Dissertation Abstract

学 位 論 文 概 要

THE PLANNING STRATEGIES FOR ACHIEVING SUSTAINABLE URBAN FORM BASED ON SPACE PRODUCTION THEORY

空間生産理論に基づく持続可能な都市形態を実現するための計画戦略に関する研究

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Abstract

This Ph.D. dissertation aims to propose planning strategies for sustainable urban form based on the analysis of the space production process. This research can contribute to sustainable urban form from sustainable strategies in the elements of urban space production. According to the research aims, the following several objectives to be achieved: 1) Analyze the production process of modern urban form based on the space production theory, and examine the elements of urban form production and the operating logic. 2) Propose sustainable planning strategies for the material element in space production to promote the sustainable use of space resources through water resources management in Japan. 3) Propose sustainable planning strategies for the production elements in space production to promote the sustainable output of space products through the port area construction in Japan.4) Propose sustainable planning strategies for the consumption elements in space production to encourage the sustainable organization of urban residents through a planning support system based on the GA algorithm.

The main body of this Ph.D. dissertation is divided into four chapters. The first component analyzes the elements in the space production process, which clarify the three critical elements of material, production, and consumption. Next, the second component takes water management in Japan as an example to discuss the implementation of water-sensitive urban design for materials of space production. Then the third component examines the regional industrial chain of international trade ports in Japan and discusses the product organization in space production. Finally, the fourth component proposes an urban planning support system based on the genetic algorithm in response to the urban decentralization trend in the consumption of space production.

A sustainable urban form is essential for contemporary urban development, which requires an in-depth understanding of urban space production and targeted planning strategies. The primary purpose of this Ph.D. dissertation is to propose planning strategies for sustainable urban form based on the analysis of the space production process. This dissertation confirmed each element's corresponding relationship in the production process in space by analyzing space production in Japan and clarify the corresponding elements of raw materials, production process, and consumption process. On this basis, this dissertation proposes sustainable planning strategies from the perspective of these three elements.

Keywords. Urban spaces, Sustainable Urban form, space production, Spatial planning

1. Introduction

Urban life has become the symbol and cornerstone of our modern civilization. However, the urban space and urban form are determined by the capital logic, bringing problems like pollution, inequality, and unsustainability. Therefore, proposing the planning strategies to achieve sustainable urban form is an important research topic, closely related to its production process under the space production theory. Analyzing space production and exploring the corresponding planning strategies is fundamental to the sustainable urban form, and Japan can provide valuable experience and reference.

This Ph.D. dissertation aims to propose planning strategies for sustainable urban form based on the analysis of the space production process. This research can contribute to sustainable urban form from sustainable strategies in the elements of urban space production. According to the research aims, the following several objectives to be achieved: 1) Analyze the production process of modern urban form based on the space production theory, and examine the elements of urban form production and the operating logic. 2) Propose sustainable planning strategies for the material element in space production to promote the sustainable use of space resources through water resources management in Japan. 3) Propose sustainable planning strategies for the production elements in space production to promote the sustainable output of space products through the port area construction in Japan.4) Propose sustainable planning strategies for the consumption elements in space production to encourage the sustainable organization of urban residents through a planning support system based on the GA algorithm.

DISSERTATION	PURPOSE	METHOD	CONTRIBUTION
Chapter 2 The Innovative Framework of Sustainable Urban Form supported by the Space Production Theory	Propose new framework of **sustainable urban form** based on the space production theory.	☐ Theoretic analysis	Establish a new framework for achieving sustainable urban form.
Chapter 3 The Measures of Water-Sensitive Urban Design in the Context of Japan's Sustainable Ecological Environment Construction	Discuss sustainable urban forms from **environmental construction** of **natural space.**	☐ Case study	Summarize the planning strategies for sustainable urban form regarding to water-sensitive urban design.
Chapter 4 The Impact of the Development of International Trade Port in Japan on the Formation and Evolution of Regional Industrial Chain Response to the Requirement of Sustainable Industrial Development	Study the **economic development** in **urban space** by discuss the evolution of industrial development in port cities.	☐ Case studies of fifteen port cities	Summarize the planning strategies for sustainable city form regarding to industrial chain development in port cities.
Chapter 5 The Construction of Urban Planning Supporting System using Genetic Algorithm Responding to Urban Decentralization from the Perspective of Population Change	Study the population change in **social space** under development programs responding to urban decentralization.	☐ Genetic algorithm ☐ Land attractiveness model	Develop planning support system & Explore population changes under development programs for sustainable urban form.

Figure 1 The framework of this Ph.D. dissertation

The main body of this Ph.D. dissertation is divided into four chapters (Figure 1). The first component analyzes the elements in the space production process, which clarify the three critical elements of material, production, and consumption. Next, the second component takes water management in Japan as an example to discuss the implementation of water-sensitive urban design for materials of space production. Then

the third component examines the regional industrial chain of international trade ports in Japan and discusses the product organization in space production. Finally, the fourth component proposes an urban planning support system based on the genetic algorithm in response to the urban decentralization trend in the consumption of space production.

2. Space Production in the Practice of Japan – Motivation, Policies, Strategy, Mode and Enlightenment

Chapter 2 is delivered to deeply analyze how space is produced in the urbanization in Japan and indentify the key elements in the space production process. Based on the theoretical system of space production, this chapter systematically analyzed how capital enters and shapes urban space and puts forward the "capital circuit" consistent with the historical trajectory of Japanese urban development. Under the macro picture, this chapter indicates that several essential elements such as raw materials, production, distribution, exchange, consumption, and production relations can find appropriate correspondence in the production of space.

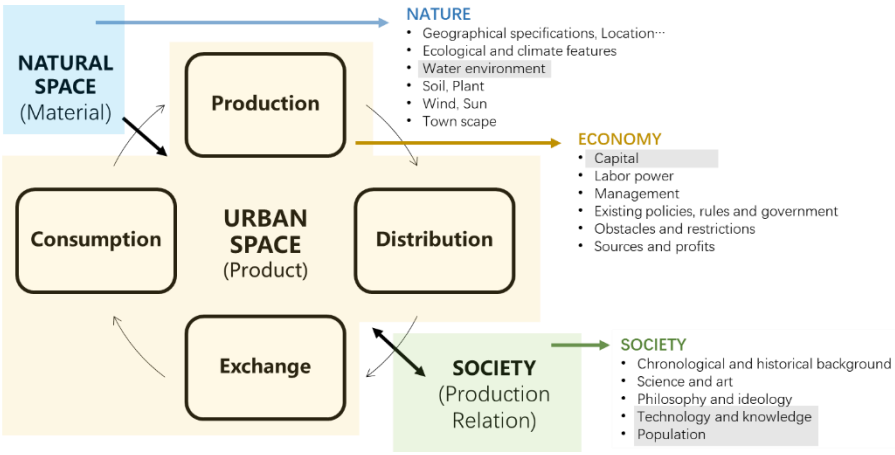

Figure 2 The essential elements of space production and their relationship with sustainable urban form

Based on this analytical framework, a sustainable urban form needs to respond from all elements of space production, including adjusting urban density and population in exchange and distribution and optimizing energy use in production. Therefore, the planning strategy for sustainable urban form can be analyzed from all levels of spatial production.

3. The Measures of Water-Sensitive Urban Design in the Context of Japan's Sustainable Ecological Environment Construction

Chapter 3 examines sustainable planning strategies for raw materials in space production. Concerning the use of natural resources, the theory of space production emphasizes the laws of natural resources themselves and believes that humans are natural perceptual existences, but only in social practice can natural space become the basis for human development. Among the various natural resources, water resources

are the most compelling case for reflecting the combination of natural laws and labor practices in human utilization of natural resources.

This chapter introduces relevant Japanese practices in the three main aspects of water source protection, flood control, and waterfront landscape. In general, Japan adheres to the WSUD principles and combines natural conditions, engineering technologies, and cultural traditions into the practices, forming WSUD with distinctive Japanese characteristics. Specifically, Japan emphasized forest conservation in terms of water source protection and adjusts the water environment at the urban scale through water supply facilities and water demand; adopted comprehensive flood control measures and created a series of valuable engineering measures; achieved a more natural landscape by creating nature-oriented rivers with regional material and various sections and guided the design of waterfront space through regulations.

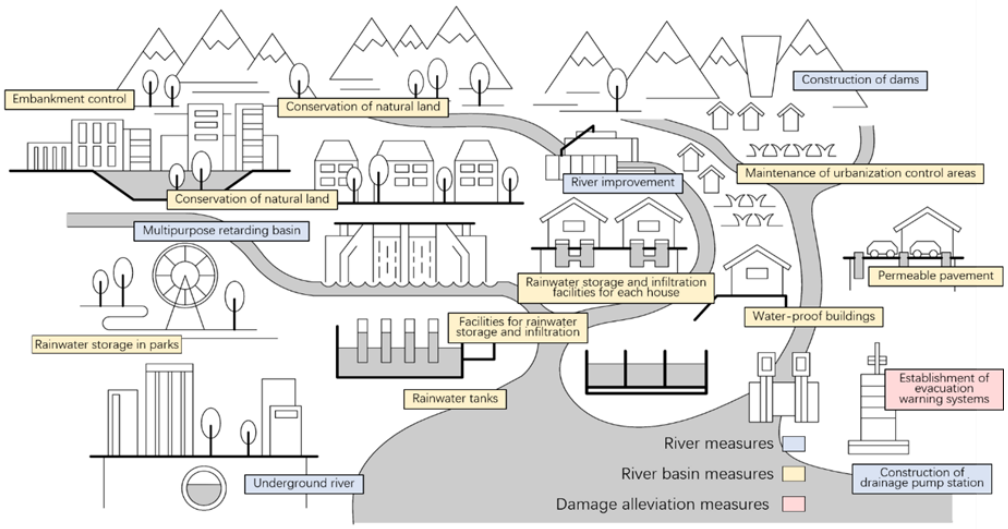

Figure 3 Comprehensive Flood Control Measures in River Basin as Planning Strategy

4. The Impact of the Development of International Trade Port in Japan on the Formation and Evolution of Regional Industrial Chain response to the Requirement of Sustainable Industrial Development

Chapter 4 is designed for exploration in sustainable planning strategies for the production process in space production. Japan has long-term development history and a profound development foundation in port trade and has also formed a characteristic model of the combination of ports and inland industrial chains. This combination of ports and inland industrial chains is based on the operational logic of capital circulation, but the unsustainability of capital logic also poses new challenges to the sustainability of urban space.

To answer the rise of Asian competitors pre and post the commencement of BRI, Japan has been exploring new port strategies on both trade policies and port city construction. These explorations lead to complete industrial chains and regional economy connections, a reference for BRI about developing economically vibrant ports. This chapter takes the construction of Japanese ports and port cities to clarify the

development path and organization model of Japanese trade ports and provide a reference for future maritime trade cooperation between China and Japan based on the Belt and Road Initiative.

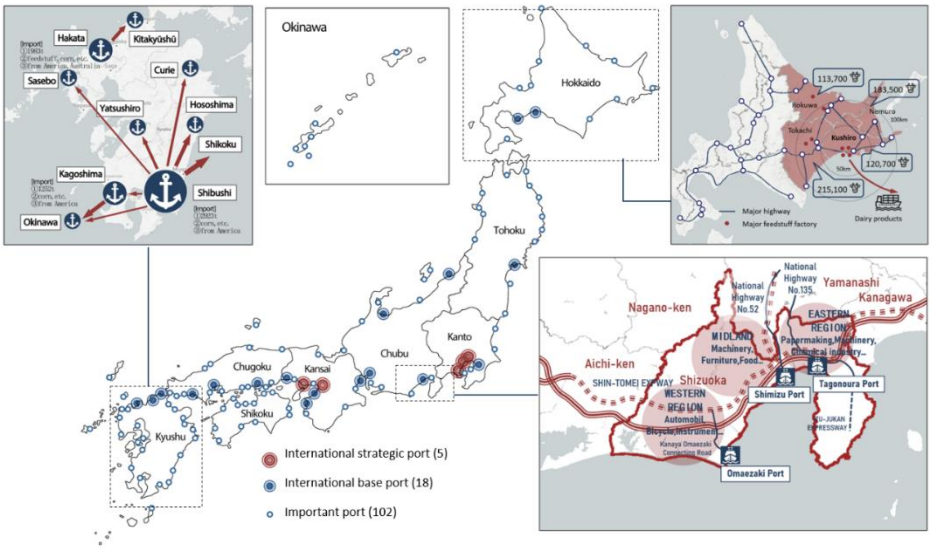

Figure 4 The industrial chain structure of Japan's Ports

Lots of sustainable planning strategies can be learned from the development of the port cities in Japan. The construction of the port area should be based on developing the regional economy, integrating the existing development foundation, establishing a complete industrial chain, forming a unified operation as a whole, and improving production efficiency. Another important lesson is to focus on the formation of scale economies effect and industrial clusters, strengthen regional cooperation, strengthen regional advantages, establish a refined division of labor based on the industrial chain, organize production resources with innovative models, and form regional production complexes to improve regional competitiveness as a whole.

5. The Construction of Urban Planning Supporting System using Genetic Algorithm responding to Urban Decentralization from the Perspective of Population Change

Chapter 5 supports the effort in population change by viewing urban decentralization as a space consumption problem. Relying on the theory of space production, compact cities, and other sustainable urban theories emphasizes the flexibility of space to resist the rigidity of space brought by technological rationality. Regional development plans usually have different aggregation modes and different development structures for different functional areas. This difference was evaluated as a different development model, further response to the space consumption problem.

This chapter studied urban development planning on population changes in central urban areas from a macro perspective. Kanazawa was used as a case study area, and different development models determined the corresponding development plan. Set up three development modes of "concentrated central urban area development mode,"

"decentralized central urban area development mode," and "maintenance-oriented central urban area development mode." Each development program is defined as a chromosome in the GA system. The optimal development program is generated through the selection, crossover, and mutation process of the algorithm. The corresponding population change and land use structure are obtained through the spatial interaction model based on the obtained development program. Under the guidance of three different development modes, calculation and analysis are performed using genetic algorithms. The population recovery, the degree of the land-use mix, and the degree of land-use specialization in the central urban area are three indicators. On this basis, a land-use planning support system has been developed.

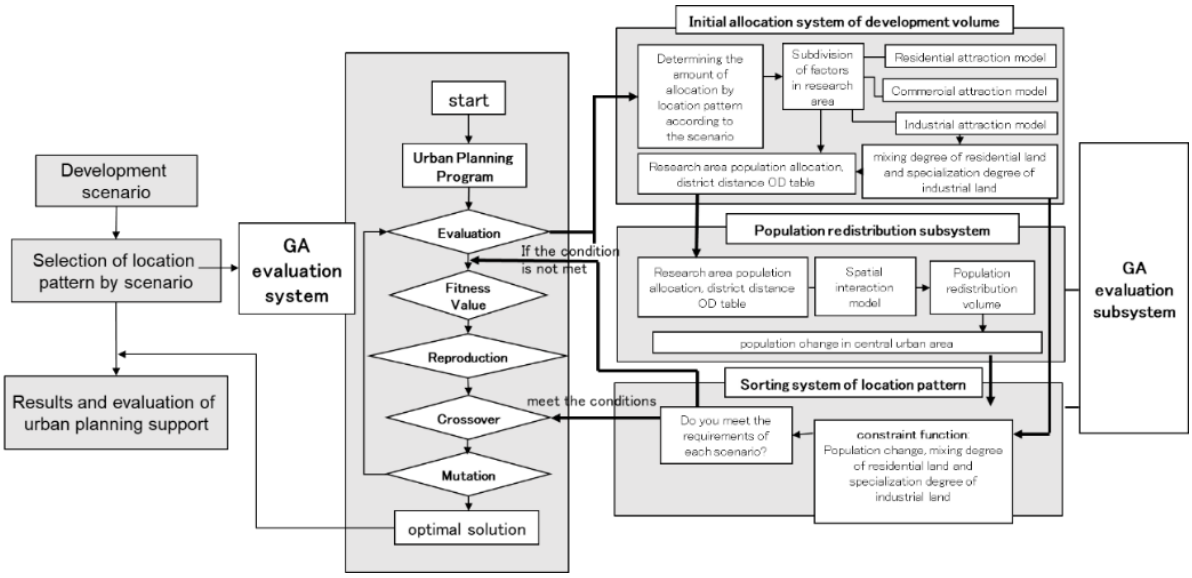

Figure 5 Framework of the land-use and population planning support system

The results reveal the migration of Kanazawa City under three different development modes. In the concentrated development mode, revitalizing the commercial functions of the central city through large-scale commercial development can help restore the population and increase the complexity of land use, which is consistent with the idea of the compact city. Conversely, if unitary urban centers by residential development, the process of urban decentralization will be accelerated. It can be seen that moderate and functional mixed urban land use are the critical factors for establishing a compact city and counter urban decentralization.

6. Conclusion

A sustainable urban form is essential for contemporary urban development, which requires an in-depth understanding of urban space production and targeted planning strategies. The primary purpose of this Ph.D. dissertation is to propose planning strategies for sustainable urban form based on the analysis of the space production process. This dissertation confirmed each element's corresponding relationship in the production process in space by analyzing space production in Japan and clarify the corresponding elements of raw materials, production process, and consumption process.

On this basis, this dissertation proposes sustainable planning strategies from the perspective of these three elements.

For future work, there are still many specific strategies necessary to sustainable urban form, from other natural resources such as air and soil to the social elements such as symbols, ideology, and historical background. In addition, there are still many aspects worth exploring regarding space production, such as how the produced space enters the daily life and concepts of urban residents, which represents the "thrilling leap" of the exchange process of commodities. Achieving sustainable development still requires more contributions from urban planning researchers.

令和３年８月３日

学位論文審査報告書（甲）

１．学位論文題目（外国語の場合は和訳を付けること。）

The Planning Strategies for Achieving Sustainable Urban Form based on Space Production Theory

（和訳）：空間生産理論に基づく持続可能な都市形態を実現するための計画戦略に関する研究

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３．審査結果の要旨（600～650字）

張氏の学位論文は持続可能な都市形態の実現のため、理論的に計画フレームワークの検討を行った研究であり、空間生産理論の生産活動と空間創成からみて、持続可能な開発のための環境、経済、社会的公平のコンセプトに対応した自然空間、経済活動空間と社会空間において、生態環境保全、地域と都市的開発の計画的施策が持続可能な都市形態の形成へもたらす影響を考察した。

既存研究では、持続可能な都市形態に関して、交通と土地利用との関連からコンパクトシティ、自然エコ環境の視点からエコシティなどの研究がみられる。本研究では、持続可能な開発の３つのＥコンセプトと地域・都市の空間創成の３つの空間概念との関連から持続可能な都市形態の計画的対策の考察を行い、新規性がある。具体的には、日本を対象として取り上げ、地域レベルおよび都市レベルから検証した。まず、自然空間に関して、水の生態空間を考察し、地域レベルでは流域の水源地保全、都市レベルでは都市地域の水害などの計画的課題を検証した。そして、経済活動空間に関して、地域レベルでは港湾物流と都市生産機能の立地の計画的課題を検証した。なお、社会空間に関して、都市レベルでは社会的効用の最適化を目標とした経済需要ニーズに基づく土地利用配分の計画的課題などを考察した。上記に述べたように持続可能な都市形態を実現する計画的フレームワークの検討を試みた。

張氏は、在学中において参考論文として、いずれも英文で査読論文２編（うちSCI1編）、国際会議１編を公表した。なお、副論文２編がある。本審査委員会は、張氏が学位論文審査基準を満たし、必要な研究成果を挙げており、博士（学術）に値すると判定した。

４．審査結果　(1) 判　　定（いずれかに○印）（合　格）・　不合格

(2) 授与学位　博　士（学術）