

# The Research of Urban Development System Model Based on System Dynamics

CHEN Xue<sup>1, a</sup>

<sup>1</sup> School of Management, Wuhan University of Technology, Wuhan 430070, China

<sup>a</sup> ChenXue1031@yeah.net

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**Abstract.** Urban development is the basic condition of human social development, is also an important symbol of human civilization progress. A city of the healthy, harmonious and rapid development not only conducive to the residents to live and work in peace and contentment, but also help to promote the overall social and economic sustainable development. In this paper, the research method of combining the theory research and model, from the point of view of system dynamics analysis of the characteristics of urban development, this paper introduces the knowledge of relevant theory of system dynamics and the basic modeling method, put forward to population, resources and environment of the city's comprehensive development model, the city's planning and construction and management, having great significance.

## Introduction

City is the human society, economic and cultural development to a certain period of the product, is the habitat reproduction, production life of the community. City's geographic location, natural products, traffic conditions, social and cultural factors will have the effect of acceleration or restriction on its development. In the study of urban development model, if the conventional mathematical methods, such as linear programming, not the full performance dynamics, nonlinear and complexity of the system [1]. While the system dynamics method is based on feedback control theory, system structural model is established through the causal relationship, with the aid of computer digital simulation, from two aspects of qualitative and quantitative comprehensive research system as a whole movement mechanism, through the analysis of contact information and feedback mechanisms, comprehensive coordination of various factors, promote the economic sustainable development of the city, thus to provide theoretical guidance for urban development strategy. So this article choose system dynamics method to study urban development issues.

## The analysis of urban development in view of system dynamic analysis

From the dynamic point of view, the city is by the natural environment and human social interaction, the interaction of complex systems. This including resources, environment and population and other subsystems of complex system is set, the entirety, relevance, functional, level, etc., and also has the characteristics of the system dynamics [2].

**Dynamics and openness.** In the development process of city on the one hand constantly exchange material, energy and information with the outside world, on the other hand it's internal between each subsystem, or subsystems of internal elements also are constantly changing, constantly in motion. For such a dynamic and open complex giant system, not to deal with a simple system method to study the dynamic behavior, and can only be on the basis of macroscopic observation, overall grasp, obtained solution to the development and changes of things during a certain period, and dynamic development of city determines there is no once and for all [3].

**Nonlinear and complexity.** The city presents obvious nonlinear characteristics, its internal there exists a complicated nonlinear relationship between each subsystem, and it is difficult to use traditional system analysis method of calculating the optimal solution. Many feedback loops in the city, and there are positive feedback loop, there is also a negative feedback loop. Exponential to

leave some positive feedback can make the system stable equilibrium point, the starting performance characteristics and growth behavior; Negative feedback can make the system to the target. Urban development under the interaction of positive and negative feedback, showing obvious uncertainty. Urban development also involves multiple levels of system elements and influence factors, these factors restraining each other, promote each other, social phenomena, a detail processing is not good, will affect the system's overall benefit, under the action of these factors, the complexity of the development of the city to show the obvious.

**More time and more targeted.** The city is an open system, constantly exchange material, energy and information with the outside world, the system structure is orderly, performance as an inherent in time. Urban development involves several subsystems, in its pursuit of the overall consideration of development process, the pursuit of resources benefit, economic benefit, environmental benefit and social benefit.

### The basic principle of system dynamics analysis

System dynamics is a kind of based on feedback control theory, by combining qualitative analysis and quantitative research to study the social economy management system analysis method. Causality system dynamics is the study of the system and the system structure, to use it, can be based on the system behavior and internal mechanism on the basis of mutual close dependencies between, through the establishment of the mathematical model and operation, get the understanding of the research question, meanwhile can gradually develop to produce some form of causality.

System dynamics model can reflect the complex system structure function and the interaction relationship between the dynamic behaviors, is suitable for processing accuracy is not high complex social economy and ecological environment problems [4]. Using system dynamics model to evaluate the processes are shown in figure 1 below.

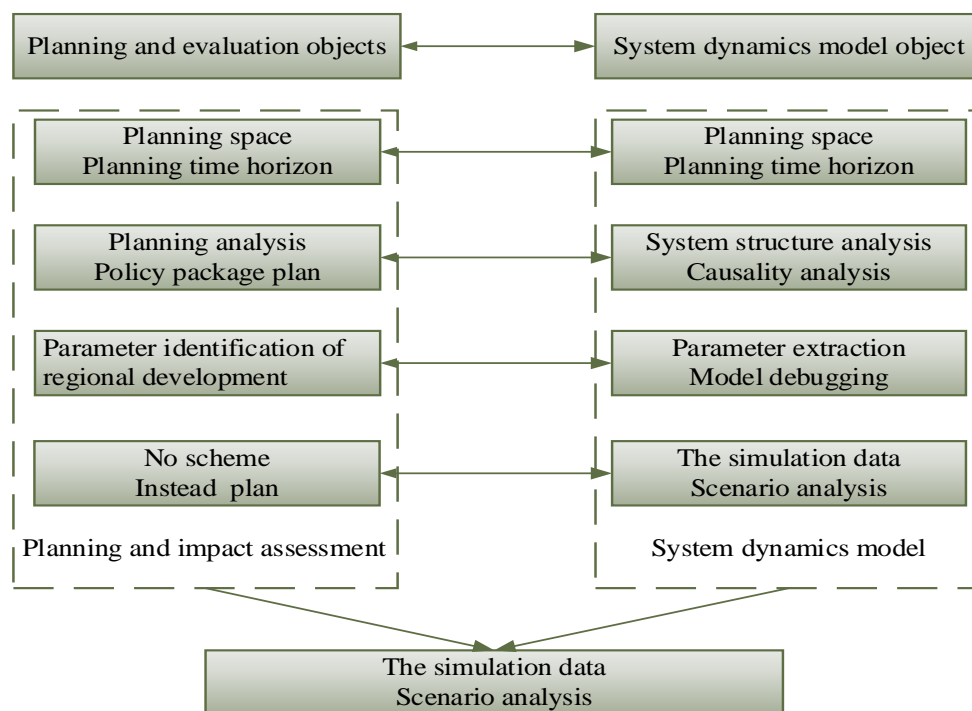


Figure 1. The evaluation process based on system dynamics

### The system dynamics analysis of urban development

From the perspective of system dynamics, a model is a set of specific questions in order to research, set up by the modeling is in order to solve the problem, rather than for system modeling. That is to say, the purpose of modeling is to study the issue of system and system of internal feedback structure and the relationship between the dynamic behavior of analysis in order to improve the

structure of the system behavior and policy research. Urban development and system dynamic model mainly has the following objectives [5]:

(1) Studies sustainable development of resources city economy, discusses how to achieve long-term planning of resources city should have the internal and external conditions and what kind of policy should be taken.

(2) Master correlation between each subsystem and changes in resources city, analysis of key factors for the sustainable development of resources city economy, suggest some potential problems should be noticed.

(3)The forecast resources, environment, economy, society and the development trend of the future, aiming at the problems may be, put forward a variety of solutions, and simulated, judge and select the optimal development plan.

According to the analysis above, the city by population subsystem, resources subsystem, environment subsystem and such urban development and system dynamic model including three subsystem of population, resources and environment. Interaction and mutual restriction between the three systems, determines the behavior characteristics of the overall urban development. The system structure is shown in figure 2.

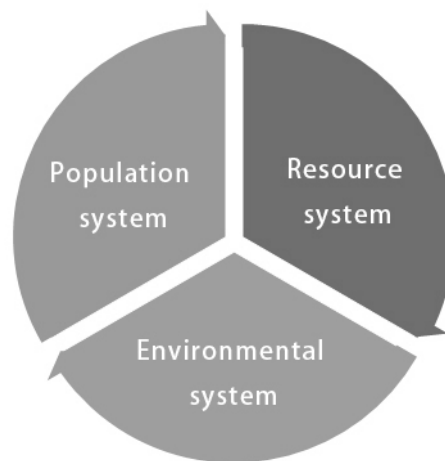


Figure 2. Urban system structure

In urban development and system dynamics model, each model are interrelated, mutual restriction, interacting. Each child model run, depending on the sub models of the internal structure, and depends on its links with the outside. For child model, external connection is mainly refers to the output of the other sub models will be as an external variable input to the model, its own internal variable and output to other models.

### **Urban comprehensive development model with the population, resources and environment based on system dynamics**

Confirm the cause and effect feedback relation model loop is an important step of the model, it is determined through continuous debugging later. In this paper, based on the following resources city economy sustainable development of the system dynamics model is established. Introduced the instrumental variables GDP. GDP as indicators of center of national economic accounting system, is the comprehensive reflection of social production, in the macroeconomic analysis has an important position and role. But it doesn't take into account resource depletion and environmental degradation caused by the economic loss. Net GDP model introduced in the auxiliary variables, therefore, it is deducted from GDP resource depletion and environmental degradation value after the economic loss. In the comparison of simulation program, the size of the net GDP to the simulation schemes can be evaluated. This paper determined the population, resources and environment system for urban comprehensive development dynamics model feedback diagram is shown in figure 3.

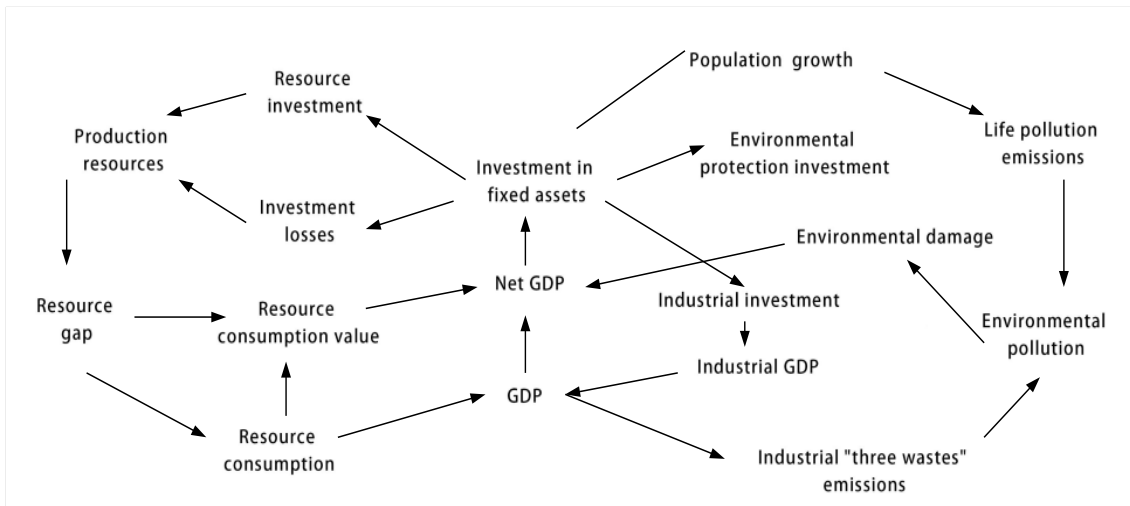


Figure 3. Feedback diagram of urban comprehensive development dynamics model

**The population model analysis.** In the development of resource-based cities, the human to meet the increasing material requirements, through the analysis of production and consumption activities, to participate in the process of material circulation and energy flow of nature, to the natural environment for resources, the consumption of resources.

**Resource model analysis.** Resources subsystem is the basis of resource-based cities is the material energy. Resource is the important foundation of human survival and development, is the necessary condition of social production and the reasonable development and utilization of resources is the premise of sustainable development, the unreasonable resources use will cause the shortage of resources and environmental pollution, thus affect human health and economic development and social progress.

**Model analysis of the environment.** Environment subsystem is a place for human survival and development, the environment quality directly affects the quality of human existence and use of resources; at the same time, the environment is the material conditions of economic development, it can directly promote the development of economy, also can hinder the development of the economy.

## Conclusion

This paper constructed the city development system based on system dynamics theory, and the system theory is introduced to the development of the city concept defining, analyzing the connotation of urban development, put forward the main content of the urban development. City is a population subsystem, resources subsystem, environment subsystem and human society as the foothold, on a particular area in the city by interdependence, interaction and mutual restriction of composite entity. Through the analysis of urban structure and its elements, it puts forward the urban development theoretical analysis framework, build the concept of system dynamics model of urban development, for the direction of the research work providing theoretical basis and support.

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