Open Journal of Social Sciences, 2025, 13(4), 156-169
https://www.scirp.org/journal/jss
ISSN Online: 2327-5960
ISSN Print: 2327-5952

The Characteristics and Optimization of Science and Technology Innovation Policy Mix in China's Transportation Sector

Xiumei Zheng[1], Jing Wu[1], Xiaoyang Chen[1], Guoyu Ma[1], Lan Ye[2]

[1]School of Transportation Science and Engineering, Civil Aviation University of China, Tianjin, China
[2]School of Cabin Crew, Civil Aviation University of China, Tianjin, China
Email: xmzheng@cauc.edu.cn

How to cite this paper: Zheng, X. M., Wu, J., Chen, X. Y., Ma, G. Y., & Ye, L. (2025). The Characteristics and Optimization of Science and Technology Innovation Policy Mix in China's Transportation Sector. *Open Journal of Social Sciences, 13,* 156-169.
https://doi.org/10.4236/jss.2025.134010

Received: March 18, 2025
Accepted: April 15, 2025
Published: April 18, 2025

Abstract

Technology innovation is the key to accelerating the construction of a vital transportation country. Sorting out transportation technology innovation policies helps to grasp the characteristics of government attention allocation and is of great significance for optimizing transportation technology innovation governance. Taking the national level transportation technology innovation policy texts from 2012 to 2023 as samples, an LDA topic model and content analysis method were used to construct a policy mix system of "policy topic and policy instrument" to explore the tool characteristics and combination models of transportation technology innovation policies. The results indicate that the instrument structure of transportation technology innovation policies is relatively balanced, with environmental policy instruments occupying a relatively dominant position. There are four types of combination characteristics of transportation technology innovation policies: promoting the improvement of technology innovation capabilities through resource factor supply, promoting the integration of technology innovation through environmental system construction, jointly driving the generation of innovation ecology through supply and environmental instruments, and promoting collaborative development of innovation through multiple instruments balance. Finally, optimization recommendations are proposed for further precise coupling of the policy combination system.

Keywords

Science and Technology Innovation, Policy Mix, Policy Instrument, Content Analysis

1. Introduction

Since the 18th National Congress of the Communist Party of China, the integration of science and technology with transportation has deepened continuously. The 19th National Congress report has elevated transportation science and technology innovation to a national strategy, proposing strategic plans for constructing a transportation powerhouse. Following this, the Ministry of Science and Technology of China and the Ministry of Transport of China have jointly deployed various initiatives to regulate and optimize transportation science and technology innovation's strategic direction and resource allocation.

In the field of transport innovation research, on the one hand, technological innovation has propelled leapfrog advancements in transportation. Zhu et al. investigated the impact of technological innovation on the energy-environmental efficiency of the transportation sector (EETS) using a spatial econometric approach (Zhu et al., 2021). Chen et al. employed the static panel model and spatial Durbin model to analyze the impact and mechanism of digital innovation on carbon emissions in the transportation industry (Chen et al., 2022). On the other hand, the rapid development of technological innovation has posed challenges to transportation governance, impacting political, economic, and social aspects. Huang et al. analyzed the problems and challenges faced by the ITS in China (Huang et al., 2017) and proposed development recommendations for low-altitude intelligent transportation systems (Huang et al., 2024). Scholars have mainly focused on how technological innovation drives transportation and the challenges it faces. However, research on transportation technology innovation policies, especially policy mix, is limited.

As the socio-economic environment becomes increasingly complex, individual policy instruments can no longer meet governance needs (Nuñez-Jimenez et al., 2022). As a result, policy mix—an extension of traditional policy instruments—has gained heightened attention in innovation studies (Costantini et al., 2017; Wang et al., 2019). Policy mix integrates diverse instruments to address specific thematic areas (Kern & Howlett, 2009). Through multi-level interactions between these instruments and their respective themes (Flanagan et al., 2011), governments establish governance priorities and shape governing styles (Mavrot et al., 2019), collectively fostering innovation. This study aims to answer two main questions: 1) What are the main objectives and instruments in transportation science and technology innovation (TSTI) policies, and how do they interact to form combination models? 2) How can innovation capabilities and collaborative development be enhanced through an optimized TSTI policy mix?

The remaining sections of this study are organized as follows: Section 2 introduces the policy framework and data sources established. Section 3 displays the outcomes. Section 4 includes a discussion, and Section 5 presents the conclusion.

2. Research Design

2.1. Policy Text Screening

The Ministry of Transport of China issued the first particular document on technological innovation in transportation in 2012, a milestone for China's transportation industry. Therefore, we selected "transportation science and technology" and "transportation innovation" as keywords, limiting the policy publication time-frame from January 1, 2012, to December 31, 2023. After a full-text fuzzy search on the official websites of the State Council, Ministry of Transport, Ministry of Science and Technology, Civil Aviation Administration of China, National Railway Administration, State Post Bureau, Maritime Safety Administration, and the PKULaw database, and simultaneous review by three researchers, 64 valid documents were retained to form the research sample for this study.

This study independently used NVivo software to encode, classify, and quantify TSTI policy texts by three researchers. The coding rules were set as follows: 1) Each policy was coded in the format "policy number-order of policy clauses." 2) The type of policy instrument for each policy was then coded in the format "instrument type-policy measure type." 3) The target type of each policy was coded from T1 to T4. Reliability testing of the three coding results was conducted using the Kappa coefficient. After multiple rounds of discussion and re-coding, the Kappa coefficient reached 0.830, indicating that the coding data is valid.

2.2. Framework Construction

Policy instruments are essential elements within the policy ecosystem, encompassing various methods and measures governmental agencies use to achieve policy objectives. Rothwell's classification of demand, environment, and supply policy instruments has gained recognition among domestic and international scholars and has been widely applied in policy analysis across various fields (Rothwell & Zegveld, 1984). This study adopts Rothwell's classification. The specific measures for each policy instrument are summarized in **Table 1**.

Table 1. System of TSTI policy instruments.

Types	Name	Description of the Measure and Examples
Supply-side S (Wang & Li, 2021)	Talent Resources (S-1)	Supporting the development, attraction, and retention of TSTI professionals by implementing talent advancement programs, etc.
	Fiscal Support (S-2)	Direct fiscal support for TSTI projects through the establishment of special funds, guidance funds, post-subsidies for technological innovation, etc.
	Innovation Platform (S-3)	Supporting the establishment of software and hardware platforms to promote TSTI, such as key laboratories, technology innovation centers, etc.
	Public Services (S-4)	Public service support for TSTI through technical services and educational support, such as technical consulting, science popularization, etc.

Continued

Demand-side D (Daugbjerg, 2009)	Government Procurement (D-1)	Promoting TSTI research and new product applications through service procurement, such as initial purchase of first-unit products etc.
	Industry-University-Research Collaboration (D-2)	Supporting enterprises, universities, and research institutes in strengthening cooperation in technological innovation, such as establishing innovation alliances, joint development, etc.
	International Cooperation (D-3)	Supporting companies to engage in international exchanges, including scientific exchange, joint research efforts, and technology transfer, etc.
	Pilot Demonstration (D-4)	Promoting the early adoption of new technologies, products, and systems through pilot projects, such as digital transportation trials etc.
Environment-side E (Yin et al., 2024)	Planning Guidance (E-1)	Overall design for the development concepts, structural layout, and resource allocation of TSTI.
	Institutional Development (E-2)	Optimizing the management system for TSTI, such as streamlining administration and establishing research integrity guidelines, etc.
	Financial Support (E-3)	Supporting funding for TSTI in direct or indirect forms, such as loans, and venture capital, etc.
	Technology Transfer (E-4)	Supporting the protection, promotion, and application of technological innovation achievements.

1) Policy topic dimension

Latent Dirichlet Allocation (LDA) is a statistical model that uses algorithms for semantic analysis and corpus clustering to identify and learn text topics unsupervised. This study employed the LDA model to identify the optimal number and categories of topics within policy texts. Firstly, by calculating the probability distribution of multiple topics within documents and multiple keywords within topics, a three-layer Bayesian model, "document-topic-keyword," following a Dirichlet distribution, is constructed, as shown in Equation (1).

$$P\left(k_i \middle| d_j\right) = \sum_{t=1}^{n} P\left(k_i \middle| z=t\right) P\left(z=t \middle| d_j\right) \tag{1}$$

where $P\left(k_i \middle| z=t\right)$ means the probability that keyword k_i belongs to topic t, and $P\left(k_i \middle| d_j\right)$ means the probability that topic t belongs to document d_j.

Secondly, determining an appropriate number of topics facilitates topic clustering with the LDA model. This study adopts the cosine similarity method to identify the optimal number of topics for TSTI policy. Equation (2) represents the cosine similarity between topic vectors Z_i and Z_j, while Equation (3) represents the average cosine similarity of the topic number K.

$$\cos\left(Z_i, Z_j\right) = \frac{\sum_{n=0}^{N} \varphi_{in}\varphi_{jn}}{\sqrt{\sum_{n=0}^{N} \varphi_{in}^2}\sqrt{\sum_{n=0}^{N} \varphi_{jn}^2}} \tag{2}$$

$$\text{avgcos} = \frac{\sum_{i=1}^{K-1}\sum_{j=i+1}^{K} \cos\left(Z_i, Z_j\right)}{\left[K*\left(K-1\right)\right]/2} \tag{3}$$

Finally, the vectorized TSTI policy text was input into the LDA model, and it was found that when K equals 4, avgcos is minimized. Therefore, based on a comprehensive qualitative analysis of the policy texts, this study defined the optimal number of topics for TSTI policy as 4. The top ten keywords by probability for each topic were retained, resulting in the topic classification outcomes for the TSTI policy (**Table 2**). This finding is consistent with the conclusions of previous studies (Sun & Yin, 2017).

Table 2. Distribution of subject headings in TSTI.

Topics	High-probability words	Topic name
Topic 0	Science and Technology, Innovation, Infrastructure, Key Technologies, High-Speed Railway, Core Technologies, Technological System, Talent, Innovation Capability, Laboratory	Science and Technology Innovation Capability (T1)
Topic 1	Policy, Government, Development Plan, Innovation, Technology Transfer, Talent, Standard System, Resource Allocation, Strategic, Sharing	Science and Technology Innovation Environment (T2)
Topic 2	Government, Research Institutes, Technological System, Universities, Integration, Collaborative Innovation, Collaboration, Exchange, Multi-level, Integration	Collaborative Innovation Development (T3)
Topic 3	Intelligence, Big Data, Integration, Informatization, Internet, New Energy, Automation, Industrialization, Technology Transfer, Engineering Construction	Innovation-Driven Integrated Development (T4)

Topic 0: Science and Technology Innovation Capability. This topic focuses on science and technology innovation capability, using keywords such as "key technologies," "talent," and "innovation capability." The aim is to build a high-level team of TSTI talent and innovation platforms, promoting breakthroughs in critical core technologies to achieve self-reliance and strength in the field of TSTI.

Topic 1: Science and Technology Innovation Environment. This topic centres on the science and technology innovation environment, using keywords such as "government," "policy," and "development plan." It aims to deepen reforms in the science and technology system and address institutional barriers to TSTI. It also focuses on fostering an atmosphere and culture of innovation to unleash the vitality of TSTI fully.

Topic 2: Collaborative Innovation Development. This topic centres on collaborative innovation development, using keywords such as "government," "research institutes," and "collaborative innovation." It focuses on promoting resource integration and complementary strengths across domestic and international entities, among various innovation actors, and across different transportation sectors.

Topic 3: Innovation-Driven Integrated Development. This topic centres on innovation-driven integrated development, using keywords such as "intelligence," "big data," and "integration." It adopts an innovation application perspective, promoting cross-disciplinary integration, the fusion of frontier technologies with transportation, the integration of traditional and emerging industries with transportation, and regional transportation integration. These multidimensional synergies empower the development of TSTI.

Based on the above, this study built a framework for the TSTI policy mix from two dimensions: policy instrument and policy topic. The policy framework is shown in Figure 1.

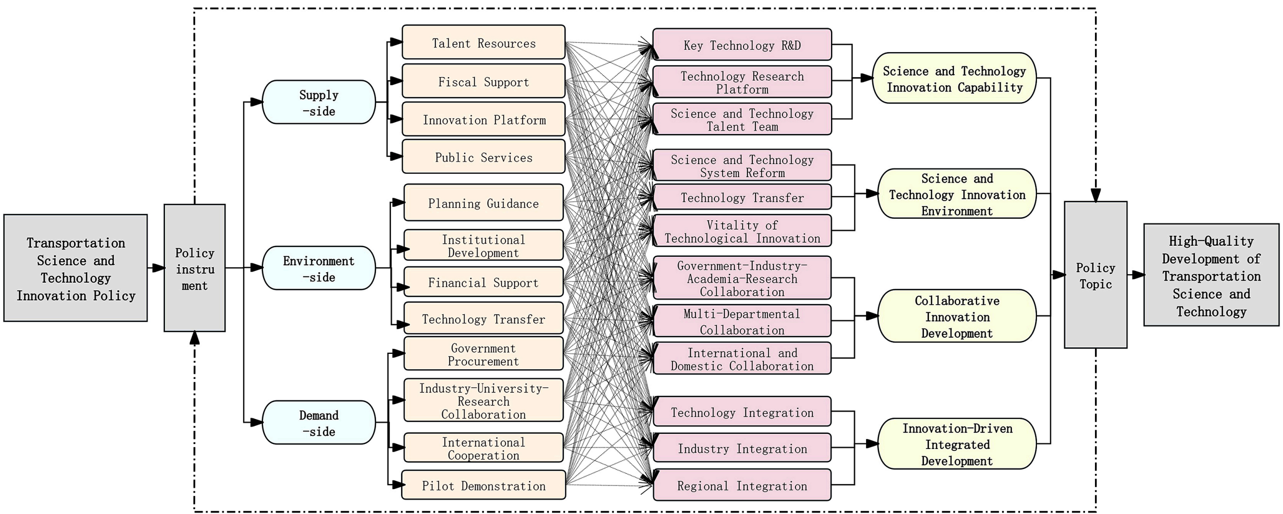

Figure 1. Analysis framework for the policy mix of TSTI.

3. Results

3.1. Characteristics of TSTI Policy Instruments

By analyzing the configuration structure of TSTI policy instruments, the intragroup and total proportions of policy measures under different policy instruments were calculated to determine the proportions of supply, demand, and environmental policy instruments, as shown in Table 3. The following four features characterize the configuration of transportation science and technology policy instruments:

Table 3. Structure of policy instruments configuration in TSTI.

Policy instruments	Proportion of policy instruments	Policy measures	Intra-group proportion	Total proportion
Supply-side	34.07%	Talent Resources	36.50%	12.44%
		Fiscal Support	14.50%	4.94%
		Innovation Platform	37.50%	12.78%
		Public Services	11.50%	3.92%
Demand-side	23.00%	Government Procurement	2.96%	0.68%
		Industry-University-Research Collaboration	40.00%	9.20%
		International Cooperation	25.93%	5.96%
		Pilot Demonstration	31.11%	7.16%
Environmental-side	42.93%	Financial Support	9.13%	3.92%
		Planning Guidance	37.70%	16.18%
		Institutional Development	25.79%	11.07%
		Technology Transfer	27.38%	11.75%

1) Well-Structured Configuration of TSTI Policy Instruments: The composition of TSTI policy instruments shows a distribution of 34% supply-side, 43% environment-side, and 23% demand-side, with environment-side instruments holding the largest share. This notably contrasts prior research findings, which generally indicate a predominance of supply-side instruments in science and technology innovation policy. This trend is mainly because relative to broader national or regional science and technology systems, the transportation science and technology innovation system has a later inception, leading government focus to prioritize creating an enabling environment through planning guidance and institutional development. Nevertheless, the TSTI policy instruments exhibit a more balanced structure, with smaller gaps between the supply, environment, and demand than broader innovation policies, indicating a well-structured policy system.

2) Balanced Allocation of Environment-Side Policy Instruments: Planning guidance measures are the most prominent in configuring environment-side policy instruments, accounting for 37.7%, reflecting the government's strategic priorities and resource allocation in advancing TSTI. Institutional development and technology transfer follow at 25.79% and 27.38%, respectively. Effective innovation demands robust institutional foundations, which, in the transportation science and technology sector, are mainly represented through strengthening innovation systems and mechanisms, promoting an open and fair market environment, cultivating an innovation ecosystem, and building strategic technological capacities. As a core driver in transforming scientific and technological advance-

ments into a primary force of productivity, technology transfer emphasizes enhancing transfer mechanisms, establishing transfer platforms, and strengthening incentive policies to foster widespread application. Financial support measures, comprising 9.13%, are designed to create a diversified funding ecosystem for transportation science and technology innovation, strategically directing financial and social capital into high-impact projects.

3) Talent Resources and Innovation Platform as the Core of Policy Supply: In supply-side policy instruments, talent resources and innovation platform dominate, constituting 36.5% and 37.5%. Talent forms the foundation for a firm transportation nation, with policies targeting two goals: advancing strategic talent teams to lead global transportation science and technology and fostering young talent with resources and clear development paths. Innovation platform acts as hubs for aggregating resources and talent, driving innovation through industry laboratories, technology centers, research facilities, and collaborative platforms. At 14.5%, fiscal support provides a structured framework with special funds, subsidies, and tax incentives. Public service (11.5%) supports innovation services and promotes a culture of innovation.

4) Multi-Source Collaboration and Pilot Demonstration as Key Drivers of Demand-Driven Initiatives: Within demand-side policy instruments, industry-university-research collaboration, and international cooperation aim to enhance TSTI efficiency by integrating diverse innovation resources, accounting for 40% and 25.93% of policy measures, respectively. Pilot demonstration policy measures, at 31.11%, include various transportation pilot projects such as enterprise R&D, talent training bases, and pilots for new technologies and models. Government procurement constitutes only 2.96%, reflecting multi-industry policy characteristics and a strategic focus on instrument optimization. While government procurement effectively fosters innovation, its limited allocation may hinder the dissemination of new technologies and products in the transportation sector, constraining TSTI growth.

3.2. Structural Characteristics of TSTI Policy Mix

The interaction between policy instruments and policy topics facilitated the extraction of the configuration characteristics of the TSTI policy mix. This study employs a Sankey diagram to depict the interrelationship between policy instruments and policy topics in TSTI (**Figure 2**), focusing on policy topics. The two sections represent the distribution of policy instruments under different topics and the configuration of policy measures within each topic. The results reveal a reasonably equitable distribution among policy topics, with "Science and Technology Innovation Environment" as the largest topic at 33.98%, followed by "Science and Technology Innovation Capability" (25.76%) and "Collaborative Innovation Development" (23.59%); "Innovation-Driven Integrated Development" has the smallest proportion at 16.76%. Following is a summary of the combined characteristics of policy topics and policy instruments:

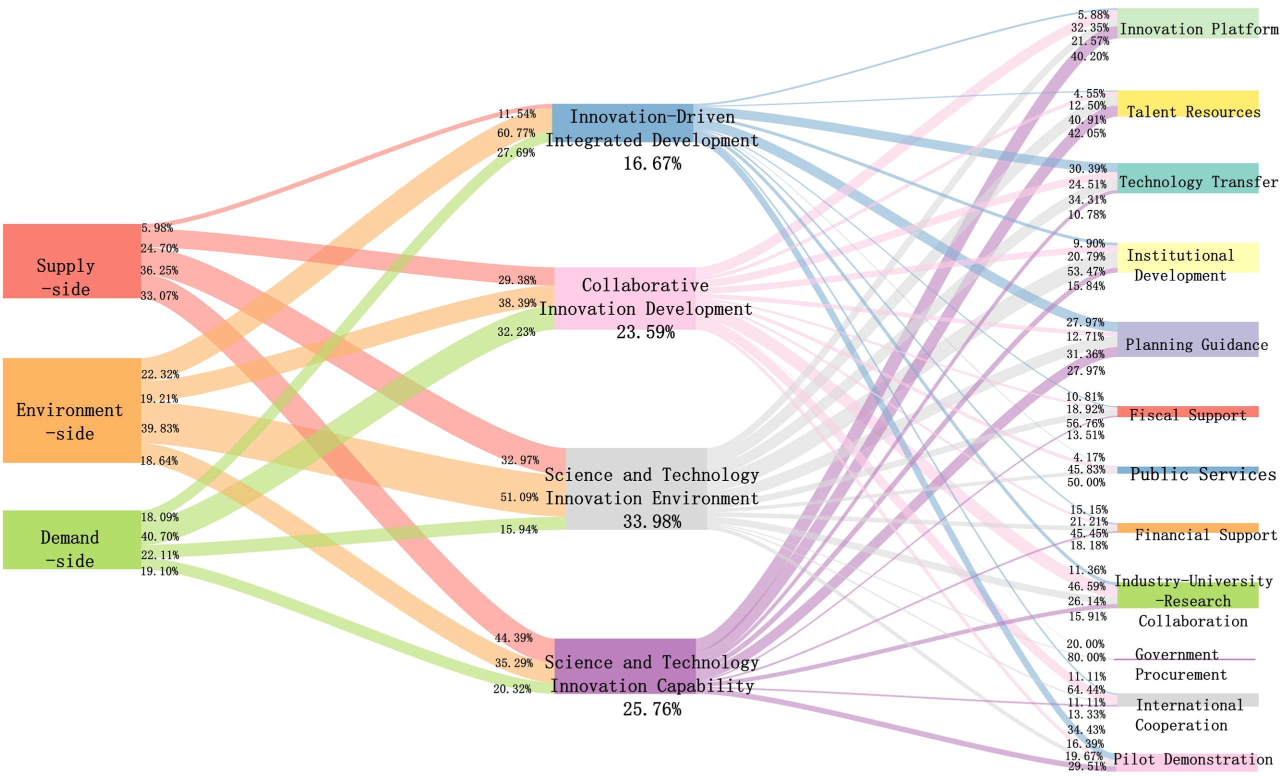

Figure 2. Structural characteristics of TSTI policy mix.

1) Strengthening the capacity of Science and Technology Innovation through Stimulating the Supply of Resources and Elements as the Main Policy Means: The "Science and Technology Innovation Capability" topic focuses on tackling critical technical challenges in transportation and enhancing product autonomy, driving the goal of a strong transportation nation. Instruments within this topic are predominantly supply-side (44.39%), with environment-side (35.29%) making up a combined 80%. Supply-side instruments boost innovation by expanding resource channels, establishing high-level TSTI platforms for critical technologies, advancing foundational research, and developing talent teams. This includes cultivating high-level leaders and young scientific talent to stimulate innovation vitality. Environment-side policies indirectly enhance capabilities through Planning Guidance and financial support, such as outlining strategies, goals, and directions. These instruments show both competition and complementarity in supporting the policy topic. It is essential to examine how well transportation science and technology innovation policy instruments work together when making policy. Supply-side and environment-side innovation policy instruments must be constantly changed and improved to make the transportation sector more innovative.

2) Fostering a Favorable Science and Technology Innovation Ecosystem Focused on Innovation Environment and Innovation Elements as the Primary Policy Means: The "Science and Technology Innovation Environment" topic focuses on redefining the government's role in transportation innovation and leveraging science and technology system reform to build a favorable innovation ecosystem.

The instrument's configuration of this topic is mainly supplied (44.39%), supplemented by environmental (35.29%), accounting for about 80%. Environment-side instruments provide lasting support by shaping the TSTI ecosystem through improved institutional frameworks, including research management systems, talent evaluation mechanisms, and funding systems, offering sustained momentum compared to the immediate effects of supply-side instruments. For example, the principles, directions, and content of the transportation science and technology innovation ecosystem are shaped and guided by the improvement of the institutional framework of this field. Talent resources and technology transfer are two critical levers through which the government aims to foster a healthy innovation environment. Promoting TSTI requires combining long-term environment-side policies with short-term supply-side measures to drive sustainable ecosystem development.

3) Balanced Application of Policy Instruments to Promote Collaboration in TSTI. The instrument configuration is balanced in the "Collaborative Innovation Development" topic, with supply-side, environment-side, and demand-side instruments at 29.35%, 38.39%, and 32.23%, respectively. The core focus is on "collaboration," such as promoting the formation of a transportation science and technology innovation model with enterprises as the main body and high cooperation between government, industry, universities, and research institutes; promoting international exchanges to globalize talent, technology, products, and standards; and establishing innovation platforms for large-scale transformation of scientific achievements. Environment-side instruments create favourable conditions for TSTI, supply-side instruments increase innovation resource supply, and demand-side instruments guide TSTI development. The coordination of these instruments forms a robust framework that promotes cross-regional and cross-sectoral cooperation while enabling the integration and efficient use of innovation resources.

4) Environment-Side Policy Instruments as the Primary Drivers of Integration in TSTI: The "Innovation-Driven Integrated Development" instrument configuration is primarily environment-oriented, accounting for as much as 60.77%. This topic emphasizes "integration," advancing transportation toward smart, connected, and unified development by combining technologies, industries, and regions. Key policies include comprehensive planning to guide integrated development, promoting technology transfer through institutional, platform, and funding support especially for significant technologies and military-to-civilian applications and guiding pilot projects for new systems, technologies, and products to create scalable innovation practices. Supply-side instruments, at only 11.54%, face challenges such as talent shortages, high transfer costs, and geographical constraints, limiting their effectiveness in regional coordination and industry integration. Future policies should address these challenges to enhance the role of supply-side instruments in supporting TSTI and integrated development.

4. Discussions

1) Strengthening the Role of Government Procurement in Advancing TSTI:

Government procurement is a vital link between the government and the market and is a crucial instrument in managing technological innovation. The amended Law of the People's Republic of China on Scientific and Technological Progress (2021) mandates that the government should lead by example in procuring domestic technological innovations and new products. Similarly, the revised Government Procurement Law, for the first time, prioritizes support for technological innovation as a core function. Numerous studies highlight the positive impact of government procurement on technological progress, underscoring its role in fostering innovation. However, its current application within TSTI policy remains limited. To address this, it is recommended to increase focus on targeted government procurement in transportation, prioritizing domestic innovations in areas like infrastructure, vehicle deployment, and transportation planning. This shift would enable government procurement to play a more transformative role in advancing innovation in the transportation sector. Excessive government procurement risks undermining the market's self-regulating capacity, leading to inefficiencies in resource allocation. If the government remains the dominant purchaser over the long term, businesses may rely more on policy support than on market competition, stifling technological innovation and market responsiveness. This could ultimately distort the supply-demand balance and disrupt the natural evolution of the transport technology sector. Therefore, while government procurement should play a guiding role, it is essential to strictly limit its scope to avoid replacing market mechanisms, ensuring that policies complement, rather than supplant.

2) Strengthening the Role of Supply-Side Policy Instruments in Advancing Innovation-Driven Integrated Development: Innovation-driven integrated development is critical to innovation-driven growth, as highlighted by President Xi Jinping. TSTI integration spans technology, industry, and region, requiring a balanced policy instrument system. However, current policies show an imbalance, with a low proportion of supply-side instruments, limiting their effectiveness. To improve this, increasing the allocation of supply-side instruments is recommended, focusing on strengthening integration platforms, enhancing support services, and providing targeted financial backing for integration projects to drive development effectively. While supply-side policy tools offer quick and direct results, they can lead to selective enforcement by local governments and excessive fiscal burdens under pressure. Therefore, in driving innovation and integration, it is crucial to carefully adjust the intensity of policy, balancing government intervention with market mechanisms. This ensures that policies are neither ineffective nor overly intrusive, prevents excessive fiscal strain, and enables the market to gradually become self-sustaining.

3) Enhancing the Precision of Demand-Side Policy Instruments in Targeted Policy Topics: Effective policy-driven science and technology innovation requires balanced policy instruments. Research shows that most topics rely primarily on environmental or supply-side instruments, with demand-side instruments receiv-

ing less emphasis. This imbalance limits the synergy of the policy system. Increasing demand-side instruments is recommended to better align with TSTI characteristics to address this. For example, pilot demonstration policies should be strengthened to support innovation-driven integrated development, expand international cooperation to promote TSTI globalization, and increase government procurement to stimulate R&D and boost innovation capacity.

5. Conclusion

Based on content analysis and LDA topic clustering methods, this study empirically analyzed the characteristics of China's TSTI policy mix. The primary conclusions are as follows:

1) TSTI policies are predominantly environment-oriented, with a balanced distribution of supply-side, environment-side, and demand-side instruments. Supply-side instruments focus on talent resources and innovation platform; environment-side instruments prioritize planning guidance; and demand-side instruments are balanced across industry-university-research collaboration, pilot demonstration, and international cooperation.

2) These policies' thematic priorities emphasize the science and technology innovation environment, followed by science and technology innovation capability and collaborative innovation development, with Innovation-Driven Integrated Development receiving the least focus. This suggests the system is still in early development, with the innovation environment as the primary focus of government attention.

3) Government efforts prioritize enhancing innovation capability through resource provision, particularly in talent and platform development; fostering Innovation-Driven Integrated Development through environmental system construction focused on planning guidance, institutional development, and technology transfer; and building an innovation ecosystem by combining supply and environment factors, using diverse instruments to promote collaborative innovation.

Future research could explore several key areas. First, this paper outlines the themes and tools used in China's central transportation technology innovation policies. Future studies could employ advanced text mining techniques to compare central and provincial policies, providing a clearer understanding of local government implementation and adaptation of central directives. Second, this study focuses on the composition of transportation technology innovation policies. Future research could apply nonlinear models to more accurately assess policy impacts, particularly in complex socio-economic contexts, where these models can capture regional and temporal variations in outcomes. Finally, while this study briefly addresses policy intensity, future work could develop a multidimensional framework for its evaluation, considering factors such as policy level, financial support, and the comprehensiveness of supporting measures. A policy shock index model could be used to assess policy intensity by analysing indicators such as compulsory term density, update frequency, and the thoroughness of implementation guidelines. This approach would enable a dynamic assessment of policy fluctuations and their impact on transportation technology innovation.

Acknowledgements

This work was supported by the Fundamental Research Funds for the Central Universities of Ministry of Education of China (Grant No. 3122025063).

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

Chen, X., Mao, S., Lv, S., & Fang, Z. (2022). A Study on the Non-Linear Impact of Digital Technology Innovation on Carbon Emissions in the Transportation Industry. *International Journal of Environmental Research and Public Health, 19,* Article No. 12432. https://doi.org/10.3390/ijerph191912432

Costantini, V., Crespi, F., & Palma, A. (2017). Characterizing the Policy Mix and Its Impact on Eco-Innovation: A Patent Analysis of Energy-Efficient Technologies. *Research Policy, 46,* 799-819. https://doi.org/10.1016/j.respol.2017.02.004

Daugbjerg, C. (2009). Sequencing in Public Policy: The Evolution of the CAP over a Decade. *Journal of European Public Policy, 16,* 395-411. https://doi.org/10.1080/13501760802662698

Flanagan, K., Uyarra, E., & Laranja, M. (2011). Reconceptualising the "Policy Mix" for Innovation. *Research Policy, 40,* 702-713. https://doi.org/10.1016/j.respol.2011.02.005

Huang, C., Fang, S., Wu, H., Wang, Y., & Yang, Y. (2024). Low-Altitude Intelligent Transportation: System Architecture, Infrastructure, and Key Technologies. *Journal of Industrial Information Integration, 42,* Article ID: 100694. https://doi.org/10.1016/j.jii.2024.100694

Huang, W., Wei, Y., Guo, J., & Cao, J. (2017). Next-Generation Innovation and Development of Intelligent Transportation System in China. *Science China Information Sciences, 60,* Article ID: 110201. https://doi.org/10.1007/s11432-017-9182-x

Kern, F., & Howlett, M. (2009). Implementing Transition Management as Policy Reforms: A Case Study of the Dutch Energy Sector. *Policy Sciences, 42,* 391-408. https://doi.org/10.1007/s11077-009-9099-x

Mavrot, C., Hadorn, S., & Sager, F. (2019). Mapping the Mix: Linking Instruments, Settings and Target Groups in the Study of Policy Mixes. *Research Policy, 48,* Article ID: 103614. https://doi.org/10.1016/j.respol.2018.06.012

Nuñez-Jimenez, A., Knoeri, C., Hoppmann, J., & Hoffmann, V. H. (2022). Beyond Innovation and Deployment: Modeling the Impact of Technology-Push and Demand-Pull Policies in Germany's Solar Policy Mix. *Research Policy, 51,* Article ID: 104585. https://doi.org/10.1016/j.respol.2022.104585

Rothwell, R., & Zegveld, W. (1984). An Assessment of Government Innovation Policies. *Review of Policy Research, 3,* 436-444. https://doi.org/10.1111/j.1541-1338.1984.tb00138.x

Sun, L., & Yin, Y. (2017). Discovering Themes and Trends in Transportation Research Using Topic Modeling. *Transportation Research Part C: Emerging Technologies, 77,* 49-66. https://doi.org/10.1016/j.trc.2017.01.013

Wang, P., & Li, F. (2021). Science, Technology and Innovation Policy in Russia and China—Mapping and Comparisons in Objectives, Instruments and Implementation. *Technological Forecasting and Social Change, 162,* Article ID: 120386. https://doi.org/10.1016/j.techfore.2020.120386

Wang, X., Zou, H., Zheng, Y., & Jiang, Z. (2019). How Will Different Types of Industry Policies and Their Mixes Affect the Innovation Performance of Wind Power Enterprises? Based on Dual Perspectives of Regional Innovation Environment and Enterprise Ownership. *Journal of Environmental Management, 251,* Article ID: 109586. https://doi.org/10.1016/j.jenvman.2019.109586

Yin, X., Zhang, J., & Zheng, X. (2024). How Does Digital Economy Influence Green Mobility for Sustainable Development? Moderating Effect of Policy Instruments. *Sustainability, 16,* Article No. 9316. https://doi.org/10.3390/su16219316

Zhu, Y., Wang, Z., & Zhu, L. (2021). Does Technological Innovation Improve Energy-Environmental Efficiency? New Evidence from China's Transportation Sector. *Environmental Science and Pollution Research, 28,* 69042-69058. https://doi.org/10.1007/s11356-021-15455-4