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Mapping New Quality Productive Forces
A Grounded Theory Approach Enhanced by DeepSeek

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Abstract: New quality productive forces have become a central driver of China's transition toward high-quality economic development. This study employs a grounded theory approach and integrates DeepSeek, a large language model, to construct an evaluation framework based on five dimensions: technological innovation, industrial restructuring, institutional coordination, green transformation, and social support. The analysis reveals that these productive forces operate as a co-evolutionary system that combines technology, institutions, and society. It emphasizes the dynamic interaction among foundational technological breakthroughs, policy innovation, and the alignment of human capital. The proposed framework provides both theoretical insights and practical guidance to support innovation-driven development while addressing ecological sustainability.

Keywords: DeepSeek; Grounded Theory; New Quality Productive Forces; Evaluation Framework

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1.Introduction

In recent years, the global economy has been undergoing profound transformations, driven by accelerated technological innovation and continuous industrial restructuring. Within this evolving context, China's economic development is transitioning from a phase of high-speed growth to one that emphasizes high-quality development. The traditional model based on factor-driven expansion is gradually being replaced by a new development paradigm, characterized by innovation-led growth, low-carbon initiatives, and the rise of the digital economy. The concept of "new quality productive forces" has emerged under these conditions as a central engine for economic transformation and industrial upgrading.

Concurrently, the rapid development of artificial intelligence (AI), particularly large-scale language models such as DeepSeek, has opened new frontiers for both theoretical research and practical applications in the field of productivity studies. DeepSeek is capable of efficiently processing and analyzing complex data from the domains of economics, science, and industry. This capability provides more accurate support for constructing evaluation systems. With strengths in natural language processing, automated knowledge generation, and decision assistance, tools like DeepSeek enable policymakers, enterprises, and researchers to develop more responsive strategies, predict economic trends, and promote collaborative innovation (Wang & Kantarcioglu, 2025; Allen, 2025). Incorporating such AI technologies into academic inquiry helps to overcome conventional methodological limitations, encouraging interdisciplinary integration and enhancing the systematic study of new quality productive forces.

Guided by these developments, this study investigates the conceptual foundations, structural features, and evolutionary logic of new quality productive forces. It further aims to build a scientifically robust evaluation framework by integrating AI-assisted analysis, offering novel insights and methodological pathways to better understand and assess this emerging economic paradigm.

2.Literature Review

The concept of "new quality productive forces" represents a theoretical breakthrough from traditional paradigms of productivity. It responds to the need to restructure productive forces under the dual imperatives of the digital technology revolution and sustainable development. From a historical perspective, productivity theory has gradually moved beyond a linear factor-based model centered on capital and labor since Schumpeter's pioneering theory of innovation-driven growth (Evangelista, 2018). Later, Freeman expanded the analytical scope by incorporating institutional environments into the framework of national innovation systems (Huang et al., 2024). More recently, studies such as Li et al. (2021) have shown that in the context of the digital economy, technological change has a significant nonlinear impact on total factor productivity. These theoretical advances reflect a growing recognition that traditional productivity theories are insufficient to explain the driving forces behind high-quality development in an era of rapid technological advancement, institutional diversity, and social restructuring.

In this context, the notion of new quality productive forces has gradually gained prominence in both academic and policy circles. In China, the term was formally introduced by President Xi Jinping in 2023, who emphasized the central role of scientific and technological innovation while calling for coordinated development across technological revolutions such as artificial intelligence, institutional restructuring such as data ownership reforms, and broader societal transformations such as the dual carbon strategy (Xie et al., 2024). This marked a new phase in the evolution of China's productivity theory. In contrast to Porter's theory of competitive advantage, which focuses on factor endowments and industrial structure, the framework of new quality productive forces places greater emphasis on disruptive technological innovations, such as quantum computing, and their critical role in enabling transformative upgrades of traditional industries. As such, it presents a more complex and systemic perspective (Rubio-Andrés et al., 2024).

Despite increasing scholarly interest, the evaluation of new quality productive forces remains an area marked by disagreement and fragmentation (Yao et al., 2025). The technology-oriented school argues that the essential features of new quality productive forces arise from the emergence of original and disruptive technologies (Zheng, 2024). These innovations have redefined the functions and configurations of traditional production elements—such as labor, tools, and materials—and have introduced new elements like data and information. This has enabled a qualitative leap in productivity. However, while such frameworks are operationally feasible, they often fall short in addressing regional disparities in technological capabilities and variations in local innovation ecosystems (Xue & Chen, 2025). In parallel, the institution-oriented school centers its analysis on changes in production relations and institutional innovations. It often uses policy text analysis to quantify institutional effectiveness, for instance through policy quality indexes or incentive strength metrics (Huang & Li, 2025). Yet these methods face empirical challenges such as semantic complexity in policy language and time-lagged policy effects.

In sum, new quality productive forces represent a vital engine for China's high-quality economic development. Developing a scientific evaluation framework for this concept is therefore not only a theoretical priority but also a practical necessity for policymaking and resource allocation. At the same time, AI-powered tools such as DeepSeek introduce new possibilities for overcoming traditional methodological bottlenecks. Accordingly, this study adopts an integrated framework that combines grounded theory with large-scale AI models. This approach enhances the consistency and efficiency of text coding, better captures the semantic depth of policy discourse, and facilitates a transition from manual interpretation to AI-enhanced theoretical modeling. Ultimately, it aims to offer both conceptual clarity and technical support for constructing an effective evaluation framework for new quality productive forces.

3.Research Design

3.1 Research Methodology

This study adopts grounded theory as the primary research method and integrates DeepSeek, a large-scale language model, to assist with data processing, coding, and theory development. Grounded theory emphasizes deriving conceptual categories and theoretical frameworks directly from empirical data through systematic coding procedures. It is particularly well-suited for exploratory research, especially in fields such as new quality productive forces, which remain in the early stages of theoretical development. By incorporating DeepSeek, the study enhances the efficiency of data processing and improves the scientific rigor and structural consistency of theory construction.

Data Collection

This study employed big data techniques to collect and filter policy documents and news articles issued by Chinese government and official media sources. Texts were selected based on their relevance to the concept of new quality productive forces, with particular attention to policy authority, thematic clarity, and representativeness across different time periods and administrative levels. The final dataset consists of 127 documents, including 18 policy documents, 18 government reports, and 91 news articles.

Table 1 Statistics of Data Types and Quantities

Category	Number of Documents
Policy Documents	18
Government Reports	18
News Articles	91

4.Coding Process

4.1 Open Coding

During the open coding stage, over 480 distinct codes were generated using DeepSeek through the analysis of 127 policy-related texts published between September 18, 2023, and March 10, 2025. These texts, issued by official government sources, reflect the evolving discourse on the development of new quality productive forces.

The results of the coding process reveal a clear shift in thematic focus over time. In the early stages, discussions primarily concentrated on initial exploration, often approached from a user-centric perspective. As policy efforts progressed, the discourse gradually expanded to emphasize broader stakeholder engagement, cross-sector coordination, and the simultaneous pursuit of technological advancement and systemic security. These trends are reflected in the codes, which capture both direct policy directives such as “prioritizing science and technology-driven development” and “accelerating the formation of new quality productive forces” as well as practical strategies including “digital empowerment,” “industrial chain collaboration,” and “green and low-carbon transformation.” The emergence of these codes corresponds closely with the phased evolution of policy priorities during the 2023 to 2025 period. Table 2 provides selected examples of initial codes, and Table 3 further illustrates how the model effectively extracted meaningful thematic patterns from the overall dataset.

Table 2. Examples of Initial Conceptualization (Selected)

Date	Document Title	Initial Concepts	Quoted Example
2023/9/18	Xinhua Commentary: Leading Development with Scientific and Technological Innovation – First in the Series on Accelerating the Formation of New Quality Productive Forces	Science and technology as the driving force	“Prioritizing scientific and technological innovation in development”
		New quality productive forces	“Accelerating the formation of new quality productive forces”
		Self-reliance and overcoming bottlenecks	“Working urgently to achieve self-reliance in science and technology and overcome key bottlenecks”
		Commercialization of research outcomes	“If going from zero to one represents original breakthroughs, then market application is the path from one to infinity”

Date	Document Title	Initial Concepts	Quoted Example
2023/9/18	Xinhua Commentary: Leading Development with Scientific and Technological Innovation – First in the Series on Accelerating the Formation of New Quality Productive Forces	Increased R&D investment	"In recent years, China's basic research funding has increased from 49.9 billion yuan in 2012 to 202.35 billion yuan in 2022"
		Innovative policy instruments	Improving the competitive leader selection mechanism by releasing 28 major task lists.
		Strategic emerging industries	"Vigorously developing strategic emerging industries such as new energy, new materials, advanced manufacturing, and electronic information"
		Integration of innovation and industry	"Accelerating the integration of scientific innovation and industrial development"
		Industrial modernization and upgrading	"Promoting qualitative, efficiency, and power shifts in economic development"

Table 3. Initial Category Coding

Initial Category	Conceptual Elements	Source Examples
Technological innovation capacity	Strength in science and education, increased R&D investment, key core technology breakthroughs, original disruptive innovations, policy instruments, institutional reforms, innovation-driven strategy, international cooperation	Central and local government reports, policy briefings, national innovation directives
Industrial restructuring pathways	Deep integration of innovation and industry, strategic emerging industries, future industry planning, commercialization of research, industrial upgrading, national science projects, modernization of the industrial system	Commentaries on industrial upgrading, work reports, statements on innovation-industry integration
Digital empowerment mechanisms	Industrial automation, development of data markets, intelligent manufacturing, metaverse industries, AI applications, digital transformation, computing infrastructure, enterprise digitalization, intelligent operations, autonomous driving	National plans on smart manufacturing, digital economy policies, local pilot projects
Institutional innovation and policy tools	Capital market reforms, competitive leader selection mechanisms, data governance innovations, regional coordination strategies, innovation-friendly policies, factor market reform, science and technology system reform, IP protection, major project investment tools	National policy speeches, five-year plans, ministerial regulations
Green development paradigm	Green productivity, expansion of the NEV industry, low-carbon technologies, circular economy, biomedical innovation, carbon neutrality goals, environmentally friendly technologies, hydrogen energy pilot programs	Policy series on ecological civilization, government work reports, sustainability-focused white papers
Human capital support system	Cultivation of new labor forces, integration of education–research–industry, training of top talent, vocational education reform, promotion of craftsmanship spirit, talent development systems, youth scientist support, international academic cooperation	Speeches by central leadership, Ministry of Education guidelines, provincial education reform documents
Enterprise-driven innovation ecosystem	Role of enterprises as innovation actors, transformation of research outcomes, joint innovation mechanisms, industrialization of R&D, innovation platforms, SME innovation support, research–market matchmaking, restructuring of research institutes	Reports from SOEs and private enterprises, industrial policy updates, commentary on commercialization of innovation
Global competition and cooperation strategies	Regional integration (e.g., Yangtze River Delta), global competitiveness, industrial chain restructuring, international technology exports, innovation clusters, cross-border data flows, international phenomics projects	International cooperation strategies, regional development reports, Belt and Road policy documents
Frontier technology sources	Increase in basic research funding, deployment of large science facilities, quantum R&D, brain–computer interface research, controlled nuclear fusion, general-purpose AI, mesoporous materials, humanoid robotics, third-generation superconducting quantum computers	Reports on major technology projects, expert briefings, science and technology white papers
Modernization of social governance	Public service improvements, data-driven governance, smart cities, health technologies, elderly care solutions, educational equity, autonomous logistics, intelligent emergency response systems	Smart city blueprints, digital governance frameworks, social service innovation reports

4.2 Axial Coding

The purpose of axial coding is to refine and organize the initial codes generated during open coding by identifying their internal relationships and grouping them into higher-level conceptual categories. With the support of DeepSeek's topic modeling capabilities, this stage enabled the identification of recurring themes and the construction of a more abstract and structured coding framework.

Based on a thorough analysis of policy texts and empirical examples, the study extracted five core categories: technological innovation, industrial ecosystem restructuring, green development, institutional and market coordination, and social and human capital support. These categories reflect the key dimensions through which new quality productive forces are conceptualized in both policy narratives and practical implementation.

Table 4. Results of Axial Coding

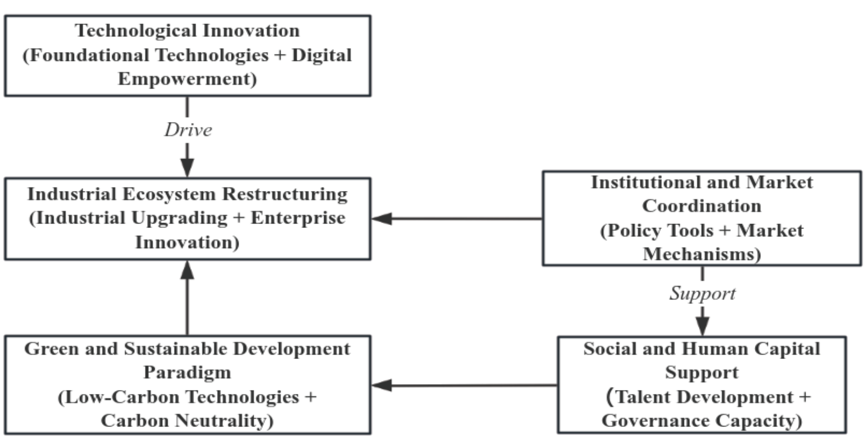
Core Category	Initial Categories	Category Description
Technological Innovation	Technological innovation capacity, Frontier technology sources, Digital empowerment mechanisms	The core driving force of new quality productive forces stems from breakthroughs in foundational research and the widespread application of digital technologies such as the industrial internet.
Industrial Ecosystem Restructuring	Industrial restructuring pathways, Enterprise-driven innovation ecosystem	Focuses on integrating strategic emerging industries with scientific innovation and upgrading traditional industries to build a closed loop from technology to application to market outcomes.
Green and Sustainable Development	Green development paradigm	Green productivity is a defining feature of new quality productive forces. Through carbon neutrality goals, hydrogen energy programs, and circular economy initiatives, it ensures the alignment of economic growth with ecological sustainability.
Institutional and Market Coordination	Institutional innovation and policy tools, Global competition and cooperation strategies	Relies on institutional design and global strategies to break administrative barriers, stimulate market activity, and coordinate innovation policies with industrial transformation.
Social and Human Capital Support	Human capital support system, Modernization of social governance	Emphasizes talent cultivation and governance reform, forming a support network that strengthens institutional performance and enhances long-term innovation capacity.

4.3 Selective Coding

4.3.1 Model Construction

Selective coding represents the final phase of grounded theory analysis. In this stage, the five core categories—technological innovation, industrial restructuring, institutional coordination, green development, and social support—were integrated to form a unified conceptual model. The model reveals the core logic underlying the emergence of new quality productive forces. Specifically, it illustrates how technological breakthroughs drive industrial upgrading, how institutional policies provide structural support, and how social and human capital offer foundational guarantees. The green development paradigm functions as an external constraint that shapes the direction and boundaries of this transformation. Together, these elements constitute a dynamic cycle of innovation, upgrading, support, and sustainability.

Figure 1. Development Model of New Quality Productive Forces



By linking the five core categories, the study conceptualizes new quality productive forces as a co-evolutionary system involving technology, institutions, and society. DeepSeek was employed to assist in generating the visual representation of the model and to validate its internal logic. The result is a five-dimensional framework that illustrates the complex interdependencies among various forces contributing to high-quality economic development.

4.4.2 Model Interpretation

The proposed model reveals the structural logic and dynamic mechanism underlying the formation of new quality productive forces. At its core, technological innovation functions as the initiating mechanism that sets the system in motion. Through foundational research breakthroughs and the deployment of digital technologies, this dimension reshapes traditional production factors and introduces new ones such as data, algorithms, and computing power. It does not operate in isolation, but rather triggers downstream restructuring throughout the industrial ecosystem.

Industrial ecosystem restructuring serves as the primary channel for translating technological potential into economic value. This transformation is not limited to isolated upgrading of specific sectors but entails a systemic reorganization of industrial chains, value networks, and innovation platforms. Strategic emerging industries are embedded into existing structures through processes of coupling and substitution, while traditional sectors are revitalized through technological retrofitting and cross-sectoral integration.

Institutional and market coordination plays a critical enabling and stabilizing role. It creates the necessary institutional infrastructure to reduce transaction costs, allocate innovation resources efficiently, and align market incentives with long-term technological development. This dimension also mitigates the risks associated with uncertainty in innovation by providing regulatory clarity, financial support, and platform governance. The coordination of administrative regulation with market flexibility ensures adaptive policy feedback, which is essential in complex innovation systems.

The dimension of social and human capital support represents the underlying capacity condition of the system. Talent formation, knowledge transfer, and governance capabilities constitute the soft infrastructure that sustains long-term innovation. These human and institutional resources not only absorb and diffuse technological change, but also ensure its contextual adaptation and social acceptability. In this sense, social support is not a passive backdrop but an active participant in shaping the trajectory and effectiveness of new quality productive forces.

Green and sustainable development functions as an external constraint as well as a normative orientation. It sets ecological boundaries within which technological and industrial transformation must take place. This dimension introduces a teleological logic to the model by defining what constitutes “quality” in productive forces. Sustainability is not only an outcome but also a guiding principle that influences decision-making across all other dimensions.

The interaction among these five core dimensions forms a recursive and co-evolutionary system, driven by feedback loops, mutual reinforcement, and functional complementarity. Technological breakthroughs stimulate institutional adaptation; institutional arrangements, in turn, shape innovation pathways; social foundations absorb and sustain systemic change; and green constraints redirect innovation toward long-term equilibrium. The model thus conceptualizes new quality productive forces as an integrated and adaptive system characterized by innovation-driven transformation, institutionally conditioned evolution, and ecologically bounded development.

5.Validation with LDA Topic Modeling

To further verify the robustness and explanatory power of the grounded theory model, this study applies Latent Dirichlet Allocation (LDA) to conduct topic modeling on the full corpus. LDA is a probabilistic generative model that identifies latent semantic structures within a large volume of unstructured text (Liao, 2025). It is particularly useful for uncovering implicit themes in policy discourse and provides empirical support for the conceptual categories established during the qualitative coding process.

The analysis was conducted using Python, and the optimal number of topics was determined through a coherence score test. As shown in Figure 2, coherence scores peaked when the number of topics was set to 5, indicating that a five-topic solution achieves the best semantic interpretability and thematic consistency. Each topic generated by the model was manually labeled based on the top 20 keywords and representative texts associated with it. The resulting topics correspond closely to the five core categories identified in the grounded theory analysis: technological innovation, industrial restructuring, green development, institutional coordination, and social support. This high degree of alignment between the LDA results and the conceptual model reinforces the validity of the theoretical framework constructed in this study.

Table 5. LDA Topic Extraction Results and Corresponding Manual Labels

No.	Top Keywords	Manual Label
1	industrial upgrading, intelligent manufacturing, integration, enterprise, scenario, application, industry, transformation, platform, chain	Industrial Restructuring
2	talent, training, education, youth, innovation, development, support, mechanism, governance, employment	Social and Human Capital Support
3	green, carbon, low-carbon, hydrogen energy, emission reduction, neutrality, ecology, resources, environment, recycling	Green and Sustainable Development
4	technology, innovation, science, digital, breakthrough, core technologies, internet, platform, research, data	Technological Innovation
5	reform, system, coordination, market, investment, globalization, policy, mechanism, capital, regulation	Institutional and Market Coordination

6.Discussion

This study applies grounded theory, supported by large language model tools, to extract latent logic from policy discourse. Based on a corpus of policy documents, government reports, and media texts, it constructs a five-dimensional framework consisting of technological innovation, industrial ecosystem restructuring, green development paradigm, institutional and market coordination, and social and human capital support. This model reflects the multi-level structure and systemic logic of new quality productive forces.

The model shows that new quality productive forces are not composed of a single factor, but are the result of the co-evolution and interaction among multiple dimensions. Technological breakthroughs initiate the transformation of the industrial ecosystem. Institutional and market systems provide external structural support and incentive guidance. Social and human capital act as the foundation for sustaining innovation. Meanwhile, green development defines the boundary and direction of transformation. These five dimensions form an internally consistent system, reflecting the comprehensive requirements of high-quality development in the new era.

At the methodological level, this study attempts to incorporate large language models into the grounded theory process. Compared with traditional manual coding, AI assistance enhances efficiency, improves coverage, and provides semantic consistency in open coding. At the axial coding stage, the topic modeling capability of the large language model effectively identifies internal semantic links and conceptual clusters, reducing the subjectivity of human aggregation. During selective coding, model-generated visual tools assist in structural inference and help validate theoretical saturation. This approach compensates for the limitations of traditional grounded theory in handling large-scale and complex policy texts.

However, the use of large language models also presents certain risks. First, as a language generation tool, the model's understanding of social context is limited, and it may produce structurally coherent but semantically hollow interpretations. Second, the interpretability of the model remains opaque, making it difficult to fully explain how specific conceptual associations are generated. Therefore, in the application of grounded theory, large models should not replace human interpretation but rather serve as an auxiliary mechanism to enhance inductive analysis.

In sum, this study provides a preliminary demonstration of combining grounded theory with AI tools in policy research. It shows that under conditions of strict human oversight, AI-assisted coding can enhance analytical transparency and efficiency while retaining the theoretical depth and flexibility of grounded theory.

7.Conclusion

This study takes new quality productive forces as its core research object and, through grounded theory methods supported by large language model tools, constructs a five-dimensional analytical framework consisting of technological innovation, industrial ecosystem restructuring, green development paradigm, institutional and market coordination, and social and human capital support. This framework reveals the internal structure and operating logic of new quality productive forces, and provides a conceptual basis for subsequent measurement and evaluation.

Methodologically, this study explores the feasibility of combining grounded theory with AI-based text analysis, offering a scalable and transparent approach to theory development from large-scale unstructured policy texts. The model demonstrates that artificial intelligence can play a supportive role in the qualitative research process without undermining its inductive logic.

Overall, this study provides a theoretical foundation for understanding new quality productive forces and offers a potential reference framework for future policy design and empirical evaluation.

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Conflict of Interests

The authors declare that there is no conflict of interest regarding the publication of this paper.

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Appendix: Instructional Protocol for AI-Assisted Grounded Theory Research

This study adopts grounded theory as the core qualitative research strategy to systematically analyze the conceptual structure and categorical composition of China's policy discourse on "new quality productive forces." To enhance efficiency, reduce subjectivity, and improve semantic depth and breadth, a large language model (DeepSeek R1) was introduced as a coding support tool. The following records the instructions issued to the AI system at each stage of the research process, enhancing reproducibility and procedural transparency.

Step 1: Open Coding: Instruction Design and Execution

During the open coding stage, the researcher uploaded and annotated representative raw policy documents, including media commentaries, government work reports, and departmental policy drafts. The instruction to the AI was as follows:

"Please analyze each policy text provided, identify core semantic units with theoretical relevance, and extract potential concepts. Each concept should be accompanied by its original citation sentence. The output structure should include document date, title, initial conceptual item, and quoted text."

Based on this instruction, the AI system performed automated text parsing and preliminary coding, with researcher review to confirm meanings, standardize terminology, and add interpretive notes. The results focused on high-frequency policy terms and governance intentions such as "technological innovation leadership," "industrial chain coordination," and "green and low-carbon transformation."

Step 2: Initial Category Formation: Instruction for Semantic Grouping

Upon completion of open coding, the study proceeded to group concepts into initial categories. The instruction was:

"Please group all previously generated initial concepts based on semantic similarity. Each category should include: a category name, a set of included concepts, a brief definition, and examples of source documents."

This stage facilitated the transition from concept-level to category-level abstraction, laying the foundation for mid-level analysis. It resulted in eight initial categories, such as "basic capacity for technological innovation," "institutional incentive mechanisms," and "green transformation practices."

Step 3: Axial Coding: Instruction for Core Category Construction

To raise the level of theoretical abstraction, the researcher guided the AI through axial coding. The instruction was:

"Based on the existing initial categories, extract and integrate 5 to 7 higher-level core categories that serve as the first-tier structure of theoretical analysis. Each core category should clearly indicate its included initial categories, structural characteristics, and analytical function."

Through identifying dynamic relationships among policy objects, instruments, and goals, the study identified five core categories: "technological innovation," "industrial ecosystem restructuring," "green and sustainable development paradigm," "institutional and market coordination," and "social and human capital support." This five-dimensional structure provided a coherent framework for theorizing the formation and evolution of new quality productive forces.

Step 4: Selective Coding: Instruction for Model Integration

After establishing axial categories, the researcher instructed the AI to perform selective coding and assist in theoretical model construction. The instruction was:

"Based on the established core categories, identify causal pathways and feedback mechanisms, and construct a theoretical model describing the formation of 'new quality productive forces.' The model should include: core dimensions, structural logic (e.g., spiral, hierarchical, or cyclical), and interaction mechanisms."

The AI generated a dynamic path model of "innovation → upgrading → support → ecological constraint." After interpretive refinement by the researcher, this was finalized into a five-dimensional spiral co-evolution model centered on the "technology–institution–society" triadic interaction.

Step 5: Theoretical Saturation Test

To ensure theoretical saturation, additional policy documents were input, and the AI received the following instruction:

"Please apply the same open coding and category matching process to the new texts. Determine whether any novel concepts or categories emerge. If none, confirm that the theoretical model is saturated."

The results showed that while new examples enriched existing categories, no new conceptual dimensions emerged, supporting the model's explanatory sufficiency and structural stability.

Note: AI Tools and Roles

The AI platform employed was DeepSeek-R1, which supported the following functions:

- Semantic recognition and concept extraction
- High-dimensional text clustering and topic modeling
- Categorical inference and structural simulation
- Stability testing of researcher-refined models

AI was used solely as a recommendation engine for coding. Final concept formation and model structuring remained under the researcher's control to ensure theoretical validity and semantic rigor.