Study on Influencing Factors of Urban Land Use System Performance in Heilongjiang Province

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Abstract. The paper proposes the concept of land use system that is considered as a whole of interaction among the three main bodies of government, enterprises and residents, land and nature. With the help of structural equation model, based on SPSS and AMOS software, according to the path coefficients of latent variables and observed variables in the model, the paper determines the impact process of 20 influencing factors at Heilongjiang Province at the government, enterprise and resident level on the economic, environmental and social performance of urban land use system. The results show that the main influencing factors are the importance degree that industrial enterprises attach to low carbon technological innovation, the government's supervision and management on the pollution discharge of industrial enterprises, residents' awareness of energy conservation and environmental protection. The system diagram and SEM realize the comprehensive design of the land use system in Heilongjiang, and take the interaction between the internal factors of the system into account.

1. Introduction

Since entering the stage of "13th Five-Year Plan", Urbanization is developing rapidly all over China, so land resources have been developed and utilized extensively and intensively. Heilongjiang province is rich in natural resources including forestry and mineral resources etc., however, the available land area is limited and the economic development is slow. As a strategic city, in order to realize the revitalization of the old industrial base in northeast China, Heilongjiang has been accelerating expansion of urban scale, and significant changes are bound to take place in the layout, functions and benefits of Urban land-use.

Foreign studies on Urban land-use efficiency and performance started earlier, mainly including Ecological location theory, Economic location theory and urban planning theory. Ecological location theory contributes to understanding urban land-use efficiency and urban spatial function distribution, but it cannot reveal the relationship between land-use and human activities. The economic location theory studies the land-use model on the basis of market balance theory. In the perspective of urban planning on optimization of land resource of research, focuses on constructing land-use efficiency evaluation index system, using mathematical methods to establish evaluation method and model, to
study the effect of land use efficiency factors[1], the relationship between land use and economic benefits [2], the optimization of land resource utilization structure [3], the application of GIS in land resource optimal allocation[4], land use policies and measures[5], etc. Research on urban land use in China mainly focuses on urban spatial structure[6], spatial form expansion[7], land use efficiency[8] and land related system reform[9]. In the study of urban land use efficiency, most of the literature is to study from the perspective of institutional economics and urban planning, and the commonly used research methods mainly include Lorenz Curve[10], Entropy method[11], Data Envelopment Analysis[12], Sampling Statistics and Empirical Analysis[13].With structural equation model, based on SPSS and AMOS software, this paper determined the degree of each influence factor for the urban land use system performance in Heilongjiang to give the reference in the analysis of influencing factors of land use efficiency.

2. Concept presentation

2.1. Urban land use system
At present, there is no clear definition of urban land use system in the world. Based on the systematic idea, this paper defines the urban land use system as a whole with three subjects, government, enterprises and residents. Land is the core of it, nature is the independent external environment.

2.2. Urban land use system performance
Government has the responsibility to plan and manage the land, to regulate enterprises, to serve residents, and to protect environment. So the stand or fall of the whole urban land use system performance can be seen as part of the government responsibility or government performance, and can not be seen as part of the urban land use system performance. This paper defines urban land use system performance as the comprehensive effect of urban land use impacting and effecting on the internal and external environment of the system, as the product of the integration of economic performance oriented to enterprises, social performance oriented to residents and environmental performance oriented to nature in the process of urban land use.(refer with: Fig. 1).

![Figure 1](image_url)

*Figure 1. One of the government performance: Urban land use system performance.*

3. Research Methods

3.1. Introduction of Structural Equation Model (SEM)
Compared with traditional statistical methods, the advantages of SEM lie in its ability to simultaneously deal with the intricate structural relations among variables, to deal with the interrelations between multiple causes and multiple results, to allow errors between latent variables and observed variables, and to solve the statistical situation of variables that cannot be directly observed. It is difficult to directly observe urban land use performance, and performance can be
indirectly analyzed by using SEM as a latent variable. SEM can process the error of influencing factors of urban land use system so that the reliability of the research results can be improved.

3.2. Primary Selection of Latent and Observed Variables

According to the three social subjects and three performance dimensions involved in the research system, six latent variables are set in the model. In order to make the influencing factors more comprehensive and more intuitive to reflect the actual problems, this paper introduced more subjective variables indicators into the selection of exogenous latent variable (variables that can act on other variables) (Look at the table 1).

As shown in table 1, social performance, environmental performance and economic performance are taken as endogenous latent variables reflecting the performance of urban land use in Heilongjiang. 14 main performance indicators are selected as the observed variables of the three latent variables. As shown in table 2, residents, government and enterprises are taken as exogenous latent variables of urban land performance in Heilongjiang province. From these three levels, 21 representative influencing factors were found as the observational variable of exogenous latent variables.

**Table 1.** Exogenous Latent Variables and Observed Variables of Urban Land Use System Performance.

| Government | A1: fiscal and tax policies of the government on investment attraction of industrial land |
|------------|--------------------------------------------------------------------------------------|
|            | A2: incentives for industrial enterprises to reduce emissions                         |
|            | A3: supervision and management of pollution emissions from industrial enterprises      |
|            | A4: whether land development planning is reasonable and long-term                     |
|            | A5: proportion of industrial land and residential land development                     |
|            | A6: investment in public facilities                                                   |
|            | A7: whether the total development area of residential real estate meets the needs of residents |
|            | A8: scale and intensity of commercial land development                                 |
| Residents  | B1: if residents concern and actively participate in the environmental evaluation in decision-making for new industrial projects |
|            | B2: residents have the awareness of energy conservation and environmental protection   |
|            | B3: current situation of per capita housing area relative to other provinces           |
|            | B4: current situation of residents' consumption ability                                |
|            | B5: cultural quality of residents                                                     |
|            | B6: residents' employability and working ability                                       |
| Enterprise | C1: awareness level of environmental responsibility of industrial enterprises          |
|            | C2: current situation of pollution emission from industrial enterprises                |
|            | C3: degree of technological innovation of industrial enterprises                      |
|            | C4: advanced management concept of the enterprise                                     |
|            | C5: proportion of heavy industry polluting and energy-consuming enterprises             |
|            | C6: whether there are many well-known domestic large enterprises                       |
### Table 2. Endogenous Latent Variables and Observed Variables of Urban Land Use System Performance.

| Performance | Observed Variables |
|-------------|--------------------|
| Social      | D_1: development status of science and technology education resources |
|             | D_2: current state of job market in the scope of industrial and commercial land |
|             | D_4: number of hospital beds |
|             | D_5: development level of entertainment and cultural activities |
|             | E_1: water quality of urban domestic water |
|             | E_2: air index of the city |
|             | E_3: the level of urban greening and the development of nature reserves |
|             | E_4: the overall natural environment of the city |
| Environmen- | F_1: gross national product |
| tal         | F_2: economic benefits of commercial land |
|             | F_3: government revenue brought by industrial land use |
|             | F_4: industrial land use brings GDP |
|             | F_5: level of GDP per capita that commercial land use brings |
|             | F_6: economic benefits brought by industrial land use |

### 3.3. Data Collection

The application of the structural equation requires a large number of sample data. Considering that only the sample size of indicator data for 10~15 years can only be obtained in the urban statistical yearbook, the sample size of SEM model cannot be satisfied. In order to make the analysis results of influencing factors more intuitive to reflect practical problems, more subjective or managerial variable indicators are introduced, and it is difficult to obtain the objective data of such indicators directly, so this research adopts the questionnaire data collected in 2019.

This questionnaire survey is conducted mainly by online survey (with the help of the questionnaire star platform) and supplemented by expert survey. Specific questions were designed according to 25 observation variables of 6 latent variables, and the questionnaire was divided into five categories: strongly agree, relatively agree, generally agree, relatively disagree, and disagree. The survey subjects are divided into three categories: (1) college teachers of land-related majors in Heilongjiang province; (2) technical and managerial personnel of industrial enterprises; (3) staff of provincial and municipal government departments of land, environmental protection and planning. A total of 156 valid questionnaires were collected in this questionnaire survey, which could meet the standard of sample number used by AMOS.

### 3.4. SEM Model's Establishment

#### 3.4.1. SEM model diagram

The application of structural equation needs a large number of sample data, which can be used to test the fitting degree of SEM model, and to evaluate and modify the model appropriately. Through studying observed variables, the relationship between latent variables and observed variables are finally obtained (refer with: Fig. 2).
3.4.2. Valid Reliability Analysis. The reliability analysis coefficients of the six latent variables in this questionnaire are all greater than 0.8, and the data in the total scale are also greater than 0.8, indicating that the data are reliable. KOM value was equal to 0.836 and Sig value was equal to 0.000, indicating that validity was available.

3.4.3. Model modification. After running the constructed structural equation model of factors influencing the performance of urban land use system in Heilongjiang province, it was found that the path coefficient was greater than 1 in the running results, indicating that the fitting degree of the model was not high, so it is necessary to modify the existing model. From AMOS, select "view -- Analysis Properties -- Out put" and check "Modification indices" to modify the model. MI value between e32 and e5 is the maximum, so residual e32 and residual e5 are connected with double arrows to improve the fitting degree of the model (refer with: Fig.2). Through screening of the path coefficient in the model, impacts of various factors on the performance of urban land use system in Heilongjiang was analyzed.
3.5. Analysis Result

Table 3. Path coefficient of SEM latent variable.

| Latent variables | Path coefficient | Latent variables | Path coefficient |
|------------------|------------------|------------------|------------------|
| Government level - social benefits | 0.32 | Residents level - economic benefits | 0.30 |
| Government level - environmental benefits | 0.28 | Enterprise level - social benefits | 0.65 |
| Government level - economic benefits | 0.46 | Enterprise level - environmental benefits | 0.93 |
| Residents level - social benefits | 0.03 | Enterprise level - economic benefits | 0.74 |
| Residents level - environmental benefits | 0.25 |  |  |

Table 4. Path coefficient of influencing factors in government and enterprises level.

| Influence Factors | Path coefficient | Ranking |
|-------------------|------------------|---------|
| A1: fiscal and tax policies of the government on investment attraction of industrial land | 0.59 | 7 |
| A2: government incentives for industrial enterprises to reduce emissions | 0.60 | 6 |
| A3: government's supervision and management of pollution emissions from industrial enterprises | 0.86 | 1 |
| A4: rationality and long-term nature of government land development planning | 0.80 | 3 |
| A5: proportion of urban industrial land and residential land development | 0.83 | 2 |
| A6: investment in public facilities | 0.62 | 5 |
| A7: total residential real estate development area | 0.66 | 4 |
| A8: scale and intensity of commercial land development | 0.44 | 8 |
| B1: residents' attention and participation in decision-making of new industrial projects | 0.83 | 3 |
| B2: residents' awareness of energy conservation and environmental protection | 0.89 | 1 |
| B3: housing area per capita | 0.88 | 2 |
| B4: residents' consumption ability | 0.68 | 4 |
| B5: cultural quality of residents | 0.67 | 5 |
| B6: residents' employability and working ability | 0.49 | 6 |
| C1: environmental responsibility consciousness of industrial enterprises | 0.67 | 4 |
| C2: emission standards for industrial enterprises | 0.65 | 5 |
| C3: emphasis of industrial enterprises on low carbon technological innovation | 0.76 | 1 |
| C4: enterprise management concepts | 0.75 | 2 |
| C5: proportion of heavy industry polluting and energy-consuming enterprises | 0.69 | 3 |
| C6: number of well-known large enterprises | 0.60 | 6 |

4. Conclusion and suggestions

4.1. The conclusion
(1) The influences of enterprise level on the economic, social and environmental performance of urban land use system in Heilongjiang are all absolutely significant, especially on environmental performance. The results show that industrial enterprises in Heilongjiang have a direct and decisive role. The optimization of the internal structure of industrial land and the improvement of enterprise quality should be paid most attention. (2) There are obvious differences among the influencing factors
at the government level. The top three influencing factors shows that the government plays an indirect and guiding role in the three major achievements of urban land in Heilongjiang, and its most important responsibility should be to supervise enterprises and make good land use planning. (3) Resident level has little impact on the social performance of urban land use system in Heilongjiang, that is because residents are only the audience of social performance, and play a auxiliary role in economic development and environmental protection. The result of the top three influencing factors shows that the most important concerns at the level of residents in Heilongjiang are residents' awareness of environmental protection and participation, as well as housing issues related to people's livelihood.

4.2. Suggestions
(1) Aiming at the influencing factors at the enterprise level, the study of low-carbon technology can be organized by establishing a technology exchange platform for enterprises inside and outside Heilongjiang province, encouraging the r&d and promotion of low-carbon technology, so as to promote the rapid improvement of low-carbon technology innovation ability of industrial enterprises in Heilongjiang province; By organizing the study of advanced enterprise management concepts outside Heilongjiang province, we will intensify efforts to introduce excellent enterprise management talents, improve and implement the incentive and performance evaluation system of management talents, so as to accelerate the transformation of enterprise management thinking and mode in Heilongjiang province. Through rational planning and strict implementation of industrial land grade to control heavy industry pollution and high energy consumption of the proportion of enterprises.

(2) In view of the influencing factors at the government level, it is necessary to formulate specific local pollution emission standards and regulatory mechanism in Heilongjiang Province, check the situation of sewage discharge from time to time, increase the punishment of illegal sewage discharge, and implement the responsibility system of sewage discharge supervision, so as to effectively improve the intensity of sewage discharge supervision. It is supposed to rationally plan the land use structures of various cities, to coordinate the proportion of industrial land, commercial land and residential land; strengthen the review of long-term and overall urban land planning; organize coordination among relevant planning departments, and establish an overall planning system.

(3) In view of the influencing factors of residents, it is proposed to formulate and implement the progressive Bill standard for water bill and increase the media-oriented role in order to raise residents' awareness of environmental protection; stabilize housing price through finance and tax law, clarify and promote housing preferential and welfare policies matching with talent introduction, and improve per capita housing area; ensure public participation in the approval process of new industrial projects, be truly open and transparent, and strengthen the regulation and punishment of formalization of environmental impact assessment and falsification of environmental impact assessment, and build efficient public communication channels to improve public supervision over industrial enterprises.

Acknowledgements
This research was financially supported by Heilongjiang Provinicial Philosophy and Social Science Fund Project (Approval No.15JYE10), Ministry of Education Humanities and Social Sciences Fund (Grant No. G2016002), Daqing Humanities and Social Science Fund (Grant No. DSGB2018066).

References
[1] Handavu Ferdinand, Chirwa Paxie w. C, Syampungani Stephen, Socio - economic Factors Influencing Land use and Land cover - Changes in the Miombo Woodlands of the chinese-owned Province in Zambia, The Forest Policy and Economics, 2018 (10) 75-94.
[2] Myung-jin Jun, The Economic Costs and Transport Benefits of Seoul's Industrial Land Use Controls, Urban Studies, 2012 (8) 1791-1810.
[3] Butrym, The structure of The land resources in Kyiv region and The optimization of ways for their using, Balanced Nature Using.2013 (3) 83-89.
[4] C.G.Ma and M.Zhou, A gis-based Interval Fuzzy Linear Programming for Optimal Land
Resource Allocation at A City Scale, Social Indicators Research, 2018 (1) 143-166.

[5] Deslatte, A., Tavares, A., Feiock, R.C: Policy of Delay: Evidence from A Bayesian Analysis of Metropolitan Land use Choices (Article). Policy Studies Journal, 2018 (3) 674-699.

[6] L.Tian, J.L.Chen, J.L.Gao, Coupling analysis of compact urban spatial structure and land use efficiency – study of taking Nanjing as an example, Resources and Environment in the Yangtze River Basin, 2017 (1) 26-34.

[7] T.D.Liu, Y.B. Li, X.Z.Yu, Analysis of research progress on urban space expansion and urban land use expansion, Jiangxi Building Materials, 2015 (20) 28-29.

[8] B.X.Hu and J.Li, B.Kuang, Evolution characteristics and influencing factors of urban land use efficiency difference under the concept of green development, Economic Geography, 2018 (12), pp. 183-189.

[9] X.F.He, Land use problems in three pilot land system reforms, Journal of Central South University (social science edition), 2018 (3) 1-9.

[10] B.Kuang, X.H.Lu, B.X.Hu, Kuznets curve effect of economic development and urban land use efficiency— based on panel data of 12 prefecture-level cities in hubei province, Regional Research and Development, 2018 (6) 139-144.

[11] N.Li, D.T.Xue, S.Wang, Evaluation of structural efficiency of land use in chongqing based on regional differentiation— comprehensive application of information entropy and Malmquist index, Journal of Southwest University (natural science edition), 2018 (6) 115-123.

[12] Y.Feng and C.Wang, Improvement of land use efficiency based on DEA method, Journal of Southwest Normal University (natural science edition), 2019 (5) 74-78.

[13] C.L.Zhong and X.P.Hu, Rural land development rights, spatial spillovers and urban land use efficiency— an empirical study based on spatial error model, China Economic Issues, 2016 (6) 24-36.