noise, which should be researched in further. Furthermore, tradition research focuses on the high environmental sound exceeding national standards. Of course, high urban environmental sound exceeding national standards would certainly cause harm, but in the national standards, the urban environmental sound also may cause irritability, only its lesser degree. Therefore, only researching harm of the high urban environmental sound might not be sufficient to respond the relations of urban acoustic environment and human.

Therefore, based on traditional hedonic price methods and contingent valuation methods, a new method for analyzing value loss of traffic noise is proposedin this study. This theoretical model considerers the human reaction of traffic noise in the national standards, which deduces loss of traffic noise. On this basis, the value loss of Chinese key cities due to traffic noise is analyzed in last five years.

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THE RATE OF NOISE POLLUTION LOSS

Individual noise loss: According to the concentration of pollutants-pollution loss theory (Gu *et al*., 2005), the damage of noise on human life quality is not a simple linear relationship. The level of low sound does not cause harm to humans. But with increasing of sound level, human health damage due to noise begins slowly increases. When the sound level reaches a critical level, the damage on human health reaches a relatively strong performance. When the noise increases to a certain value, the damage will gradually become flat. Accordingly a noise loss model can be made as:

$$S = \frac{K}{1 + a \times e^{-b \times C}} \tag{1}$$

where,

- K = Total service value of comfortable sound environment
- S = Noise pollution loss in the determining the traffic noise
- C = Equivalent continuous A sound level
- a,b = Constant

In the above model, sound loss rate R=K/S close to 0 in the lower sound level. Along with increasing in noise level, sound loss rate R is an S-type nonlinear curve in the study of the region. When the sound level C is high, the sound loss rate R closes to 1.

The correlation coefficient of individual noise loss: According to the Chinese national standard GB3096-2008 "Environmental quality standard for noise", urban environmental noise can be divided into five categories, in which area around the road traffic route belongs to the fourth category, with the highest standards in the daytime noise limit of 70 dBA and minimum of 55 dBA. This means that the majority of experts believe that: traffic noise over 70 dBA, noise may great harm urban residents. When traffic noise is less than 50 dBA, the urban road traffic noise hurts small urban residents. Thus it may be assumed that when C = 55dBA, S =1K and C = 70dBA, S = 99K. Put this assumption into formula (1) yields:

$$\begin{cases} a = 4.2687 \times 10^{16} \\ b = 0.6127 \end{cases} \tag{2}$$

Formula (2) can be substituted in formula (1):

$$S = \frac{K}{1 + 4.2687 \times 10^{16} \times e^{-0.6127C}} \tag{3}$$

Various noise loss rates: Using formula (3) can calculate noise loss rate R = S/K in different sound level.

The loss of urban road traffic noise: The loss of traffic noise can be classified as sound environmental use value, which is related to the crowd. The greater the crowd, the sound environment has the greater service value. Therefore, the loss of urban road traffic noise can be expressed as:

$$K = \sum k \tag{4}$$

k is the service value of urban environmental sound of the individuals willingness to pay, which is closely related to per capita disposable income. Here assumpts that sound environmental individual's willingness to pay is direct proportion to per capita personal income:

$$k = f \times M \tag{5}$$

where,

- f = The ratio coefficient
- M = Per capita personal income

Theebe (2004) reports that, in a rising market such as China, the impacts of traffic noise on house prices reaches a maximum of 12% with an average of about 5%. The number of investigations and studies (Jamrah *et al*., 2006; Cherie and Morrell, 2006; Pandya, 2001) show, f can be assume as 1/20 for Chinese urban residents.

Formula (4) (5) can be substituted into formula (3) yielding:

$$S = \frac{\sum f \times M}{1 + 4.2687 \times 10^{16} \times e^{-0.6127C}} = \frac{f \times \sum M}{1 + 4.2687 \times 10^{16} \times e^{-0.6127C}} \tag{6}$$

For a city, $\sum M$ is the income of urban residents and equals to urban per capita disposable income multiplies by the city's urban population.

THE LOSS OF URBAN ROAD TRAFFIC NOISE IN CHINESE KEY CITIES

Using the formula (6), the loss of urban road traffic noise in Chinese 31 key cities are analyzed from 2007 to 2011. Figure 1 and 2 show the loss of urban road traffic noise in Chinese 31 key cities over the last five years. The key cities in Fig. 1 include Lhasa, Xining, Yinchuan, Haikou, Hefei, Lanzhou, Hohhot, Nanchang, Guiyang, Urumqi, Shijiazhuang, Nanning, Kunming, Taiyuan, Changsha and Zhengzhou. The key cities in Fig. 2 include Changchun, Fuzhou, Xi'an, Harbin, Jinan, Chengdu, Shenyang, Wuhan, Chongqing, Hangzhou, Tianjin, Nanjing, Guangzhou, Beijing and Shanghai.

It can be seen from Fig. 1 and 2 that: in all key cities the past five years, the loss of Lhasa urban road traffic noise is lowest: 1 million yuan and that of Shanghai in 2011 is highest: 0.131 billion yuan. The

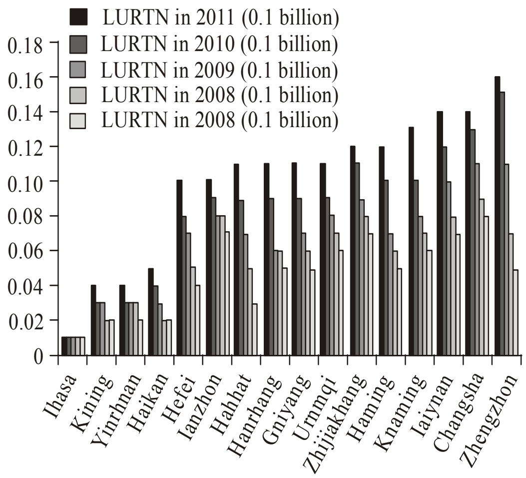

Fig. 1: The Loss of Urban Road Traffic Noise (LURTN) in Chinese 16 key cities

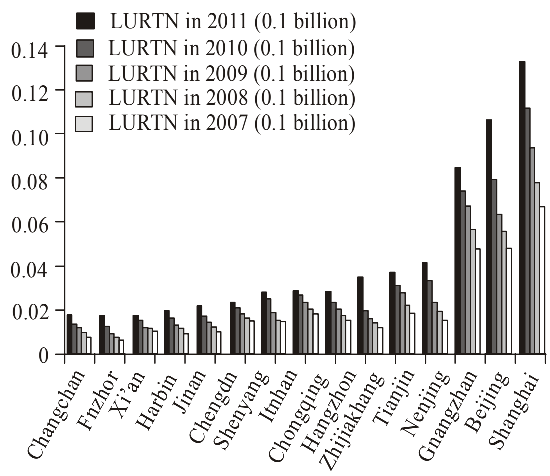

Fig. 2: The Loss of Urban Road Traffic Noise (LURTN) in Chinese other 15 key cities

loss of urban road traffic noise of Lhasa, Xining, Yinchuan, Haikou is lower relatively and is no more than 10 million yuan, which is mainly due to these cities lower noise level, relatively small population, low per capita disposable income.

The loss of urban road traffic noise of Shanghai, Beijing, Guangzhou is relatively higher and is more than 50 million yuan, which is mainly due to these cities higher noise level, relatively large population, high per capita disposable income. Furthermore, for the great majority of Chinese cities, the loss of urban road traffic noise has increased year by year in the last five years.

The average loss of urban road traffic noise of Chinese 31 key cities in 2007, 2008, 2009, 2010, 2011 are 12, 15, 17, 21, 25 million yuan respectively. The total loss of urban road traffic noise of Chinese 31 key cities in 2007, 2008, 2009, 2010, 2011 are 0.385, 0.450, 0.535, 0.646, 0.789 billion yuan, with an average annual increase of 15.43% more than the gross national product of 11.0% average annual increase. These studies show that the loss of urban road traffic noise of Chinese key cities increase more rapidly in recent years.

Figure 3 shows the loss of urban road traffic noise of 31 Chinese key cities in 2011. It can be seen from Fig. 3 that: the loss of urban road traffic noise of coastal areas in the east and central parts of the city is significantly higher, while that of the western region is relatively lower. The reason is that the cites of coastal areas in the east and central parts own relatively large population, high per capita disposable income, while the cities of the western region have relatively small population, low per capita disposable income.

Fig. 3: The value loss of 31 Chinese capital cities due to traffic noise in 2011 (Units: 0.1 billion yuan)

CONCLUSION

This study presents a calculation method of the loss of urban road traffic noise in Chinese cities and accordingly the loss of urban road traffic noise in calculates Chinese 31 key cities. The conclusions list below:

- The theory model of sound loss rate is proposed and analyzed in this study. Within the framework of national standards, the service value of urban environmental sound is a nonlinear S-type curve. In the upper limit of the national standard, sound loss rate reached the peak of S-curve. When the sound level exceeds the national standard limit, sound loss rate has been above 99%. When sound level under the limit lower than the national standard, the sound loss rate is below 1%
- The calculation method of the loss of urban road traffic noise in Chinese cities is proposed. The loss of urban road traffic noise is not only related to the sound loss rate, but also with the traffic noise affecting per capita disposable income crowd, the number of the crowd, the crowd noise is related to willingness to pay
- According to the city the loss of urban road traffic noise model, the loss of urban road traffic noise in 31 Chinese key cities is analyzed from 2007 to 2011. The total loss of urban road traffic noise of Chinese 31 key cities in 2007, 2008, 2009, 2010, 2011 are 0.385, 0.450, 0.535, 0.646, 0.789 billion yuan, with an average annual increase of 15.43% more than the gross national product of 11.0% average annual increase. Furthermore, for the great majority of Chinese cities, the loss of urban road traffic noise has increased year by year in the last five years.

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