COMPREHENSIVE ASSESSMENT OF LAND-USE FOR RAILWAY CONSTRUCTION

Zhiyong MENG
Associate Professor
Faculty of Civil & Architecture Engineering
Northern Jiaotong University
Beijing, 100044, P. R. China
Fax: 86-010-63240517
E-mail: zy-meng@netease.com

Feng CHEN
Associate Professor
Faculty of Civil & Architecture Engineering,
Northern Jiaotong University,
Beijing, 100044, P. R. China
Fax: 86-010-63240217
E-mail: fengchen@center.njtu.edu.cn

Shuyu KAN
Professor
Faculty of Civil & Architecture Engineering,
Northern Jiaotong University,
Beijing, 100044, P. R. China
Fax: 86-010-63240257

Abstract: Starting from the study of the attributes of land for railway use and considering the value composition of land in a comprehensive manner, the paper proposes a concept about the generalized value of land holding that the value of land is subjected to the integrated influence of its inherent value, its social value and the attached value. And the attached value of land represents the additional value aside from its inherent value and social value that railway pays for its possession. On this basis are proposed classification criteria, established assessment procedure, set up a corresponding software system for land-use value-index assessment, and recommended relatively reasonable land-use value-indexes for use in optimizing option of railway construction programs, thus providing favorable conditions for optimization of land for railway use. After further enhancement of the research results, they may be expected to provide service to paid occupation of land and land value assessment.

Key work: Railway, Generalized value of land, Land-value index,

1. INTRODUCTION

It is well-known that land resource is not confined to the land itself, nor the possession of this resource should be interpreted simply as the occupation of the surface of the land. In a broad sense, land resource refers to the latent potentiality of the land and its surrounding space that can be exploited by mankind. Land is good for growing staple crops as well as economic crops. It can support artificial facilities built upon it. Under the ground may be embedded utilizable minerals or water. Plants that grow on the land have the role of modulating and gracing the surrounding environment. Singular landform may turn the place into scenic areas worthy of tourist visits. And there are other possibilities.

As the use of a lot may be different in different time periods, it should be contemplated in terms of long-range planning. The occupation of land by railway is almost permanent and the land so occupied would not be otherwise used in a time span of decades, even a hundred years. Therefore, the economic environmental and social effects due to the occupation of this kind of resource must be taken into consideration. And indeed, the physical coverage of these effects, as often as not, is much larger than the area of land actually occupied. For instance, environmental pollution created by the railway will by no means stay within the right-of-way. This explains why we must, when we have to occupy land in order to live better, make careful planning and appropriate arrangements keeping long-term benefits and long-range planning in view. People are deepening their understanding gradually about the necessity of using land thriftily and sensibly along with increasing demands on land for construction use in this country and the increasing value of land. It follows that the traditional practice of simply investigating the quantity of land to be used must be replaced by investigation of the quality of land used. Consequently a scientific land-use assessment criteria system is to be set up and applied to land for railway use. The understanding of the connotation of land-use would thus be deepened and the deepened understanding will have to be embodied in design specifications. In this respect, we have made initial tries to probe into this area which has not been touched up to now.

2. DEFINITION OF THE GENERALIZED VALUE OF LAND

By the generalized value of land is meant the sum of the inherent value of land itself, the value of all natural resources and artificial facilities that are attached to the land, and the value involved in compensating for the environmental and social effects resulting from the occupation of land. It may be interpreted as the price to be paid for land occupation such as to be paid for purchasing the land, removing the facilities and houses existing on the land and quieting down the resentment of inhabitants to be resettled (by way of monetary compensation and/or promises like making arrangement for employment), in case a railway line should pass through a residential area. It may be mentioned as another instance that a railway line passes through geologically unfavorable areas when, in addition to expenses involved in land purchases and the like, costs arising from engineering measures which would have to be taken in order to check and overcome the possible consequences of unfavorable geological conditions and from troubles that might be encountered in construction should be taken into account. Here from it can be seen that the generalized value of land contains many indistinct factors that are hard to describe quantitatively and therefore must be determined with the help of practical engineering experience and expertise.

3. MEASURE OF THE GENERALIZED VALUE OF LAND

At present, the costs of land requisition usually take the form of money. This monetary form of land requisition costs, though it materializes the value of land and the supply-demand relation from a certain viewpoint, is inadequate in the general sense to completely embody its value, particularly the value of land for railway use where a sort of peculiar significance is involved (e.g. unfavorable effects on railway construction due to geological factors).

Furthermore, price is affected heavily by a number of factors and fluctuates quite frequently, and therefore cannot measure accurately the value of land. The conclusion is that a proper measure must be sought which is itself relatively stable and is capable of reflecting the true value of land. For this purpose we have introduced the concept "point" and intend to measure the quality and value of land by the number of "point" per unit area of land. The number of "point" assigned to land depends on land and associated factors only but not on market price level nor on when the assessment is made.

4. THE CONSTITUENTS OF THE GENERALIZED VALUE OF LAND

On the basis of the definition just described and taking into consideration the actual conditions of the land for railway construction, we define the constituents of the generalized value of land as shown in Fing.1. The final purpose of the definition is to provide a scientific value basis for the paid occupation of land by railway.

4.1 The Inherent Value of Land (ZSJZ)

The inherent value of land is result of comprehensive assessment of the natural and economic attributes of land assigned to a specific purpose. This value materializes the differences between the quality level, benefit potential and use of the land.

According to information obtained through investigation of railway-use land, we classify the land into farmland, forestry land, stock raising land, industry and mining land, urban land and other land according to the original purpose of the land. Brief descriptions are given below separately for the grading of land of different purposes and respective integrated "poing" marks.

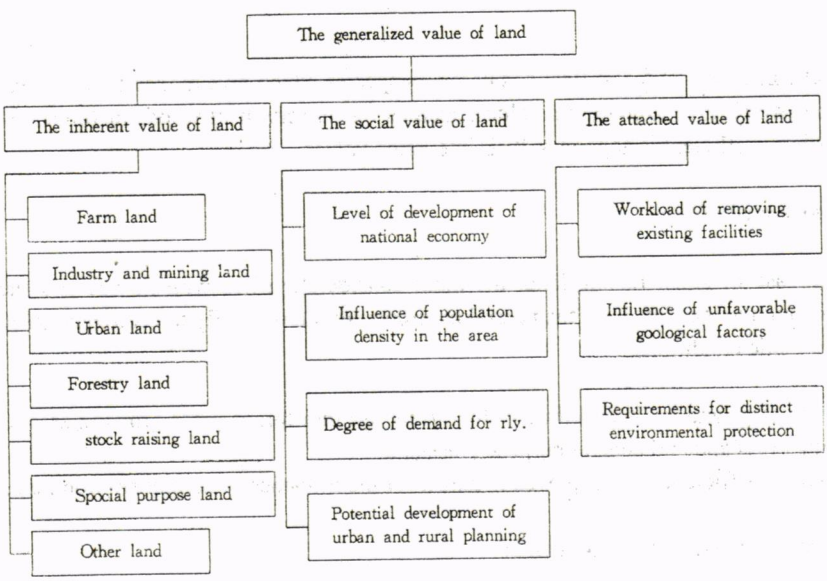

Fig.1 The Constituents of The Generalized Value of Land

(a) Farm land

Grading of farm land is performed in accordance with the train of thoughts implied in 《General Tentative Ideas about the Grading of Farm Land》 and 《Rules for Grading of Farm Land》 issued officially by the State Land Administration in August 1989. In consideration that the occupation of farm land is the most frequent form of land occupation in railway construction, it is highly necessary to engage in deep-going, systematic study on this subject.

The grading of farm land also takes into account both the natural and the economic attributes of land. Assessment is performed as to the quality level and benefit potential of land, with the results of assessment converted into grading and expressed in specific terms. On the bases of grading of farm land across the country, land administrative departments have established a cross comparison system, divided land grades based on comprehensive consideration of land quality, land utility level and economic benefits of land, and taken the yield of standard grain as the grading criterion. In our study on the present subject, we have made use of the results of their study as the bases in grading farm land. Farm land is divided into six grades depending on the yield of standard grain.

(b) Forestry land

Forestry land is graded following the same train of thought as farm land is graded. At the same time, since with forestry land more emphases is placed on its use and economic possibilities, it is classified into nursery of young plants, fruit-tree land, timber forest and economic forest in accordance with the use of and the growing condition of the plants on the land.

The classification of forestry land is based on species which give moderate output values. For species which give high output values, such as for nursery, fruit woods or timber forest, and adjusting coefficient is applied to their integrated values.

(c) Stock raising land

In the case of stock raising land, the main consideration lies with its use and the natural environment of the lot. Here the natural environment refers chiefly to ecological surroundings and climatic conditions.

Stock raising land is classified according to its use into forage grass growing area, exclusive herding grassland and general purpose grassland.
Influence coefficients are employed to adjust for the influence of natural environment.

(d) Urban land (for cities and towns)

This category of land, being complicated in nature due to the involvement of various factors, is hard to classify in a quantitative sense. Aiming at providing a set of relative assessment criteria, we make the grading chiefly in terms of the scale of the city and the nature of the land used.

Grading is based on two factors, one being the statistical price ratio of urban land and farmland, and another being the empirical data supplied by experts concerned working with the State Land Administration.

Urban land is classified into six groups according to the scale of the city, and each group is further divided into three grades according to the nature of land used.

(e) Industry and mining land

This category of land is unique in being simple in the nature of its use but distinct in its economic features. The inherent value of industry and mining land is calculated in terms of the output value per unit area in order to make it comparable in a macroscopic manner with other categories of land. In case the calculated value is less than 40, then take 40 as the inherent value of the land.

(f) Special purpose land

This is classified according to the purpose of use into military land, large piece of land used by foreign firms and land for religious purposes.

(g) Other land

Land for other purposes refers to other categories of land aside from the six categories mentioned above. They are virgin lands including undeveloped land, desert, flood land, barren hill and so on.
The inherent value of land embodies the purpose and the quality of the land. Land is characterized by oneness; that is, it falls into any one of the above-stated seven categories.

4.2 The Social Value of Land (SHJZ)

The social value of land reflects the influence of social factor on land value. Hence, the price of land in economically developed areas tends to be higher, materializing the influence of economic development level of the area on the price of the lot.
In view of the nature of the land for railway use, the social value of the land counts in the following four aspects.

(a) Influence of the level of economic development of the area on land price

Generally speaking, land price varies in direct proportion to the level of economic

development of the area where the lot is in. The tendency of the influence follows a definite relationship. Assuming β_1 as the influence coefficient to describe the relationship,

$$\beta_1 = a + bx + cx^2 \tag{1}$$

where a, b and c are coefficients yet to be determined. This equation is a quadratic parabola passing through the origin, as shown in Fig.2.

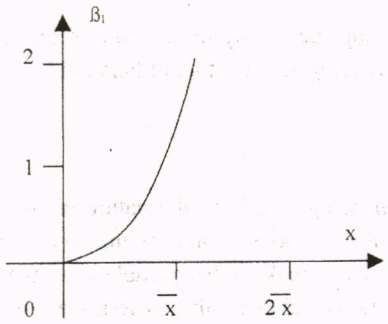

Fig.2

The influence of the level of regional economic development on land price, JJ. can be calculated from β_1.

$$JJ = \beta_1 \times \text{inherent value of land-inherent value of land} = \beta_1 \times \text{ZSJZ-ZSJZ} \tag{2}$$

(b) Influence of regional population density on land value

There is potential influence from regional population density on the price of land in the region. Owing to the fact that this country has a big population but not enough land, in regions where population density is high and the land per capita is meager, the land value will naturally be relatively higher. Inherent years in particular, there is an increasingly acute contrast between the supply of land and the demand for land resources in economically developed areas where construction projects have been growing rapidly. The situation that land resources are relatively poor is hardly improved fundamentally. This is the reason why it is essential to consider the influence of population density on land value.

Now we take β_2 to represent the influence coefficient, then

$$\beta_2 = \frac{a}{bx + cx^2} \tag{3}$$

where a, b and c are coefficients yet to be determined.

where: x ——estimated number of years before any change happens to the lot,

$x \subseteq 15$,take x; $x \supset 15$,take 15

t——reference time period, given 15 years.

The influence of potential development of urban and rural planning on land value can be calculated from the following equation:

$$QF = \beta_4 (\text{ZSJZ, after change of use-ZSJZ, before change of use}) \quad (4)$$

Combining the influences due to the foregoing aspects, we can calculate the social value of land using the following equation.

$$SHJZ = JJ + RK + TK + QF \quad (5)$$

The social value of land is expressed in "point" just as the inherent value does.

4.3 The Attached Value of Land (FSJZ)

This item reflects the price which has to be paid for land occupation addition to the inherent value and social value of the land. This additional price may cover such expenses as are incurred in removing existing facilities on the land, in taking remedial measures in areas of poor geological conditions and taking care of influences due to other factors. The attached value of land features indetermination2, i.e., it is not inevitable. Here we consider three aspects.

(a) Workload of removing existing facilities (CQ)

This aspect is divided into four grades according to the workload on lots along the railway line.

(b) The influence due to poor geological conditions (BE)

This aspect is divided into four grades according the degree of damage and the scope of influence.

(c) Requirements of environment protection (HB)

This aspect is divided into four grades according to the requirements of environment protection.

The gross attached value of land is the sum of the above three aspects, i.e.:

This equation gives a hyperbola, as shown in Fig.3

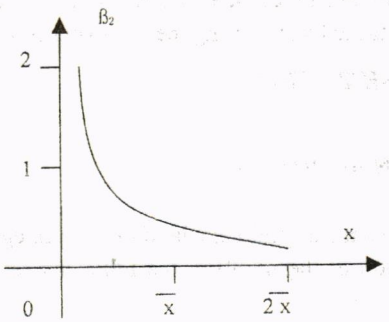

Fig.3

Let represent the influence of regional population density on land value, then

$$RK + \beta_2 ZSJZ - ZSJZ \tag{6}$$

(b) Influence of the extent of demand for railway on the value of land

In the respect of land used for railway construction, the extent of regional demand for railway bears considerable influence on the value of railway-use land, as has been indicated by the past experience in railway construction. In regions where there is a demand for new railway, the regional policy will be likely such as to favor lowering the price for railway occupation of land. And the reverse is true also. This factor of regional demand for railway, at the moment, can only be analyzed qualitatively. Thus we introduced the influence coefficient β_3 in our study.

Depending on the extent of regional demand for railway, the value of β_3 is designated as highly necessary.

Let TX represent the influence of the extent of regional demand for railway on land value, then

$$TX = \beta_3 \times ZSJZ - ZSJZ \tag{7}$$

(c) Influence of potential development of urban and rural planning on land value

As change may happen to the use of a lot in a certain period of time, e.g. farm land may be turned into urban, industry or mining land, it is most likely that the value of the lot will rise accordingly. Assuming β_4 be the influence coefficient,

$$\beta_4 = 1 - \sqrt{x/t} \tag{8}$$

$$FSJE = CQ + BE + HB \tag{9}$$

The integrated value of a land lot can be calculated from its three component values, i.e., inherent value, social value and attached value, using the following equation:

Value of land $(ZHJZ) = ZSJZ + SHJZ + FSJZ$.

5. PROGRAMMED SOLUTION APPROACH

Through the above-described constituents and calculation of the integrated value, it can be seen that for computerized solution of the problem, the following requirements have to be satisfied:

a. The system should be incorporated with a flexible inputting process. That means, it should

be provided with the function of inheriting and optionally revising the inputs of social value and attached value. This is essential to inputting data with high efficiency.

b. The system should be designed with the characteristics of an intelligent data

bank. This is to say that the user can make dynamic revision of assessment index values by relying on expert experience.

c. The system should provide favorable and friendly man-machine interfaces for user convenience.

Based on these consideration, the system is designed on the basis of the artificial intelligent language Turbo prologue.

5.1 A Brief Description of Turbo Prologue Language

Turbo prologue falls under the descriptive language group, being best used for developing expert systems, dynamic data banks and natural language operating programs. It provides excellent user interface and exquisite full-screen editing program and is adapted to multi-window facilities and alternately adjusting environment. It can merge with conventional languages such as C and Pascal languages while realizing natural, harmonious linking-up. Hence, it represents a kind of application programmed design language for use on microcomputers.

5.2 General Block Diagram

The general logic chart of the system is shown in Fig.4.

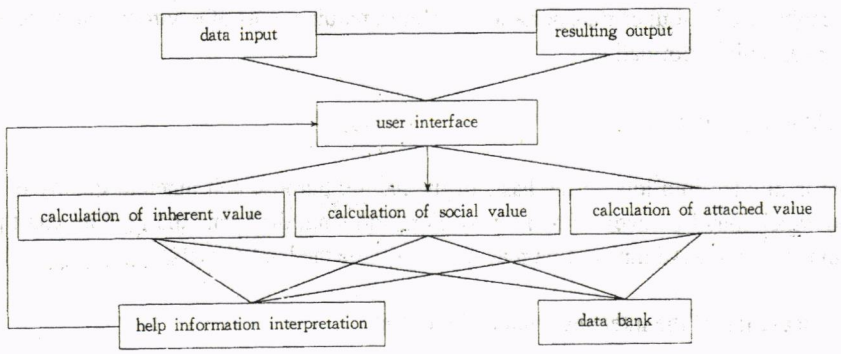

Fig.4 Logic Chart of System

Data input: Data inputting of the system follows the optional fashion, where the user can perform all inputs in the order as briefed by the system. The system is strong in its data

revising function, enabling the user to revise data easily and at any time. An intelligent data inheritance mode is incorporated in each system so that the same data from different lots which would otherwise be repeatedly inputted can be simply inherited or passed on without repetition.

Output of results: The system incorporates excellent, friendly user interface to facilitate all types of users, with the majority of information displayed in simple forms and Chinese characters are employed.

Calculation of the inherent value: This sub-module is used to perform the inherent value calculations for lots which the railway may traverse.
Calculation of the social value: This sub-module is used to perform the social value of the lot.
Calculation of the attached value: This sub-module is used to perform the attached value of the lot.

Help information: This module provides service instructions for the system, giving explanations to doubts and instructing the user on proper selection of data.
Data bank: This is used to store the generalized value data of lots of different nature as well as of different grades.

The procedure of using the sub-system to perform the calculation of the integrated value of the lot goes like the following.

(a) Collecting information about the lot

To collect information about the lot which is on the railway route, including the regional farm land grading chart, the terrain map, the distribution map of the local industries and mines, data showing the level of local economic development, data showing the average land area per capita, the lay-out of transportation facilities, requirements of environment protection, and other particular information.

(b) Dividing of lots

Land is divided into lots on the basis of the nature, purpose and inherent quality of the land used which may be traversed by railway. For farm land, the farm land grading chart prepared by the State Land Administration may used to divide the land directly.

(c) Calculation of the integrated value of the land

Based on the result of lot division, this system can be used for automatic calculation of the integrated value of each lot of land.

6. CONCLUDING REMARKS

In the foregoing paragraphs we have discussed the meaning the generalized value of land in three aspects, the way of classifying land of different purposes, the calculation method for the "point" value of corresponding generalized value and the system design. We reckon that our efforts have brought forth a new approach for the comprehensive assessment of the quality of land for railway use. This may help avoid deviation of the value of land from the actual value of land arising from a variety of factors, and provides for optimization of railway construction plans reasonable value indexes for land occupation. In turn, this also brings about conditions for the optimization of use of land. When this research subject is further enhanced, the results are expected to provide service for paid occupation of land evaluation of land transfer.

REFERENCES

Kan Shuyu, Meng Zhiyong (1992) The Study on Land Use for Railway Engineering and Construction. **China Land Science,** No.1, Jan. 1992, pp32.

Land and Resource Ministry of China (1990), **The Rules of Land Classification in China,** China Agriculture Press.