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A Quantitative Text Analysis of China's Central and Local Governments' Construction Waste Management Policies

- Focusing on the Case of Hefei City, China -

중국의 중앙 및 지방정부의 건설폐기물 관리 정책에 대한 정량적 텍스트 분석

- 중국 합비시의 사례를 중심으로 -

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Abstract

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This paper uses NVivo 12 Plus software to conduct a quantitative analysis of policy tools, policy objectives, and policy implementation steps from 1996 to 2024, focusing on 33 policy documents related to construction waste at the Chinese central government level. The analysis found that there was (1) an unbalanced allocation of policy objectives, (2) an irrational mix of policy tools, (3) a lack of market participation, and (4) a lack of public engagement and awareness of environmental issues. To improve this, it was suggested that policies should (1) optimize policy objectives, reduce resources, and improve indicators for resource recycling and harmless treatment, (2) promote a circular economy, and (2) optimize policy tools and strengthen market and public participation. In addition, from 2009 to 2023, 17 policy documents related to construction waste issued by Hefei City, a local government in China, were analyzed, and specific challenges and differences faced by local governments in the process of implementing central government policies were analyzed, and improvement plans were suggested. As a result of the analysis, it is suggested that it is necessary to provide new perspectives and innovative approaches to policy formulation and implementation so that sustainable construction waste management policies based on the circular economy can be promoted.

Keywords: Construction waste, policy instruments, policy objectives, circular economy, local government

I. Introduction

Since the Reform and Opening-up, China's urbanization rate surged from 20.6% in 1982 to 63.9% in 2020, projected to reach 76.19% by 2035. This rapid urbanization, alongside economic growth, increased urban living space per capita and led to massive construction waste generation, surpassing 2 billion tons annually. This waste, primarily landfilled or openly dumped, poses severe environmental challenges and hinders sustainable development. Effective construction waste management is crucial for reducing environmental impacts and promoting a circular economy.

Since 1996, China has issued policies like the "Regulations on the Management of Urban Construction Waste," but a mature system remains elusive due to late starts, complexity, and social resistance. Issues like weak policy enforcement, outdated technology, and low public participation persist. The central government sets macro-level policies, while local governments handle implementation.

This study examines Hefei City's construction waste policies as a case study. As Anhui Province's capital, Hefei faces significant waste management challenges due to rapid real estate development. Analyzing Hefei's policies uncovers specific challenges and strategies, offering insights for other cities and improving national construction waste management.

This study uses NVivo 12 Plus to encode and quantitatively analyze Chinese construction waste policies through content analysis, exploring their development patterns. It focuses on a cross-comparative analysis of policy instruments (voluntary, hybrid, mandatory), policy objectives (reduction, resource utilization, harmless treatment), and policy phases (initial, rapid development, mature). The aim is to reveal the characteristics and patterns of these policies, providing a scientific basis for optimization and implementation.

Analyzing policies at both central and local levels, the study investigates how Hefei City employs various policy instruments and objectives. It assesses Hefei's current status and issues in construction waste management and compares central and local policy differences, exploring the reasons behind these differences. The goal is to offer reasonable suggestions for local governments, promoting the development of construction waste management and providing guidance for other cities nationwide.

Ⅱ. Theoretical Background and Previous Research

1. Theoretical Background

1) Policy Instruments Theory

Policy instruments are methods used by government departments to achieve objectives. Kirschen et al. (1964) first categorized policy instruments into 64 groups, initiating scholarly exploration in this area. Peters and Van Nispen (1998) noted that policy instruments, related to public interest, include measures to promote social development and bridge policy objectives and implementation environments (Table 1).

〈Table 1〉 Classification of Policy Instruments Proposed by Various Scholars

Scholar	Classification Basis	Types of Tools
Hood (1983)	Political resources available to the government	Informational tools, Authoritative tools, Financial tools, Organizational tools
Rothwell and Zegveld (1985)	Expected goals of policy instruments	Supply-side tools, Environmental tools, Demand-side tools
McDonnell and Elmore (1987)	Function and purpose of policies	Coercive tools, Incentive-based tools, Capacity-building tools, Organizational tools
Howlett and Ramesh (1995)	Level of state intervention	Voluntary instruments, Hybrid instruments, Mandatory instruments
Beryl (1996)	Characteristics of intergovernmental relations and interactions	Structural tools, Project-based tools, Activity-based tools, Capacity-building tools

Howlett and Ramesh (1995) categorize policy tools into three types based on the level of government involvement in the provision of public goods and services: voluntary tools, Hybrid tools, and Mandatory tools. For the reasonable selection of policy tools, they integrate economic and political theories and suggest that the choice should be based on two factors: state capacity and the complexity of the policy subsystem. This study examines construction waste management policy instruments, with their specific classification and forms shown in (Table 2).

〈Table 2〉 Classification and common forms of construction waste policy instruments

Policy Instruments Type	Policy Tool	Common Forms
Mandatory	Regulation	Laws, regulations, supervision, assessment standards, norms and standards related to construction waste disposal, etc.
	Direct Provision	Government purchase of recycled materials from construction waste, government-led construction of recycling bases, construction waste treatment plants, etc.
	Public Enterprises	Using the leading role of public enterprises to manage and dispose of construction waste
Hybrid	Subsidies	Tax reductions, financial support, fiscal transfers to reduce the cost of construction waste disposal for related enterprises
	Information and Persuasion	Government-issued construction waste management guidelines, media campaigns, public education activities, and professional training to raise public and corporate environmental awareness, advocating green building concepts
	Taxes and Fees	"Polluter pays" principle, charging fees for construction waste disposal, and environmental taxes for those who do not dispose of construction waste
	Property Rights Auctions	Implementation of emission trading, carbon emission trading, etc.
Voluntary	Families and Communities	Community and family involvement in supervising construction waste management, understanding and learning related policies and concepts
	Voluntary Organizations	Utilizing the power of NGOs and volunteers to promote construction waste management, benefiting from construction waste treatment industry associations, public welfare environmental organizations, etc.
	Market Tools	Leveraging the leading role of the market, supporting market entities to carry out construction waste recycling, treatment, and reuse businesses, improving efficiency through market competition, promoting resource recycling

2) Policy Objectives: Circular Economy 3R Principles

The circular economy is a closed-loop model transforming materials from resources to products and back to renewable resources, promoting conservation, low pollution, and environmental friendliness. The "3R Principles"—Reduce, Reuse, and Recycle—introduced by Germany's DuPont in the 1980s, are fundamental. Reduction is the core principle, with reuse and recycling built on effective reduction. Germany's 1990s legislation, including the "Packaging Waste Ordinance" and the "Circular Economy and Waste Management Act,"

prioritized waste avoidance, followed by reuse and disposal.

Originating in the US in the 1960s and adopted by Europe in the 1980s and 1990s, the term "circular economy" reached China in the 1990s. It became a development strategy in 2002. China's "Circular Economy Promotion Law" outlines the objectives as reduction, reuse, and recycling, aiming to improve resource efficiency, protect the environment, and achieve sustainable development. The "Solid Waste Pollution Prevention and Control Law" aligns with these objectives, emphasizing reduction, resource utilization, and harmless treatment to promote cleaner production and circular economy development. Both laws target source control, process treatment, and end-use, shifting enterprises towards sustainable development。

The solid waste management process aligns with the circular economy's 3R principles. Construction waste management policies, as part of solid waste management, follow these objectives. This study adheres to the "Solid Waste Pollution Prevention and Control Law," defining construction waste management objectives as reduction, resource utilization, and harmless treatment, detailed in Table 3 below.

〈Table 3〉 Classification and Common Forms of Construction Waste Policy Objectives

Policy objectives	Main Content	Forms of Expression
Reduce	Reduce the generation of construction waste at the source	Modular construction, green building materials, refined management, scientific construction
Resource Utilization	Promote the recycling and reuse of construction waste	Construction waste classification, on-site reuse, recycled aggregate products
Harmless Disposal	Ensure that the treatment of construction waste does not harm the environment or human health	Classification of hazardous construction waste, environmental monitoring system

3) Policy Phases: Historical Institutionalism Theory

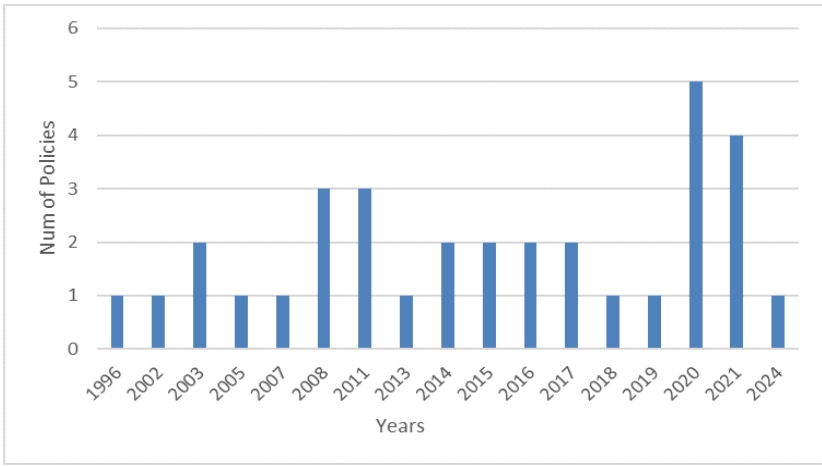
Historical Institutionalism (HI) emerged from new institutionalism political science in the 1960s and 1970s, introduced by Stinchcombe and Skocpol. HI emphasizes how time, sequence, and path dependency influence institutions and shape behaviors and changes, combining historical methods, institutional analysis, actor-centered approaches, and mid-level research to depict institutional continuity and change. HI provides a new theoretical perspective for analyzing and predicting institutional development.

HI's framework includes institutional theory and time theory. Institutional theory examines how social, economic, ideological, and political factors impact institutional change and how institutions affect other factors. Time theory explores the connections of institutional change over time, including path dependency, gradual change, and punctuated equilibrium.

This paper uses HI to analyze China's construction waste management policies, categorizing policy phases. Economic development and urbanization since the reform and opening up have led to massive construction waste, prompting government focus on management. In the 1990s, the circular economy concept and environmental awareness led to the Ministry of Construction issuing the "Regulations on the Management of Urban Construction Waste" in 1996, establishing a basic management framework. However, policy effectiveness and supervision were initially limited.

In 2008, the financial crisis and the Sichuan Wenchuan earthquake generated significant construction waste, leading the government to strengthen policies, increase support, and improve laws, marking the rapid development phase. Issues of system rigidity and incomplete mechanisms persisted.

In 2018, the Environmental Protection Tax replaced the pollutant discharge fee system, and the "Pilot Work Plan for the Construction of 'Zero-Waste Cities'" was issued, marking the mature development phase. By analyzing the number of policies issued each year (as shown in Figure 1). The policies are divided into three phases: initial exploration (1996-2007), rapid development (2008-2017), and mature development (2018-2024), detailed in Table 4.



〈Figure 1〉 Annual Number of Construction Waste Policies Issued in China (1996-2024)

〈Table 4〉 Policy Phases of China's Construction Waste Policies

Policy Phase	Time Period	Characteristics
Initial Exploration Phase	1996–2007	Few policies issued, mainly focused on establishing a basic management framework and initial regulations.
Rapid Development Phase	2008–2017	Frequent policy issuance; the government began emphasizing construction waste management and issued multiple policies for regulation and control.
Mature Development Phase	2018–2024	Concentrated policy issuance; the policy system became more complete, with a vigorous promotion of "no-waste city" construction, marking the entry into top-level design and systematic construction.

2. Previous Research

Jung Jong-Suk et al. (2007) compared South Korea's construction waste policies with international standards, emphasizing the need for legal, standards, and operational improvements to promote on-site reuse. Adopting international best practices tailored to local contexts was suggested to boost reuse rates and sustainable development.

Calvo N, Varela-Candamio L, and Novo-Corti I (2014) studied Spain's construction waste management using a system dynamics model, highlighting economic incentives and penalty taxes as key to increasing waste reuse rates. Their projections showed that incentives could elevate recycled aggregate utilization to 30% in 12 years, while penalties could achieve this in a decade. They recommended stronger government oversight, university involvement, and market-driven strategies for sustainable waste management.

Umar, U.A., Shafiq, N., Malakahmad, A., et al. (2017) reviewed global construction waste policies and technologies, noting low reuse rates despite efforts. They identified lax regulatory enforcement and technological and financial constraints, especially in developing nations, as barriers. They proposed stricter regulations, increased financial incentives, and advanced technologies like BIM and LCA to enhance resource efficiency and environmental conservation.

Weisheng Lu and Vivian W.Y. Tam (2013) analyzed Hong Kong's construction waste management policies, emphasizing principles like reduce, reuse, recycle, and the polluter pays principle. Despite a robust framework, challenges remain, requiring further initiatives to mitigate environmental impacts.

Li Jingru (2017) compared construction waste management policies in Japan, Germany, and Singapore, recommending China prioritize compulsory measures with market incentives and

public education, tailored to its context.

Cai Binqing et al. (2022) examined 55 Chinese construction waste policies (2003-2021), highlighting a focus on compulsory and reward-driven approaches, with less emphasis on voluntary measures. The study advocates restructuring policy tools and advancing eco-friendly construction and recycling.

In summary, research reveals challenges and areas for improvement in construction waste management policies. While much has been discussed about the state of construction waste and policy aspects, few studies address differences and impacts between central and local governments. This study will explore these differences in policy instruments, objectives, and phases, providing new perspectives and practical references for optimizing construction waste management policies in China.

Ⅲ. Research Methods

NVivo is software for qualitative and mixed-methods research, used to analyze unstructured text, audio, video, and image data, such as policies, interviews, and social media. It uses nodes and coding for data extraction and synthesis, with powerful tools for search, query, and visualization. NVivo is widely used in social sciences like anthropology, psychology, and sociology.

This paper uses NVivo 12 Plus for qualitative content analysis of policy texts, focusing on sentences. Content analysis is chosen because it suits the large volume of policy texts guiding China's construction waste management and ensures objective and accurate research. It allows for summarizing and comparing policy content, ensuring neutrality and reducing subjectivity.

1. Selection of Policy Texts

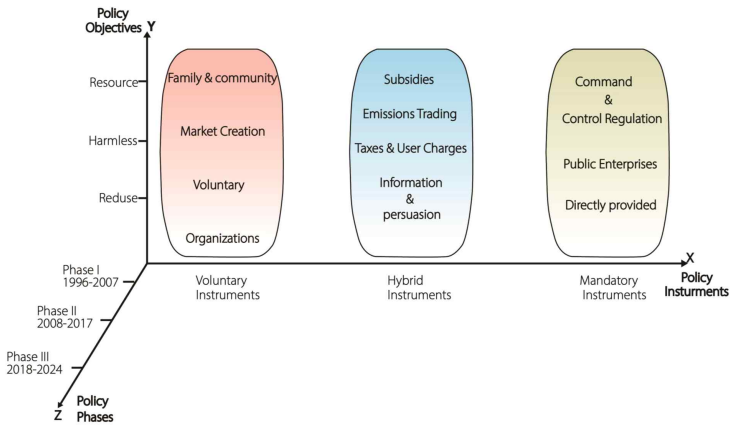
This study selected construction waste policy texts from 1996 to 2024, using data from the "Law and Regulation Database" on the "Peking University Law Information Network" and official government websites.[1] Policies were chosen based on their relevance to construction waste, focusing on national-level documents from the Standing Committee of the National

1) URLs: http://www.pkulaw.cn/ and https://www.gov.cn/zhengce/zhengcewenjianku/

People's Congress, the State Council, and various ministries, and included laws, regulations, rules, normative documents, opinions, and notices. After filtering out duplicates and unrelated policies, 33 samples were imported into NVivo 12 Plus. Additionally, 17 policy documents from Hefei City (2009-2023) were selected from local government websites,[2] ensuring they comprehensively reflected local construction waste management efforts.

2. Coding Theoretical Framework

Based on the analysis framework of existing policy content studies, and considering the structural characteristics of China's construction waste policies as well as the research questions, this study constructs a three-dimensional analytical framework. The framework includes Policy Instruments (X dimension), Policy Objectives (Y dimension), and Policy Phases (Z dimension). (see Figure 2).



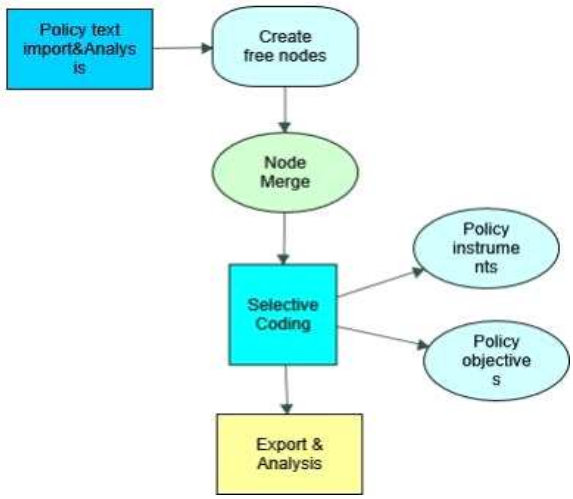
〈Figure 2〉 Three-dimensional analysis framework

3. Coding Process

In this study, NVivo software is used to systematically, quantitatively, and categorically analyze Chinese construction waste policies from 1996 to the present, including laws, regulations, policy documents, and government reports. A coding framework, based on the 3R principles of a circular economy and Howlett and Ramesh's (1995) classification, categorizes policy objectives into reduction, resource utilization, and harmlessness, and policy

2) URLs: https://www.heifei.gov.cn/

instruments into voluntary, hybrid, and compulsory. Sentences or paragraphs are used as units of analysis to create nodes for policy objectives and instruments. The process involves reading texts, coding relevant content into free nodes, and organizing them into tree nodes. NVivo's clustering analysis identifies main patterns and themes, followed by selective coding. The coded data is then exported for quantitative analysis to assess the frequencies and trends of policy objectives and instruments across different phases. This process provides a scientific basis for analyzing the evolution and characteristics of China's construction waste policies. The same coding process is applied to Hefei City's policies. The coding analysis process is shown in Figure 3.



〈Figure 3〉 Coding Process Diagram

4. Reliability Test

To ensure that the classification results of the circular economy policy objectives and the corresponding policy instruments are more scientific, an expert familiar with policy text analysis was invited to participate in the coding process in addition to the author. Each person individually coded the analysis units of three randomly selected sample policy texts. Using the "Query" - "Coding Comparison" feature in NVivo 12 Plus software, we obtained the coding classification consistency of the three construction waste policy samples, all of which were above 85%. Generally, it is considered that if the consistency rate between different coders reaches 80%, the coding results can be accepted. Therefore, the reliability meets the requirements of the study.

Ⅳ. Analysis Results of Central-Level Policy Texts

1. Analysis Based on the Policy Objectives Dimension

Based on the analysis of the frequency and proportion of policy objectives in Table 5 (where the frequency represents the number of times each policy objective appears in policy texts).

〈Table 5〉 Frequency and Proportion of Policy Objectives

Policy Objective	Frequency	Proportion
Reduce	28	29.79%
Resource	45	47.87%
Harmlessness	21	22.34%

It can be seen that the main objective of construction waste policies is resource utilization, accounting for 47.87%, followed by the reduction objective at 29.79%, and the harmless treatment objective at the lowest proportion of 22.34%. This distribution indicates that the government's attention is unevenly allocated when formulating construction waste policies, with the main focus on resource utilization, emphasizing resource reuse and economic benefits. The reduction objective receives insufficient attention, despite the fact that the foundation of a circular economy is to reduce waste generation first and pursue reuse secondarily. Regarding the harmless treatment objective, although it receives less attention, it plays a crucial role in ensuring environmental safety during the construction waste treatment process.

2. Analysis Based on the Policy Instruments Dimension

According to the frequency and proportion of policy instruments in the policy texts as shown in Table 6, the usage distribution of policy instruments from highest to lowest is as follows: mandatory policy instruments (50.87%), hybrid policy instruments (39.02%), and voluntary policy instruments (10.10%).

Overall, when formulating construction waste policies, the central government primarily relies on the more efficient mandatory policy instruments to lead construction waste management through compulsory means. This is supplemented by hybrid policy instruments, using fiscal incentives and promotional guidance to assist government management. However,

the proportion of voluntary policy instruments is too low, indicating insufficient participation from market and social forces. In summary, the mix of policy instruments is unreasonable. Although government-led initiatives are highly efficient and effective in the short term for achieving immediate goals, long-term government dominance inevitably leads to decreased efficiency, increased fiscal pressure, lack of innovation, and insufficient market motivation.

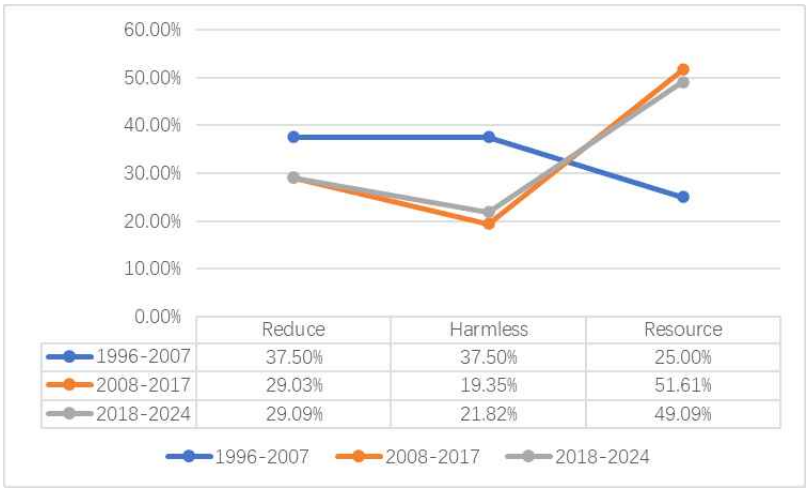
〈Table 6〉 Distribution of Policy Instruments

Policy Instrument Type	Policy Instrument Name	Frequency	Proportion
Voluntary Instruments	Family and Community	3	1.05%
	Market	19	6.62%
	Voluntary Organizations	7	2.44%
	Total	29	10.10%
Hybrid Instruments	Subsidies	30	10.45%
	Emissions Trading	2	0.70%
	Taxes and User Charges	9	3.14%
	Information & Persuasion	71	24.74%
	Total	112	39.02%
Mandatory Instruments	Public Enterprises	5	1.74%
	Command and Control Regulation	110	38.33%
	Direct Provision	31	10.80%
	Total	146	50.87%

3. Cross-Analysis

1) Cross-Analysis of Policy Objectives and Policy Phases

By summarizing the statistical results of the frequency and proportion of policy objectives across different policy phases (as shown in Figure 4), we can observe the distribution of construction waste policy objectives in China at different stages.



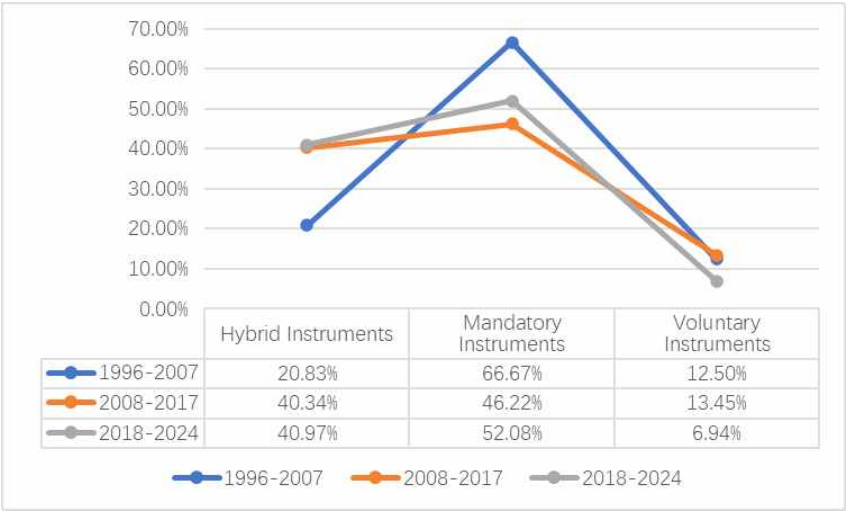
〈Figure 4〉 Proportion of each policy objective in the three-phase plan

In the initial exploration phase (1996-2007), policy objectives accounted for 8.51% of the total, with reduction and harmless treatment each at 37.50%, and resource utilization at 25.00%. In the rapid development phase (2008-2017), objectives increased to 32.98%, with resource utilization at 51.61%, reduction at 29.03%, and harmless treatment at 19.35%. In the mature development phase (2018-2024), objectives peaked at 58.51%, with resource utilization at 49.09%, reduction at 29.09%, and harmless treatment at 21.82%.

Overall, policy objectives grew across phases, but priorities varied. The initial phase focused on reduction and harmless treatment, the rapid development phase on resource utilization, and the mature phase on comprehensive objectives. However, reduction and harmless treatment remained weaker in the mature phase, indicating potential gaps in source reduction and environmental protection.

2) Cross-Analysis of Policy Instruments and Policy Phases

Based on data and chart analysis (see Figure 5), the use of construction waste management policy instruments in China shows significant changes across different phases.



	Hybrid Instruments	Mandatory Instruments	Voluntary Instruments
1996-2007	20.83%	66.67%	12.50%
2008-2017	40.34%	46.22%	13.45%
2018-2024	40.97%	52.08%	6.94%

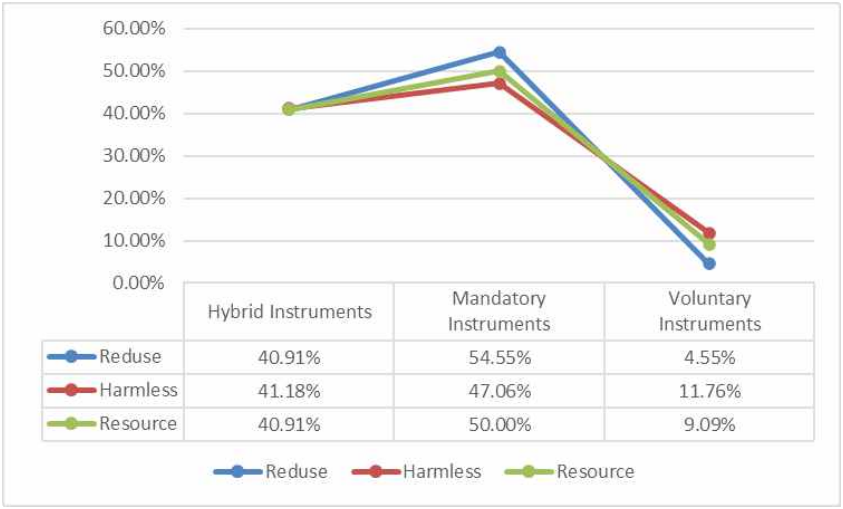
〈Figure 5〉 Proportion of each policy instrument in the three-phase plan.

In the nascent phase (1996-2007), the policies mainly relied on mandatory policy instruments, accounting for 66.67%, with voluntary policy instruments being used less frequently, accounting for 12.50%. In the rapid development phase (2008-2017), the variety of policy instruments increased, with the usage frequency of hybrid and mandatory policy instruments being close, accounting for 40.34% and 46.22% respectively, and the usage of voluntary policy instruments slightly increasing to 13.45%. In the mature development phase (2018-2024), mandatory policy instruments still dominated, accounting for 52.08%, while hybrid policy instruments accounted for 40.97%, and the usage of voluntary policy instruments decreased to 6.94%.

Overall, with the development of policies, mandatory instruments have dominated at all stages, but their proportion has gradually decreased. The usage of hybrid instruments has steadily increased, indicating that policies are continuously being enriched and adjusted to meet different management needs. Although the use of voluntary instruments increased during the rapid development phase, their proportion declined in the mature development phase. This suggests that while policy instruments are becoming more diverse, the participation of market and social forces still needs to be further enhanced.

3) Cross-Analysis of Policy Objectives and Policy Instruments

Based on the charts and data(see Figure 6), we can observe the usage proportions of different policy instruments in achieving various policy objectives.



	Hybrid Instruments	Mandatory Instruments	Voluntary Instruments
Reduse	40.91%	54.55%	4.55%
Harmless	41.18%	47.06%	11.76%
Resource	40.91%	50.00%	9.09%

〈Figure 6〉 Proportion of each policy instrument in the three-policy objective.

For the reduction objective, the usage proportions of hybrid policy instruments and mandatory policy instruments are relatively high, at 40.91% and 54.55%, respectively, while the usage proportion of voluntary policy instruments is only 4.55%. For the harmless treatment objective, the usage proportions of hybrid policy instruments and mandatory policy instruments are 41.18% and 47.06%, respectively, with the usage proportion of voluntary policy instruments at 11.76%. For the resource utilization objective, the usage proportions of hybrid policy instruments and mandatory policy instruments are 40.91% and 50.00%, respectively, with the usage proportion of voluntary policy instruments at 9.09%.

The usage proportions of different policy instruments in achieving various policy objectives indicate that mandatory and hybrid policy instruments are used more frequently for the reduction and resource utilization objectives, while voluntary policy instruments are used less frequently. This shows that the government primarily relies on legal regulations and economic incentives, and there is still a lack of efforts in enhancing public participation and market forces.

4. Implications of the Analysis and Recommendations

1) Implications of the Analysis

Through a three-dimensional analysis of central-level construction waste policies, several key issues have been identified:

Uneven Distribution of Policy Goals: Initially, the focus was on reduction and harmless treatment. Over time, the emphasis shifted to resource utilization, with reduction secondary and harmless treatment receiving the least attention. This uneven distribution may undermine the foundational role of reduction in the circular economy, affecting long-term sustainability. The core of the "3R" principles is reduction, and neglecting this can hinder sustainable development.

Unreasonable Mix of Policy Instruments: The government primarily uses mandatory instruments, such as regulations and standards, with some hybrid instruments like publicity and incentives. Voluntary instruments are underused, leading to insufficient market and social participation. A long-term government-led approach may increase implementation costs, fiscal pressure, resistance from enterprises, reduce efficiency, and stifle innovation and public engagement. The lack of voluntary instruments means missing out on the potential benefits of market mechanisms and social initiatives.

Lack of Public Participation and Environmental Awareness: The use ratios of voluntary instruments are low for reduction (4.55%), harmless treatment (11.76%), and resource utilization (9.09%), mainly relying on market tools. This indicates insufficient environmental awareness and participation from the public and enterprises. Despite the government's efforts in policy publicity and information disclosure, citizen participation in construction waste management remains low, which may affect the long-term effectiveness and sustainability of these policies.

2) Recommendations

Based on the identified shortcomings in the research analysis, the following recommendations are proposed for the formulation of construction waste policies in China:

Reasonably Allocate Policy Goals: The government should clarify specific indicators for reduction, resource utilization, and harmless treatment, promoting a circular economy. Use a mix of mandatory, hybrid, and voluntary instruments with cross-departmental collaboration. Focus on evaluating policy effectiveness and strengthening source reduction strategies, including stricter supervision, penalties, and incentives for modular and green building materials.

Optimize the Combination of Policy Instruments: Prioritize voluntary and hybrid instruments to shift from government regulation to market autonomy. Formulate specific laws for departmental responsibilities and accountability. Use hybrid tools like fiscal subsidies,

financial incentives, tax benefits, credit, pricing, user charges, and information persuasion. Increase support for innovative technologies and promote recycled construction waste products.

Enhance Citizen Participation: Strengthen publicity and education through media, schools, and community activities to raise environmental awareness. Improve policy transparency with timely public information disclosure. Encourage enterprises and the public to recognize the importance of environmental protection and participate in construction waste management.

These recommendations aim to address the deficiencies identified in the study, promoting more effective and sustainable construction waste management policies in China.

V. Case Analysis of Construction Waste Policies in Hefei

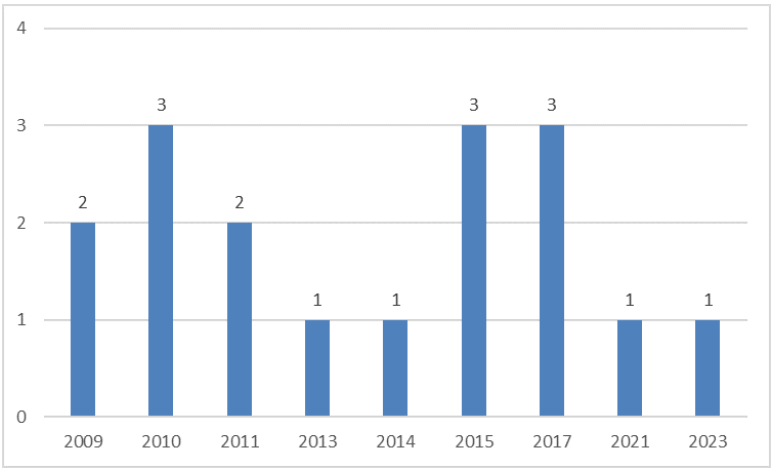
1. Background Introduction

Hefei, the capital of Anhui Province, has experienced rapid economic development and urbanization, leading to substantial construction waste due to frequent construction activities and a booming real estate industry. Effective management and regulation of this waste are crucial to maintaining the city's appearance, improving residents' living environment, and ensuring sustainable economic development.

From 2008 to 2013, Hefei's construction waste increased from 3.68 million tons to 13.89 million tons. In June 2014, the Anhui Provincial Department of Housing and Urban-Rural Development initiated a campaign to control construction dust, with Hefei leading the effort. The city established the "Three Vehicles Office" to regulate muck trucks, concrete mixer trucks, and material transport vehicles. However, current regulations focus on dust control, transportation management, and environmental protection, lacking explicit rules for the final disposal of construction waste. Most waste is still dumped in the suburbs, and the absence of designated disposal sites exacerbates random dumping.

Hefei's regulations primarily aim to maintain urban cleanliness rather than promote resource recycling. As a less developed provincial capital, Hefei can learn from the "pollution first, treatment later" approach of more developed regions and strive to lead in comprehensive construction waste resource utilization. The municipal government has introduced various policy measures to improve waste treatment and resource utilization, promoting a circular

economy. Between 2009 and 2023, Hefei issued 17 construction waste management policy documents, ensuring comprehensiveness and representativeness by sourcing from official government websites.



〈Figure 7〉 Annual Number of Construction Waste Policies Issued in Hefei (2009–2023)

As shown in Figure 7, Hefei City concentrated on issuing construction waste policies during the rapid development phase of central policies (2008–2017), with a total of 15 policies. This indicates Hefei's active response to central government directives, demonstrating high attention and proactive action towards construction waste management. In the mature development phase (2018–2024), the number of policies decreased, suggesting that the local government shifted focus to policy implementation and effectiveness evaluation. It also shows that local governments have some autonomy in policy formulation and do not rely entirely on central government management.

2. Analysis Based on Policy Objectives

From the distribution of policy objectives (see Table 7), Hefei City's construction waste management policies focus on harmless treatment (39.39%), reduction (36.36%), and resource utilization (24.24%). The highest focus on harmless treatment indicates the government's emphasis on environmental and human health safety during waste transportation and disposal, with strict measures to prevent pollution. The reduction objective ranks second, highlighting efforts to promote green building and reduce waste generation at the source. The relatively low focus on resource utilization indicates insufficient attention to recycling and

reuse of construction waste.

〈Table 7〉 Frequency and Proportion of Policy Objectives in Hefei

Policy Objective	Frequency	Proportion
Reduce	12	36.36%
Harmless	13	39.39%
Resource	8	24.24%
Total	33	100.00%

The distribution of policy objectives in Hefei City's construction waste management differs from central policies. Hefei City emphasizes reduction (36.36%) and harmless treatment (39.39%), suggesting a focus on reducing waste generation and ensuring environmental safety during transportation. In contrast, central policies prioritize resource utilization (47.87%), highlighting recycling and reuse. Hefei City's focus on resource utilization is lower, at 24.24%.

This focus is mainly due to Hefei's policies addressing the transportation phase, with deficiencies in source reduction and recycling regulations. Hefei aims to regulate waste management, prevent secondary pollution and safety hazards, and ensure legal compliance during transportation. This addresses issues like traffic accidents and environmental pollution caused by muck trucks, responds to public complaints, enhances urban civilization, improves city appearance, and boosts livability. As laws and regulations improve, Hefei must implement provisions to ensure environmental safety and management efficiency during waste transportation, promoting sustainable development.

3. Analysis Based on Policy Instruments

From the analysis of policy instruments in Hefei City's construction waste management (see Table 8), the government mainly relies on mandatory instruments (55.68%) through laws, regulations, and direct services. This effective approach may increase execution costs and reduce market motivation over time. Hybrid instruments account for 31.82%, using education campaigns and financial subsidies to encourage participation and raise environmental awareness. Voluntary instruments are the least used at 12.50%, indicating low market-driven solutions and public participation, with voluntary organizations underutilized.

〈Table 8〉 Distribution of Policy Instruments in Hefei

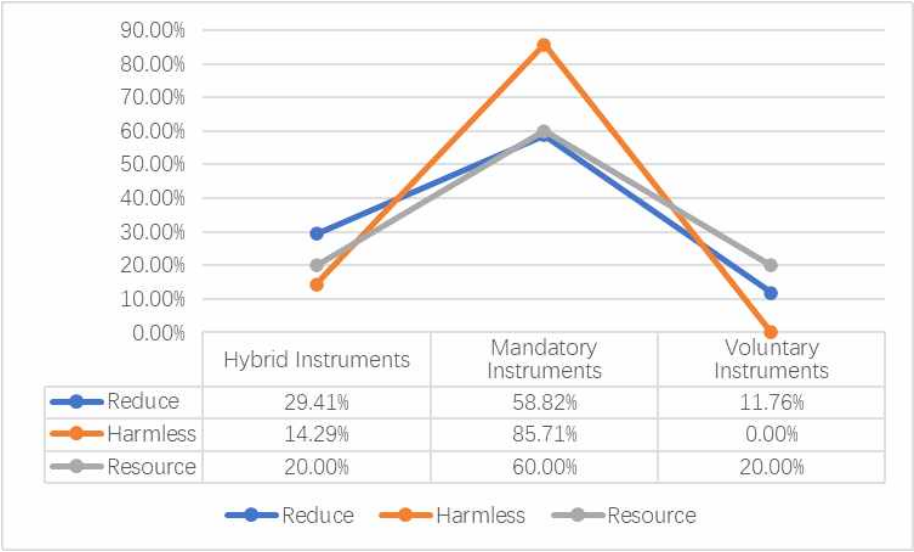
Policy Instruments	Policy Instruments Name	Frequency	Proportion
Voluntary Instrument	Family and Community	4	4.55%
	Market	7	7.95%
	Voluntary Organizations	0	0.00%
	Total	11	12.50%
Hybrid Instrument	Subsidies	9	10.23%
	Emissions Trading	0	0.00%
	Taxes and User Charges	1	1.14%
	Information & Persuasion	18	20.45%
	Total	28	31.82%
Mandatory Instrument	Public Enterprises	0	0.00%
	Command & Control Regulation	40	45.45%
	Direct Provision	9	10.23%
	Total	49	55.68%

Hefei City's reliance on mandatory instruments (55.68%) is higher than the central government's 50.87%, showing a stronger local emphasis on enforcement. The central government prioritizes hybrid instruments (39.02%), focusing on education to raise environmental awareness. While Hefei slightly exceeds the central level in voluntary instrument use, voluntary organizations remain underutilized. These differences reflect Hefei's targeted measures based on local needs. Future policy should optimize the mix of instruments, increasing voluntary and hybrid tools to enhance market and societal participation for sustainable construction waste management.

4. Cross-Analysis of Policy Objectives and Policy Instruments

Through the cross-analysis of Hefei City's construction waste management policy objectives and instruments (see Figure 8), it is evident that the government mainly relies on mandatory instruments. For harmless treatment, the reliance is 85.71%, showing significant regulatory efforts to ensure environmental and health safety during waste transportation and disposal. The reduction objective also relies primarily on mandatory instruments (58.82%), with hybrid (29.41%) and voluntary (11.76%) instruments supporting educational campaigns and financial subsidies. For resource utilization, mandatory instruments account for 60.00%, with hybrid and voluntary instruments each at 20.00%, indicating some use of market and social forces for

recycling and reuse.



〈Figure 8〉 Proportion of each policy instrument in the three-policy objective.

Compared to the central government, Hefei City relies more on mandatory instruments, especially for harmless treatment, reflecting stricter local measures for waste disposal. The central government uses more hybrid instruments, particularly for harmless treatment, through educational campaigns and financial incentives. Hefei's use of voluntary instruments is slightly higher than the central level, particularly for resource utilization, showing local efforts to engage market and social forces. However, voluntary instruments for harmless treatment remain insufficient. In the future, Hefei City can learn from the central government's successful experiences to optimize the policy instrument mix, increase the use of hybrid and voluntary instruments, and promote sustainable construction waste management.

5. Implications of the Analysis and Recommendations

By analyzing Hefei City's construction waste management policies and current status, the following conclusions and recommendations can provide references for future policy formulation and implementation.

1) Implications of the Analysis

Differences in Policy Objectives: Hefei City emphasizes reduction (36.36%) and harmless treatment (39.39%) more than central policies, which focus on resource utilization (47.87%). This shows Hefei's investment in source reduction and environmental safety during transportation, while central policies emphasize recycling and reuse.

Uneven Use of Policy Instruments: Hefei City relies heavily on mandatory instruments (55.68%), more than the central government's 50.87%. Hybrid instruments account for 31.82% in Hefei compared to 39.02% centrally. Voluntary instruments are slightly more used in Hefei, but voluntary organizations are underutilized. This indicates Hefei's targeted measures based on local needs.

Insufficient Resource Utilization: Hefei faces issues such as incomplete laws, insufficient regulation, lack of support, and inadequate promotion of recycled products. Awareness and enthusiasm for resource utilization among research institutions, the construction sector, and the public need improvement.

2) Recommendations

(1) Optimize the Distribution of Policy Objectives:

Increase Focus on Resource Utilization: Enhance policy measures for recycling and reusing construction waste. Establish clear standards and goals for resource utilization to ensure effectiveness.

Enhance Balance of Policy Objectives: Maintain focus on reduction and harmless treatment while increasing investment in resource utilization to promote comprehensive optimization of construction waste management.

(2) Rational Allocation of Policy Instruments:

Improve Laws and Regulations and Strengthen Supervision: Introduce comprehensive laws for construction waste resource utilization, clarify departmental responsibilities, standardize procedures, increase violation costs, enhance penalties, and strengthen supervision to prevent illegal disposal.

Increase Financial Support and Market Incentives: Include recycling indicators in project evaluations, offer tax incentives, mandate the use of recycled products in public projects, reward companies using recycled products, and promote these products to improve market

awareness.

Optimize Policy Instrument Mix: Increase the use of hybrid and voluntary instruments alongside mandatory ones. Raise public and corporate environmental awareness through educational campaigns and information disclosure. Explore effective voluntary instruments by encouraging third-party participation in waste management.

(3) Enhance Resource Utilization Levels:

Strengthen Technical Research and Promotion: Collaborate with construction enterprises to advance resource utilization technologies, promote production and research integration, and provide financial support for innovation.

Enhance Public Education and Participation: Conduct educational campaigns with media and universities, raise environmental and resource awareness, and increase public participation through community activities and environmental education.

Support Resource Utilization Enterprises and Market: Provide financial subsidies and tax incentives to resource utilization enterprises, reduce operational costs, and establish a comprehensive market system for recycled products to increase demand and market share.

Ⅵ. Conclusion

This study utilizes NVivo qualitative analysis software to conduct text analysis and coding of Chinese construction waste policy texts, followed by quantitative text analysis. A three-dimensional policy analysis framework was constructed based on the 3R principles of the circular economy for policy objectives, the degree of national intervention for policy instruments, and historical institutionalism for policy phases. By analyzing construction waste policy documents issued at the central level in China from 1996 to 2024 and combining these with specific case studies of construction waste policies issued by the Hefei local government from 2009 to 2023, the study explores the distribution and differences of policy objectives, policy instruments, and policy phases. The following conclusions are drawn: Central policies mainly focus on resource utilization objectives, with relatively fewer objectives on reduction and harmless treatment. Policy instruments are primarily mandatory and hybrid, with less use of voluntary instruments, indicating insufficient public participation and environmental awareness. Hefei City places more emphasis on reduction and harmless treatment objectives,

primarily relying on mandatory instruments, with insufficient use of hybrid and voluntary instruments. Resource utilization faces issues such as incomplete laws and regulations and insufficient regulatory efforts. The central policy's orientation towards resource utilization facilitates nationwide resource recycling, while Hefei City focuses on ensuring environmental and health safety but needs to strengthen resource utilization efforts. The impact of central policies on local governments is reflected in policy orientation, policy instrument selection, and the intensity of policy implementation. The central policy's focus on resource utilization and the use of mandatory instruments have prompted active local government actions in construction waste management, leading to high enforcement at the implementation level. It is recommended that central policies reasonably allocate objectives of reduction, resource utilization, and harmless treatment, optimize the combination of policy instruments, increase the use of voluntary instruments, and enhance public participation and environmental awareness. Hefei City should improve laws and regulations and regulatory mechanisms for resource utilization, optimize the combination of policy instruments, reduce reliance on mandatory measures, strengthen technological research and promotion, and enhance market promotion and publicity of recycled products. These recommendations aim to optimize China's construction waste management policies, promote efficient resource utilization, and support sustainable environmental development.

The innovation of this study lies in the construction of a three-dimensional policy analysis framework based on the 3R principles of the circular economy, the degree of national intervention, and historical institutionalism. By combining NVivo qualitative analysis software, the study conducts a systematic quantitative and comparative analysis of central and Hefei City's construction waste management policies, revealing differences in the selection of policy objectives and instruments, and providing a new research perspective. The limitations include the concentration of data collection on the central level and Hefei City, lacking comprehensive coverage of local policies nationwide. The research methodology leans towards quantitative analysis, lacking in-depth qualitative research, empirical evaluation of policy effects, and an in-depth exploration of regional differences. Future research should combine quantitative and qualitative analysis, conduct field investigations, and systematic evaluations to more comprehensively optimize construction waste management policies.

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〈국문초록〉

중국의 중앙 및 지방정부의 건설폐기물 관리 정책에 대한 정량적 텍스트 분석: 중국 합비시의 사례를 중심으로

본 논문은 NVivo 12 Plus 소프트웨어를 이용하여 1996년부터 2024년까지 중국 중앙정부 차원의 건설폐기물과 관련한 정책 문서 33개를 중심으로 정책 도구, 정책목표 및 정책집행 단계에 대하여 정량적 분석을 실시하였다. 분석결과, ① 정책목표의 불균형한 배분 ② 비합리적인 정책 도구 조합 ③ 시장 참여의 부족 ④ 공공 참여와 환경문제 인식의 부족한 것으로 나타났다. 이를 개선하기 위한 정책으로 ① 정책목표의 최적화, 감소, 자원 재활용 및 무해 처리를 위한 지표 개선 ② 순환 경제 촉진 ② 정책 도구 최적화 및 시장과 공공 참여 강화가 필요함을 제안하였다. 또한 2009년부터 2023년까지 중국의 지방정부인 합비시가 발행한 17개의 건설폐기물과 관련한 정책 문서 등을 분석하여 지방정부가 중앙정부 정책을 구현하는 과정에서 직면한 구체적인 도전과 차이를 분석하고 개선 방안을 제시하였다. 분석결과, 정책 수립 및 집행에 새로운 시각과 혁신적인 접근 방식을 제공하여 순환 경제에 기반한 지속 가능한 건설폐기물 관리 정책이 추진될 수 있도록 하는 것이 필요함을 제안하였다.

주제어: 건설폐기물, 정책 도구, 정책목표, 순환 경제, 지방정부

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