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This study seeks to explore a high-quality development model of symbiotic governance that balances and mutually enhances green ecology, societal humanities, and economic industries, framed within the historical dynamics and modern urban planning principles. With an emphasis on the municipalities along the Chinese Eastern Railway, which have traditionally relied on heavy industries, this paper addresses how these areas are now experiencing a slowdown or even stagnation in development pace due to ongoing urban contraction. This trend is further exacerbated by geographical marginalization and a sharp population decline, making the need for sustainable urban development strategies increasingly critical. Leveraging advanced unmanned aerial vehicle (UAV) remote sensing technology and comprehensive multi-source, multi-dimensional spatial big data, the research precisely measures the contraction status of these municipalities. It also conducts an in-depth analysis of the changing patterns in urban contraction spaces and the key influencing factors behind them. By employing scientific methodologies such as the rational allocation of production factors and adjustments to urban spatial layouts, the paper proposes targeted and intelligent strategies for urban spatial development control. This endeavor aims to provide robust theoretical and practical support for the revitalization of the Northeast region and the high-quality development of similar municipalities nationwide, and it has become a topic of considerable scholarly interest in the field of urban and rural planning theories and methodologies amid the intensification of Chinese reforms and rapid market economic development.

Keywords: High-quality Development Model, Symbiotic Governance, The Chinese Eastern Railway Railway, Urban contraction, Revitalization of the Northeast Region.

Introduction

The Northeast region of China, historically a pivotal base of heavy industry, has played a crucial role in the nation's economic advancement. However, the deepening economic reforms and the maturation of the market economy have seen the decline of heavy industry, leading to a deceleration in the region's economic progress and causing it to lag behind the more dynamic eastern coastal areas. This shift reflects significant transformation in the internal and external conditions for regional development. Amid China's modern urbanization drive in the new century, there has been a noticeable population migration towards larger central cities, while smaller cities and towns, especially those on the geographical periphery with a homogenous industrial makeup, are experiencing contraction. The Northeast faces severe urban challenges including population loss, economic downturn, and resource depletion—a focal point of societal concern and a key issue addressed in the nation's "14th Five-Year Plan" (Oswalt et al., 2006).

Despite its importance, research on urban shrinkage in the Northeast has been limited and fragmented, often focusing narrowly on individual cities or provincial issues without a comprehensive exploration of regional characteristics, their distinctive features, or driving factors. Through the lens of symbiosis, this study aims to quantify and analyze the extent of shrinkage across the region, investigating the patterns and determinants of urban spatial contraction and informing strategic policies. Moreover, the historical trajectory of urban development in this region, influenced by industrialization, political upheavals, and economic reforms, has imbued the current urban landscape with a complex legacy. This paper connects these historical developments with modern urban planning challenges, advocating for adaptive, symbiotic governance strategies to address the intertwined issues of economic dynamics and urban spatial contraction.

Historical background of Urban Spaces along the Chinese Eastern Railway

The Chinese Eastern Railway served as a catalyst for industrial and urban development along its route, fundamentally transforming the Northeast region of China. This railway not only facilitated economic expansion but also ignited a profound reshaping of the urban landscape. Large-scale factories and worker accommodations emerged, setting a new urban aesthetic that prioritized industrial functionality over traditional urban planning considerations like communal spaces and environmental considerations. This era of development introduced by the railway was further influenced by foreign dominations, particularly during the periods of Japanese and Russian control, each leaving its unique mark on the urban fabric (Smith & John, 2012).

The Russian influence during their period of administration brought Eastern European architectural styles and an extensive expansion of the railway itself, integrating local towns into broader industrial and commercial networks. This integration fueled a distinct pattern of urban growth, intertwining local Chinese characteristics with Russian industrial strategies. The subsequent Japanese occupation focused on extractive industries, which tailored the infrastructure toward supporting resource extraction and processing(Lee et al., 2015). The legacy of these occupations profoundly affected the structural and economic landscapes of towns along the railway line, embedding complex layers of foreign architectural and industrial practices into their development.

Transitioning into the late 20th century, the economic reforms initiated in 1978 under Deng Xiaoping's leadership marked another pivotal change. These reforms introduced a new paradigm of decentralization and market liberalization across China, propelling towns along the Chinese Eastern Railway to gradually dismantle their monopolistic industrial structures in favor of a more diversified economic model. This shift presented both significant challenges and opportunities for urban redevelopment, encouraging planners to rethink and transform urban spaces from state-dominated to market-oriented entities(Chen et al., 2016).

Today, the historical imprints of Russian and Japanese periods are pivotal in shaping contemporary urban planning along the Chinese Eastern Railway. The modern transformation initiatives focus on converting old, historical industrial infrastructures into vibrant cultural centers, technology hubs, and green spaces, making these towns emblematic of resilience and adaptability. This repurposing strategy acknowledges and utilizes the historical layers of industrialization and foreign influence as foundational elements for driving modern urban regeneration. By embracing a strategy that integrates respect for its complex historical tapestry with contemporary innovative urban planning approaches, towns along the Chinese Eastern Railway are not only preserving their unique historical character but are also spearheading sustainable development and urban revitalization that reflect a harmonious blend of past and present influences. This approach exemplifies a sophisticated understanding of how historical factors can inform and enrich present-day urban development strategies, ensuring that these towns remain relevant and dynamic players in the broader regional and

national context (Kimura & Yoko, 2017).

Symbiosis Theory in Urban Development

The concept of symbiosis was initially introduced by German biologist Heinrich Anton de Bary, who posited that different species of organisms must coexist for survival, depending on and supporting each other, ultimately forming a relationship of mutual existence and co-evolution (Liu, 2018). Since then, the theory of symbiosis has extended into various disciplines, and over the past few decades, its application in urban development has also evolved.

Urban spatial development is a complex system encompassing ecological and green development, social and cultural structures, and economic and industrial growth. Therefore, the symbiotic concept here includes three aspects: ecological and green development, social and cultural structures, and economic and industrial development. The focus of ecological and green development symbiosis lies in balancing human activities with the ecological environment of urban spaces in the Northeast, guiding how to protect the natural environment to promote sustainable ecological development. Social and cultural structures emphasize addressing issues such as population and cultural loss through technological means, injecting new vitality into the development of shrinking urban spaces in the Northeast (Long, 2016). Economic and industrial development involves leading with science and technology in agriculture, introducing new high-tech industries, upgrading traditional industries, achieving agricultural intelligence, and restoring local economic sustainability.

In this research topic, the symbiotic concept is applied to expound the symbiotic relationships between these elements, starting with the symbiosis between ecological green development and the economy, which refers to President Xi's recent proposition that "lucid waters and lush mountains are invaluable assets." Restoring the ecological environment and developing green industries are means to promote the economic development of urban spaces in the Northeast. The symbiosis between economic and industrial development and social structures refers to the fact that humans are the primary productive force. However, the Northeast region faces severe population loss, and by vigorously developing smart technology to compensate for the labor shortage caused by population loss, we can alleviate the developmental constraints brought about by urban shrinkage. Finally, the symbiosis between social and cultural structures and ecological green development refers to the use of technological means, such as drones for pesticide spraying and big data for air quality monitoring, to scientifically intervene in local ecosystems, thereby enhancing ecological and green development and creating a healthy and green living environment while maintaining a balanced and stable natural environment.

Review of Domestic and International Research

1.International Research

There has been limited research on the characteristics of urban shrinkage globally, with most studies describing shrinking cities in terms of temporal trends and spatial distribution. Urban shrinkage began earlier abroad than in China. In the 1960s, urban shrinkage was mainly seen in a few old industrial cities in developed industrialized countries represented by the United Kingdom and Germany (Oswalt P, 2005). By the end of the 20th century, with the dramatic changes in Eastern Europe, former socialist countries in Eastern Europe became major hotspots for shrinking cities, with more than 70% of large cities in Eastern Europe experiencing significant population decreases (Mykhnenko et al., 2008). By 2007, over one-sixth of the world's cities had experienced population loss (UN, 2010). From 1960 to 2003, over half of the 220 medium and large cities in Europe showed noticeable population declines (Wiechmann T et al., 2015), and from 1960 to 2010, cities like Cleveland, Buffalo, and Pittsburgh in the United States saw a population shrinkage rate of over 50% (Hollander et al., 2011) (Howe et al., 1998) (Wiechmann et al., 2012). Studies have found that internationally, shrinkage mainly occurs in regional centers and cities, such as the Greater Detroit area in the United States and the Greater London

area in the UK, due to reasons like deindustrialization and suburbanization, leading to significant population shifts from central urban areas to the periphery and resulting in the hollowing out of city centers (Liu & Yang, 2017) (Zhao, 2006).

2.Research in China

Looking at China's population trends, the national population growth rate has decreased from 2.2% in 1962 to 1.12% in 2010 (Liu, 2019), indicating a slowdown in population growth; between 2006 and 2011, the population growth rate of small cities with urban populations below 200,000 was -17.34% (Wei, 2014). Additionally, some scholars have focused on regional analysis. Since the year 2000, urban population changes in Guangdong Province have generally shown growth with localized shrinkage, with some cities exhibiting clear population shrinkage for over 15 years (Du et al., 2019). Examination of population data from the three northeastern provinces between 2010 and 2014 reveals that the ongoing population shrinkage in the Northeast region is continuing and is unlikely to stop in the short term (Liu et al., 2018). Other scholars have used data from the 2000 and 2010 population censuses and the 2008 and 2014 statistical yearbooks, with indicators such as permanent population, registered population, and year-end total population, to examine urban shrinkage in the Northeast region, showing that nearly one-third of prefecture-level cities in the Northeast experienced urban shrinkage between 2000 and 2010, and nearly eight-ninths experienced shrinkage between 2008 and 2014 (Fan Jiahui, 2018). In the study of the Jing-Jin-Ji region, it was found that the number of shrinking districts and counties increased from 73 in 2000 to 107 in 2010, with a noticeable rise in the shrinkage ratio (Wu et al., 2015). Exploring the spatial distribution of shrinking cities, urban shrinkage in China exhibits clear spatial characteristics, occurring mostly in the Northeast region and the Yangtze River basin (Liu & Zhou, 2019) (Zhang et al., 2018), especially in the Northeast, where there is a significant loss of population, rising unemployment, and severe urban shrinkage issues (Sun et al., 2019). Gansu, Chongqing, Hubei, as well as the northern parts of Liaoning and Heilongjiang, have shown clear signs of population shrinkage (Zhang et al., 2016). Some scholars have used spatial econometric methods to further explore the spatial distribution of urban shrinkage in China, forming a very distinct spatial pattern of "one core, two belts, and two zones" (Deng& Liu, 2018). The "one core" refers to the significant population shrinkage region centered on eastern Sichuan Province, Chongqing, Hubei Province, and Guizhou Province, with the outer layer mainly characterized by mild population shrinkage; the "two belts" consist of the eastern population shrinkage belt formed by Shandong Province, Jiangsu Province, Anhui Province, Zhejiang Province, and Fujian Province, and the northwest population shrinkage belt formed by Gansu Province and the Ningxia Hui Autonomous Region; the "two zones" are the population shrinkage zone composed of eastern Inner Mongolia Autonomous Region, Liaoning Province, and northern Hebei Province, and the population shrinkage zone composed of northern Inner Mongolia Autonomous Region, Jilin Province, and northern Heilongjiang Province (Deng & Liu, 2018). From the literature review, it is evident that the Northeast region of China is a severely shrinking urban area.

In summary, currently domestic and foreign areas are not addressing the problem of urban shrinkage with a balanced approach, such as only focusing on population or developing green cities. This project, integrating the governance model based on symbiotic concepts, will attempt to establish a set of measurement indicators for "quality" and "quantity" of urban spatial development and a comprehensive evaluation system, aided by big data acquisition and UAV remote sensing technology, image recognition technology, and other means. Through precise and scientific quantitative analysis, the study will paint a portrait of urban development, extract the spatial archetypes of urban growth, and on this basis, formulate intelligent targeted models for high-quality urban development (Tayloret al., 2020).

Significance of the Study

The study offers both theoretical and practical significance. Theoretically, it enriches the understanding of urban

shrinkage and its implications for urban and regional planning. Practically, it provides actionable insights and strategies for policymakers and planners to address the challenges of urban contraction in the Northeast.

1. Theoretical Significance: This research provides a comprehensive analysis of urban shrinkage in Northeast China, examining factors such as population decline, economic downturns, and urban land use intensity within the context of resource-exhausted city development. It delves into the characteristics of urban shrinkage from multiple perspectives—population, economy, and land use. By exploring the distinctive shrinkage traits across various functional types of cities, the study develops a sophisticated measurement indicator system that categorizes and investigates the formation mechanisms of resource-depleted shrinking cities in the region. This approach not only aims to enrich the theoretical understanding of transformation in China's resource-exhausted cities but also integrates the conservation of historical assets along the Chinese Eastern Railway into this framework. This innovative linkage utilizes historical lessons from past transitions influenced by foreign rule and industrial shifts to enhance current urban planning theories. By incorporating the preservation of historical heritage, the study not only addresses the challenges of modern urban shrinkage but also enriches the theoretical base, providing valuable insights and typological research outcomes that holistically consider urban planning within historical contexts (Yang et al., 2015).

2. Practical Significance: this research emphasizes the practical significance of employing a symbiotic governance model to address urban shrinkage across various resource-exhausted city types in Northeast China, ranging from coal to iron ore industries. It carefully assesses population loss, economic decline, and the extension of construction land, highlighting the specific challenges and contradictions in the economic, social, and spatial development of these cities. Integrating the concept of smart shrinkage, adapted from Western models, the study explores the application of this approach within the spatial context of Northeast China's resource-exhausted cities, evaluating its urgency and practicality while proposing tailored development paths and regulatory measures. Furthermore, the research contextualizes smart shrinkage to account for the conservation of historical heritage, drawing lessons from the resilience and adaptability shown by towns along the Chinese Eastern Railway amidst historic transformations. This approach offers a balanced strategy for urban planning that not only seeks sustainable growth and the integration of modern urbanization efforts that coordinate "people and land," but also underscores the importance of preserving and integrating historical landmarks and cultural heritage into the urban fabric. Such detailed analysis provides a pathway for the healthy development of new urbanization in China, furnishing scientific evidence and offering practical guidance grounded in historical continuity and innovation (Zhang & Wei. 2018).

Research Methodology

This study employs a multi-faceted research methodology to analyze urban contraction and develop high-quality development strategies. The methodologies include:

1. Spatial Mathematical Statistical Analysis: Utilizing statistical, imagery, and UAV remote sensing technologies, combined with multi-source data such as POI and GPS, to evaluate and measure urban space quality and quantity. This approach provides a comprehensive assessment of urban contraction and growth patterns.

2. Typological Comparative Research Method: Establishing a theoretical framework for the spatial development of shrinking towns, conducting horizontal and vertical comparisons, and deriving decision trees for quality development paths. This method helps identify best practices and tailor development strategies to specific contexts.

3. Interdisciplinary Theoretical Methods: Integrating urban and rural planning, sociology, economics, geography, and other disciplines to propose an intelligent targeting system for high-quality urban development. This interdisciplinary approach fosters innovation and ensures that development strategies are holistic and effective.

Research Objectives

This paper aims to achieve the following goals from the perspective of integrated urban and regional development, focusing on the interaction and integration of cities and regions:

1. To construct a theoretical framework for the restructuring of regional urban space**:** In light of the current state of regional urban space research in China, the study will scientifically define the concept of regional urban space. On this foundation, it will analyze the restructuring of regional urban space and functional optimization, such as the greening and commercialization of abandoned industrial land, while delving into the driving mechanisms behind the restructuring of regional urban space. The goal is to build a theoretical framework for regional urban space restructuring research based on China's national conditions, contributing exploratory research findings to the perfection of China's regional development theory (Hao, 2006).

2. To propose feasible paths for the restructuring of urban space in the Northeast region: Considering the existing conditions in the Northeast region, such as functional homogeneity of central cities, loose structure of city clusters, weak competitiveness of regional central cities, and slow progress in regional spatial cooperation and integration, the study will follow the mechanisms of regional urban space restructuring. It aims to propose feasible paths and safeguard measures for the restructuring of urban space in the Northeast region, providing strategic support and scientific evidence for optimizing the urban space system in the area.

Research Framework

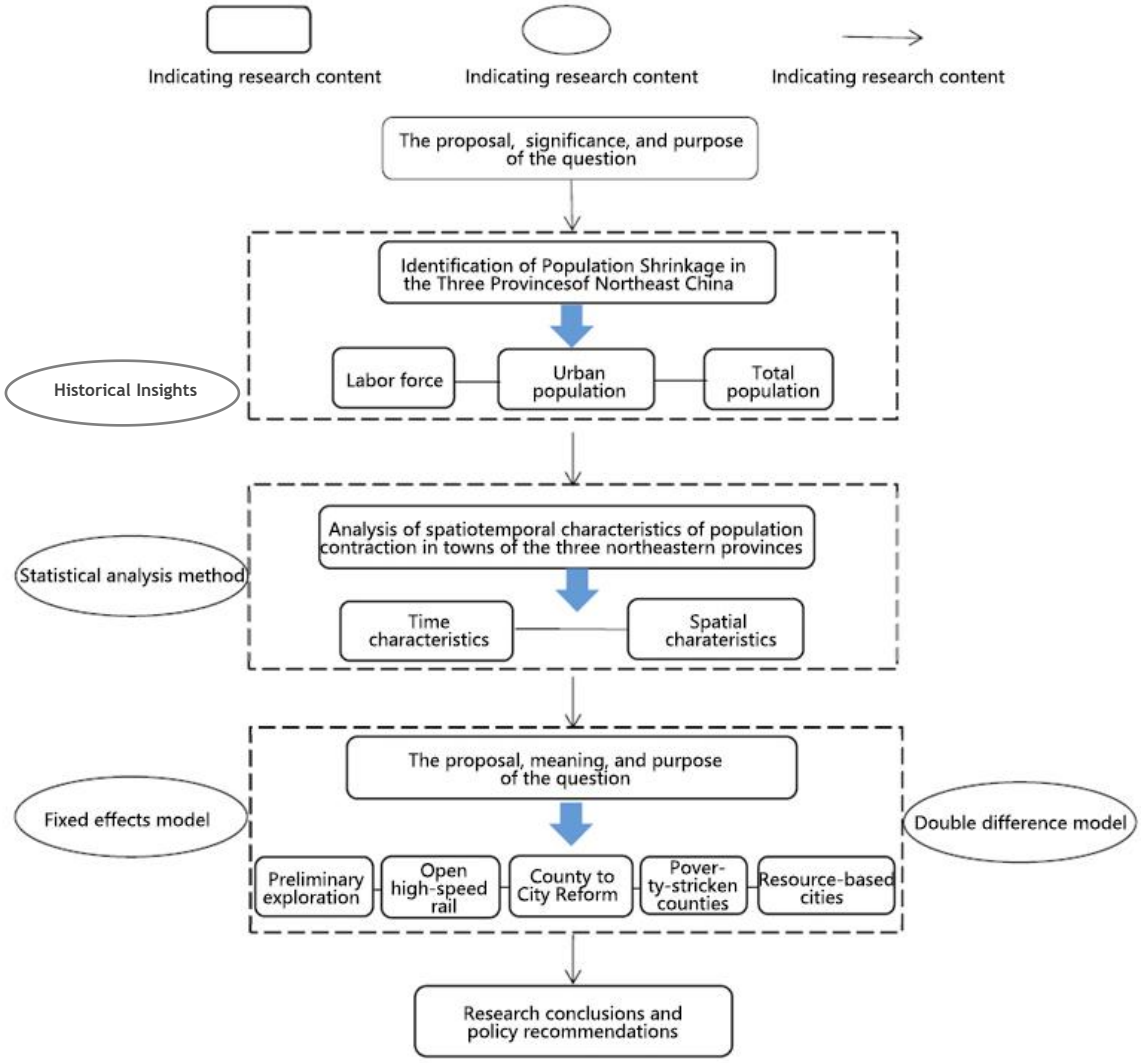

Figure 1 - Research Framework. By combining historical insights with advanced analytical techniques and interdisciplinary approaches, this research framework aims to create sustainable, high-quality urban development strategies that are informed by past experiences and tailored to contemporary challenges.

Results from study

The Results from this study illuminate the complex patterns of urban contraction along the Chinese Eastern Railway, and provide a framework for deploying significant, high-quality urban development strategies, with particular attention given to historical heritage conservation. Organized through three distinct methodological lenses, the findings underscore the urgency of tailored development approaches.

1. Spatial Mathematical Statistical Analysis Results:

a. Urban Space Quality and Quantity: Decline in both quality and quantity of urban spaces is notable in regions historically dependent on dwindling heavy industries, with high-resolution imagery and UAV data highlighting extensive land abandonment and infrastructure erosion.

b. Contraction Hotspots: Spatial analysis identifies critical zones of intense population decline and economic stagnation, primarily located in areas with limited accessibility and advanced environmental deterioration.

c. Potential Growth Areas:** These are pinpointed as regions near transport hubs or emerging industry sectors, marked by superior infrastructure and enhanced quality of urban spaces.

2. Typological Comparative Research Method Results:

a. Typologies of Shrinking Towns:This categorization based on industrial foundation, geographic setting, and demographic trends aims to inform targeted development strategies.

b. Horizontal Comparations: Across different municipalities, commonalities include industrial fallouts and infrastructure issues, though particular contraction influencers vary, necessitating bespoke strategies.

c. Development Decision Trees: These trees provide strategic pathways catering to each town typology, highlighting avenues for economic diversification, infrastructural refurbishment, and enhanced community participation.

3. Interdisciplinary Theoretical Methods Results:

a. Holistic Development Strategies: Leveraging insights from multiple disciplines, these strategies address the complex nature of urban contraction through sustainable growth, social inclusion, and economic reinforcement.

b. Intelligent Targeting System: A data-driven system to optimize intervention prioritization and resource distribution, aiming to rejuvenate areas with high redevelopment potential.

c. Policy Recommendations: The interdisciplinary perspective informs policy suggestions such as encouraging new industrial sectors, improving public services, and fostering environmental restoration.

4. Strategies for Historical Heritage Conservation:

a. Assessment and Documentation: Systematic recording of historical sites to gauge their condition and significance.

b. Integration into Urban Planning: Harmonizing new development initiatives with the conservation of historical sites, ensuring these landmarks are preserved and incorporated into the city's evolving landscape.

c. Community Engagement and Education: Encouraging local communities to engage with and take pride in their heritage, fostering a collective responsibility towards its conservation.

d. Financial and Policy Support: Implementing financial incentives for conservation projects and establishing protective legislation to safeguard historical sites against potential encroachments by modern development pressures.

These results and strategies collectively frame a comprehensive blueprint for addressing the multifaceted challenges faced by towns along the Chinese Eastern Railway, enhancing their capacity for sustainable and culturally respectful development.

Discussion

Historical Context and Contemporary Linkages

The development of the Middle East Railway and its surrounding urban areas dates back to the early 20th century, driven by both strategic and economic imperatives. This railway facilitated the movement of resources, people, and goods, bolstering the industrial capacities of the Northeast. Cities along the railway thrived as industrial hubs, attracting workers and fostering urban growth. However, this growth was heavily dependent on industries that have since declined due to various factors, including resource depletion, technological changes, and shifts in global economic patterns.

The historical reliance on heavy industries has left a legacy of environmental degradation and socio-economic challenges. The contraction of these urban spaces is not merely a contemporary issue but a continuation of historical trends exacerbated by modern economic dynamics. For instance, the shift from a planned economy to a market-oriented economy has exposed the inefficiencies and unsustainability of the region's industrial base. Moreover, the migration of populations to more prosperous regions underscores the need for a reevaluation of the Northeast's urban development strategies.

Lessons from History for Contemporary Planning

Analyzing the historical evolution of the Northeast's urban spaces can provide valuable lessons for contemporary planners. One significant lesson is the importance of economic diversification. The historical dependence on a narrow industrial base has proven to be a vulnerability. Contemporary strategies should focus on diversifying the economy, promoting high-tech industries, and leveraging the region's cultural and natural assets to attract tourism and service-oriented businesses.

Another lesson is the need for sustainable development practices. The environmental degradation resulting from historical industrial activities calls for a concerted effort to restore ecological balance. This includes implementing green technologies, promoting renewable energy, and integrating ecological considerations into urban planning processes. Sustainable development not only addresses environmental concerns but also enhances the quality of life for residents, making the region more attractive for potential returnees and new settlers.

A Symbiotic Governance Model

The proposed symbiotic governance model emphasizes the integration of ecological, social, and economic dimensions in urban development. Key strategies include:

1. Ecological Restoration: Implementing projects to restore and protect natural environments, enhancing green spaces, and promoting sustainable land use.

2. Societal Engagement: Strengthening community networks, cultural heritage preservation, and improving public services to foster social cohesion and resilience.

3. Economic Innovation: Supporting innovative economic activities, such as technology-driven industries and creative sectors, to stimulate economic growth and job creation.

Conclusions

This paper emphasizes the critical importance of understanding the historical context of urban development in Northeast China to inform contemporary planning strategies. By adopting a symbiotic approach that balances ecological, social and culture, and economic dimensions, the region can address the challenges of urban contraction and achieve sustainable development.

The historical analysis reveals that the region's dependence on heavy industry has led to economic vulnerabilities and environmental degradation. Contemporary planners must learn from these lessons by promoting economic diversification, sustainable development practices, and the integration of advanced technologies. These strategies can revitalize urban spaces, attract new residents and businesses, and ensure long-term prosperity.

The study's findings highlight the necessity of a multi-faceted approach, utilizing spatial mathematical statistical analysis, typological comparative research, and interdisciplinary theoretical methods. This comprehensive methodology provides a robust framework for understanding urban shrinkage and developing targeted, high-quality development strategies.

Ultimately, this research offers valuable insights for policymakers and urban planners, not only in Northeast China but also in other regions facing similar challenges. By drawing on historical lessons and employing innovative, symbiotic governance models, these regions can overcome the limitations of their industrial past and pave the way for a sustainable and prosperous future.

Notes on contributor(s)

Yipeng Zhang, a graduate of the University of Melbourne, where He earned both my bachelor's and master's degrees in landscape architecture. Currently, he is a first-year PhD student at Harbin Institute of Technology, specializing in urban and rural planning under the mentorship of Professor Zhao Zhiqing. My research focuses on Tourism Planning and Rural Revitalization in Tieling City, as well as Controlled Detailed Planning in Dalian City.

Zhao Zhiqing, male, professor, doctoral supervisor, currently serves as the assistant dean of the School of Architecture at Harbin Institute of Technology, the dean of the Institute of Urban Planning and Design at Harbin Institute of Technology, and the head of the postdoctoral research workstation. He also serves as the director of the China Russia Chinese Eastern Railway Cultural Heritage Protection Innovation Research Center, with profound academic influence in the fields of urban planning and architectural protection.

Bingrui Yang is a landscape architect with degrees from the University of Melbourne. She has practical experience from interning at Tongji University Architectural Design and Research Institute Co., Ltd. Her design philosophy revolves around innovation and sustainability, aiming to create landscapes that harmonize with the environment.

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