Optimizing the Transmission of Territorial Spatial Planning Use Controls through "Semantic–Element" Analysis: A Case Study of Changsha, Hunan

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Abstract: Under China's territorial spatial planning reform, establishing effective pathways for transmitting land- and space-use controls is essential to improving coordination, operability, and implementation. As the "five levels and three categories" planning system has been put into local practice, institutional effectiveness has improved, but problems in both vertical and horizontal transmission have become increasingly apparent. Combining "semantic–element" analysis with interviews of planning practitioners, this paper divides municipal use-control elements into three categories—indicators, spatial elements, and action or project matters—and clarifies their regulatory meanings. Using Changsha as a case, it identifies major problems in transmitting controls among the municipal master plan, sectoral plans, and detailed plans. Policy recommendations are proposed in three areas: clarifying the semantic objects and meanings of transmission elements; establishing the sequence and rules governing transmission pathways; and creating an integrated information platform that coordinates rigid control with flexible guidance. The study provides support for unifying the intentions of territorial spatial planning use control and improving plan implementation.

Keywords: territorial spatial planning; use control; transmission; semantic–element analysis

For many years, China's spatial-planning cluster—principally major-function-zone planning, land-use planning, and urban and rural planning—was administered by different departments at different levels. Each department built an extensive planning and legal system around its own authority, producing conflicts and overlaps in planning content. In May 2019, the Central Committee of the Communist Party of China and the State Council issued the *Opinions on Establishing and Supervising the Implementation of the Territorial Spatial Planning System* (hereafter the *Opinions*) [1], initiating a systematic and comprehensive restructuring of spatial planning.

Hunan Province issued its own implementation opinion in September 2020 [2], completing the top-level design of the provincial system and emphasizing an implementation-oriented transmission mechanism. Territorial spatial planning transmits objectives and elements through a hierarchical and categorical structure and uses use control to bridge plan preparation and implementation. Use control is not merely applied after plan approval; implementation and the top-level design of controls must be considered during plan preparation [3].

Transmission is complicated because subordinate spatial units differ in regional characteristics, functions, and development conditions. Control content is therefore difficult to classify, tier, and implement in ways that match management needs. A 2022 major research project commissioned by the Hunan Department of Natural Resources examined this problem. Building on that work, the present study analyzes the *Guidelines for the Preparation of Municipal Territorial Spatial Master Plans (Trial)* (hereafter the *Guidelines*), Changsha's territorial spatial master plan, and relevant sectoral plans. Through "semantic–element" analysis, it identifies municipal use-control elements and their regulatory meanings, maps hierarchical and categorical pathways, examines semantic deviations in transmission from master to sectoral and detailed plans, and proposes improvements. By focusing on textual semantics and the interpretation of planning transmission, it introduces a text-based approach for implementing use control and ensuring that overall planning intentions and objectives are conveyed effectively.

1 Research Foundations for Use-Control Transmission Based on "Semantic–Element" Analysis

1.1 Applications of Semantic Analysis in Spatial Planning

Modern semantics treats the meanings of morphemes, words, phrases, sentences, and groups of sentences as semantic content [4]—the concepts expressed by linguistic signs and the relationships among them. In 1957, psychologist Charles E. OSGOOD introduced semantic analysis in psychology, using scales of semantically differentiated words to assess respondents' perceptions. The method was later applied in architecture to user perception and evaluation of places [5–7].

With smart-city development and natural-language processing, semantic analysis has expanded from measuring affective tendencies to text segmentation, semantic-network construction, policy-evolution research [8], and planning-text interpretation [9]. YANG Di used semantic networks in successive Chongqing master plans to reveal changes in core planning ideas [9]. WANG Xinzhe and XUE Haoying emphasized precise professional terminology and began constructing a vocabulary for transmitting territorial spatial master plans [10]. ZHOU Jianyun and QI Dongjin examined urban land-use classification from the perspective of planning linguistics and demonstrated the effects of semantic expression on land control [11].

In 2019, the Ministry of Natural Resources proposed a "one-map" implementation and supervision system, accelerating multimodal data integration in spatial planning. As complex information converges, unified and hierarchically consistent textual semantics have become critical to transmitting all planning elements and their control requirements effectively.

1.2 Transformation of Use Control and Progress in Transmission Research

Since establishment of the territorial spatial planning system, Chinese scholarship has examined the concept, theoretical foundations, and implementation instruments of use control [3, 12–13]. LIN Jian et al. defined use control as requiring and supervising owners and users to use territorial space strictly according to the uses and conditions established by spatial plans, emphasizing coordination with hierarchical plan transmission [14].

Use control has also undergone substantial transformation. ZHANG Xiaoling and LÜ Xiao described shifts from protecting individual land categories to coordinating space as a whole and from indicator-dominated transmission to combined indicator and zoning control [15]. YU Haitao et al. argued that use control must connect closely with zoning and categorical spatial controls to overcome fragmented and unrelated regulatory rules [12]. Other studies distinguish region-based and element-based properties [16], identify transmission elements according to administrative authority [17], and construct rules for comprehensive use control based on functional zoning [18]. Research has progressed from concepts and theory toward implementation and institutional innovation, yet transmission is still obstructed by ambiguous and inconsistent elements. Few studies feed these practical problems back into the guidance texts governing planning implementation.

2 Municipal Use-Control Transmission through "Semantic–Element" Analysis

2.1 Analytical Framework

The framework is designed to clarify the core content and pathways of use-control transmission, diagnose problems, and ensure that regulatory intentions are communicated and implemented accurately.

First, it asks **what is transmitted**. "Semantics" refers to the meaning, regulatory rules, and degree of mandatory force conveyed by planning texts and diagrams; it represents the purpose of transmission. "Elements" are the substantive objects of control, such as spatial functions and facility provision. Semantic–element analysis translates the macro content of a master plan into specific control elements and meanings that can be transmitted to subordinate plans.

Second, it examines **how transmission occurs**. Horizontally, sectoral plans from different professional fields may impose different requirements on the same element. Vertically, master, sectoral, and detailed plans regulate the same element at different levels of depth. After identifying the elements in the master plan, semantics must be integrated and refined so that sector-specific rules and constraints remain coordinated and a coherent transmission pathway can be constructed.

Third, it evaluates **how well transmission works**. The accuracy, completeness, and continuity of regulatory semantics are assessed across plan types. Planning cases and expert interviews are used to identify bottlenecks. At the element level, these may appear as land-use conflicts or weak protection of distinctive townscape; at the semantic level, they may reflect vague or inconsistent wording.

The diagnosed problems are ultimately fed back into guidance documents so that planners, implementers, and supervisors can correctly interpret and execute the numerous requirements and measures within the system (Figure 1).

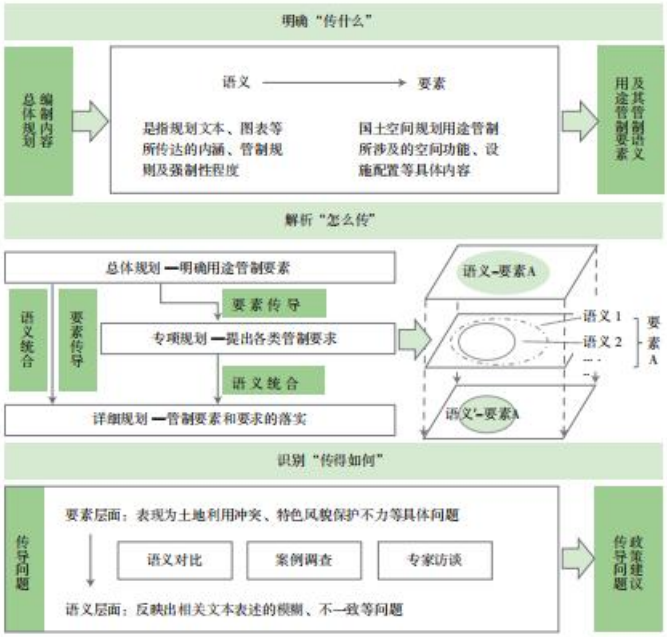

Figure 1. "Semantic–element" analytical framework for use-control transmission in municipal territorial spatial planning.

2.2 Control Elements and Transmission Pathways

The *Guidelines* organize municipal master planning into nine principal content modules. Drawing on these modules and previous studies of planning transmission [19–25], the analysis identifies 11 municipal use-control

elements, grouped into three types: **indicator**, **spatial**, and **matter/action** elements (Table 1). Each carries a specific meaning at different planning levels, enabling consistency and progressive refinement.

Indicator elements express regulatory meaning numerically and control the protection and use of territorial resources through parameters. They include binding, anticipated, and advisory indicators, moving from strict, uniform constraints toward locally adapted target setting. Municipal master plans define key parameters for land-resource use and ecological protection; sectoral and detailed plans then translate and implement these values.

Spatial elements express geographical location and extent through lines, surfaces, and three-dimensional boundaries. Control-line systems have rigid, inviolable meanings; distinctive-character areas use more flexible boundaries to guide spatial form; planning zones regulate permitted functions within defined areas. Transmission converts upper-level intentions into mapped lines and zoning boundaries, maintaining spatial stability and preventing development beyond established limits.

Matter/action elements are controlled through textual descriptions and projects. At the master-plan level they include facilities, governance actions, and major projects. Their purpose is to establish construction objectives and provide indicative spatial guidance. Sectoral and detailed plans then refine standards, boundaries, and requirements, transforming project-oriented control into parcel or boundary control.

Table 1. Use-control elements in the *Guidelines for the Preparation of Municipal Territorial Spatial Master Plans (Trial)* under "semantic–element" analysis

Type	Element	Regulatory meaning
Indicator	Binding indicator	Must not be exceeded or must be achieved during the planning period
Indicator	Anticipated indicator	Target to be achieved or not exceeded according to socioeconomic-development expectations
Indicator	Advisory indicator	Optional indicator selected according to local conditions
Spatial	Control-line system	Coordinated delineation of inviolable red lines for development and construction
Spatial	Planning zone	Functional zone based on major-function positioning, planning intention, and associated control requirements
Spatial	Distinctive-character space	Urban and rural landscape areas requiring heritage protection, character shaping, or height control
Matter/action	Urban and rural public-service facilities	Hierarchical standards and layout requirements for medical, cultural, educational, sports, welfare, funeral, and related facilities
Matter/action	Urban and rural infrastructure	Layout of major transport and energy corridors, water projects, and networked transport, energy, water, information, logistics, and solid-waste facilities
Matter/action	Major disaster-prevention facilities	Standards, layout requirements, and measures for flood and tidal defense, earthquakes, fire control, civil defense, and epidemic prevention
Matter/action	Ecological restoration, comprehensive land consolidation, and urban renewal	Objectives, priority areas, and lists of major projects and actions
Matter/action	Historical and cultural heritage	Integrated inventories of protected cultural relics, historic towns and villages, historic buildings, and other heritage resources

Together, the three types form the municipal use-control system: indicators provide parametric control, spatial elements define boundaries, and matter/action elements implement projects. Through categorical decomposition from master to sectoral and detailed plans, semantics and elements are progressively refined from overall intention to parcel-level rules (Figure 2).

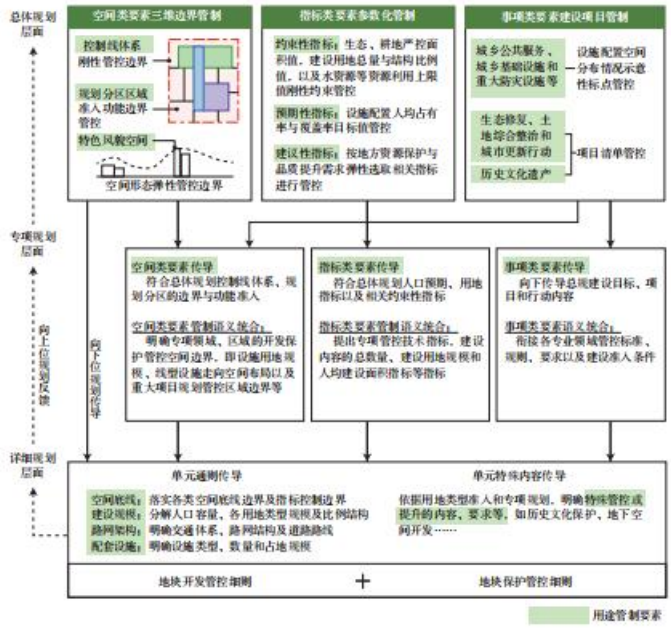

Figure 2. Transmission pathways for use-control elements under "semantic–element" analysis.

3 Main Problems in Municipal Transmission: Evidence from Changsha

The study analyzes Changsha's management policies and selected publicly available master, sectoral, and detailed plans and combines them with semi-structured interviews with planning managers and technical staff.

3.1 Misalignment between the Semantic Objects of Indicators in Sectoral and Detailed Plans

Historically, urban construction areas dominated planning, while non-concentrated development areas lacked systematic and fine-grained guidance. The territorial spatial planning system partly corrected this through integrated village planning beyond urban development boundaries. Yet where detailed plans do not effectively cover non-construction space, insufficient fine-grained zoning can lead to blanket prohibitions on construction that ignore local characteristics and hinder resource optimization.

Sectoral plans seek to fill this gap by using the master plan's project database to arrange protection, restoration, and development in special areas or fields and transmit requirements to detailed plans. However, their professional indicators differ significantly from the binding indicators used in detailed plans such as village plans, undermining the requirement for full territorial and all-element coverage.

Changsha's 2023 *Regulations on the Management of Regulatory Detailed Planning* require detailed plans to respect existing conditions and land rights, integrate underground-space and airspace controls, comply with national regulations, and coordinate deeply with sectoral plans and ecological-environment controls [26]. Interviews nevertheless revealed two principal problems. First, the main links among detailed plans, sectoral plans, development plans, and departmental work programs remain the near-term project database of the master plan; no mechanism systematically connects detailed plans to technical indicators in sectoral plans. Second, standards such as per-capita sports-facility provision specified in sectoral plans are often not translated into lower-level plans and may even conflict with detailed-plan control quantities.

Ecological-restoration plans similarly use technical indicators such as plot size and vegetation coverage. Comparison of standards used for land-consolidation projects and village plans shows differences in their semantic objects (Table 3). How professional indicators can be integrated with village-plan indicators such as retained cultivated land and ecological public-welfare forest remains unresolved. Transmission is particularly weak outside urban development boundaries.

Table 2. Examples from practitioner interviews

Interviewee	Main observation	Keyword
Technical planner	Content that cannot be geolocated or vectorized cannot be compared precisely during review. Project databases are used for transmission, but sectoral databases still lack vector data.	Vector data; project database
Planning manager	Different detailed-planning units—industrial parks, residential districts, scenic areas—should receive differentiated sectoral requirements based on complete functional boundaries. How to express such differences remains unresolved.	Differentiation; planning unit
Technical planner	Sectoral elements such as river-and-lake management boundaries and public-welfare forest lines are entered into databases and treated as preconditions for land approval, but	Control elements; control rules

Interviewee	Main observation	Keyword
	their control rules are not integrated.	
Technical planner	Sports-facility standards should be progressively transmitted from municipal indicators to sectoral layout and then parcel coordinates, intensity, and provision requirements. In practice, even the provincial target of 2 m² of sports space per capita by 2025 has not been effectively transmitted. A closed-loop management and supervision mechanism is needed.	Sectoral indicators

Note: In August 2023, the research team conducted semi-structured interviews with eight staff members involved in master, sectoral, and detailed planning at the Hunan Territorial Resources Planning Institute.

Table 3. Comparison of control and planning indicators in the *Planning and Design Specifications for Land Consolidation Projects* (TD/T 1012–2016) and the *Technical Outline for Village Planning in Hunan Province (Revised)*

Dimension	Land-consolidation specification	Hunan village-planning outline
Planning purpose	Improve mountain, water, forest, farmland, and lake landscapes and enhance ecological-landscape services	Provide the statutory basis for territorial development and protection, use control, and land approval in rural areas
Indicators	Share of field infrastructure land, cultivated-plot scale, irrigation-design reliability, protected farmland area, vegetation coverage, etc.	Retained cultivated land, permanent-basic-farmland protection area, ecological-conservation red-line area, ecological public-welfare forest area, planning reserve indicators, etc.

3.2 Unclear Rules for Semantic Integration among Sectoral Plans at the Same Level

Sectoral plans are the critical intermediate layer between the municipal master plan and detailed plans. They refine controls and measures in specialized fields and regions. However, they are prepared by multiple departments, cover numerous types and levels, and vary greatly in depth. Their content often overlaps [27].

The resulting semantic-integration problem has two dimensions. First, different fields define the same use-control element differently. Both the *Changsha Urban Renewal Sectoral Plan (2021–2035)* and the *Changsha Territorial Spatial Sectoral Plan for Public Cultural Facilities (2021–2035)* optimize district-level public-service facilities, but they do not establish a unified definition of function, spatial boundary, or proportion of mixed use. Overlapping or conflicting functions can therefore generate implementation deviations (Figure 3).

Second, the regulatory meanings assigned to the same element may conflict. "Protection of cultural facilities," for example, may emphasize static preservation in a historic-cultural-conservation plan but dynamic mixed use in an urban-renewal plan. Without explicit integration mechanisms and coordination rules, sectoral plans cannot agree on functional positioning, combinations of mixed use, or implementation pathways.

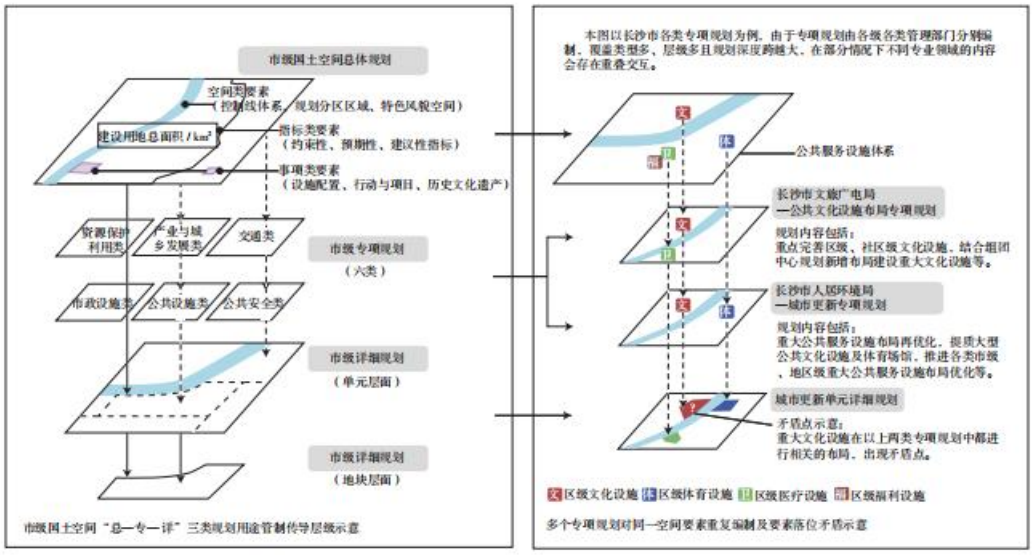

Figure 3. Contradictions in implementing sectoral plans.

3.3 Insufficient Hierarchical Rules for Flexible Transmission of Matter/Action Elements

The territorial spatial planning system integrates major-function-zone, urban and rural, and land-use planning and incorporates comprehensive land consolidation and ecological restoration. Its content and elements are therefore more diverse and complex. Coordinating rigid control with flexible guidance is crucial. Rigid semantics ensure standardized and consistent implementation, while flexible semantics allow adaptation in development and construction.

The former land-use planning system emphasized rigid control through zones and indicators; urban and rural planning used strategies, spatial structures, and layouts more flexibly. The new system should retain the strengths of both and clarify degrees of rigidity and flexibility. The *Guidelines* identify mandatory municipal-master-plan content, including ecological patterns, binding indicators, heritage and open-space control, public services, and municipal infrastructure. Spatial and indicator elements can generally be transmitted through boundaries, control lines, and binding values. Hunan's review and approval documents already translate these requirements from principles into specific measures.

Matter/action elements are more difficult. Public-service facilities may be represented only by indicative points in a master plan. At parcel level, their location and scale may be adjusted if provision standards are satisfied, but specific provisions rarely define what can be adjusted [27]. The depth of control at each level and the conversion between flexible project guidance and rigid parcel control therefore remain unclear (Figure 4).

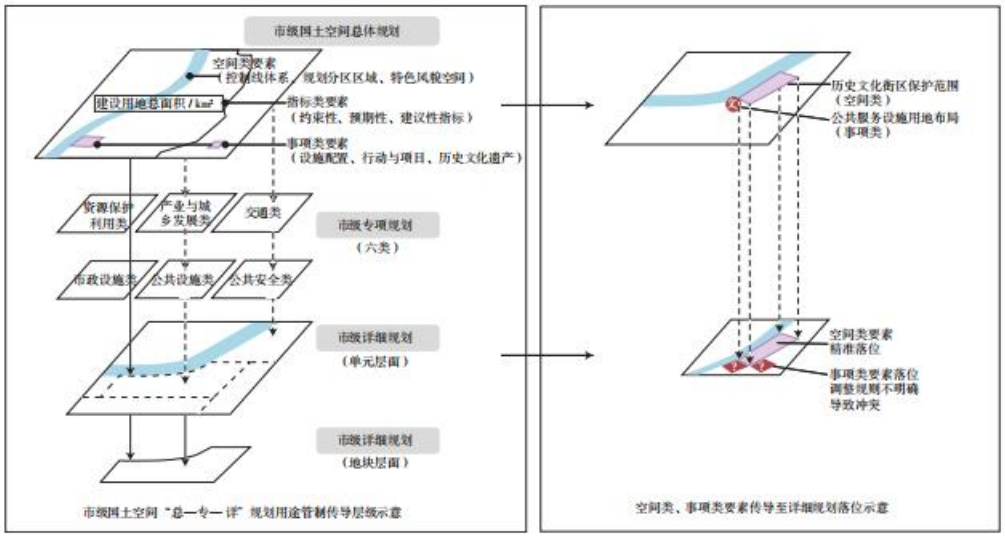

Figure 4. Contradictions in transmitting matter/action elements.

4 Policy Recommendations

4.1 Clarify Semantic Objects and Improve the Element System

Recent national policy on detailed planning fundamentally changes its philosophy and requires full-territory, all-element control. Regulatory meanings should be linked explicitly to elements and spatial carriers so they can be implemented in appropriate areas.

Hunan's pilot detailed plans show that urban development boundaries include not only contiguous urban areas but also scattered development areas. Because socioeconomic conditions and city size vary, these areas require planning units that differ in scale and function. Technical management documents should therefore specify differentiated content and use-control rules for different unit types.

Some elements cannot be located precisely. The *Guidelines*, for example, call for functionally mixed industrial communities where environmental safety can be guaranteed. Such requirements need clearly defined semantic objects and may require additional detailed-plan types or specialized implementation plans for particular fields or regions. Clarification would improve the master–sectoral–detailed system and support institutional innovation.

4.2 Establish the Sequence and Rules for Coordination among Sectoral Plans

The relationship between historic-cultural-conservation and urban-renewal plans illustrates the need for priority rules. National policy requires that urban renewal not proceed before surveys, evaluations, historic-district delineation, and historic-building identification are completed [29]. When departmental land-management spaces and measures conflict, rules such as “protection first” and “priority to projects with greater engineering impact” can help overcome technical barriers.

Changsha has begun exploring phased, hierarchical, and itemized coordination among sectoral, master, and detailed plans. At the same administrative level, sectoral plans with closely related controls should be classified, scheduled, and coordinated. Within urban development boundaries, departmental authority should be clarified and mechanisms for vertical and horizontal dialogue established.

Outside urban development boundaries, the city may develop two complementary instruments: **unit detailed plans** for comprehensive coordination and **specialized implementation plans** for operational use control. A unit plan would address all relevant elements within an implementation area, while specialized implementation modules would target concentrations of heritage resources, industry and urban–rural development, municipal infrastructure, and public services. Combining a general unit module with specialized modules can create a workable transmission pathway from master and sectoral plans to detailed control.

4.3 Build an Information Platform Coordinating Rigid and Flexible Transmission

Current practice within Changsha's urban development boundary suggests a two-tier detailed-planning path: unit detailed plans and parcel development. The unit level is critical. It should first implement rigid master-plan elements through baseline-control and transmission-control diagrams. It should also clarify flexible matters affected by government and market conditions, especially development scale and public-interest items. Population capacity, public-service facilities, and municipal infrastructure should be specified at unit level together with adjustment rules. At parcel level, they can then be translated into rigid requirements according to relationships with commercial land use and building-capacity control.

Rigidity and flexibility are thus relative rather than absolute. Defining flexible content and adjustment rules at each level is an effective way to resolve current tensions. An information platform should support this process by collecting policies, planning texts, speech, images, and real-time search terms; constructing an element knowledge graph; defining rigid and flexible boundaries; and establishing a module for reporting transmission problems. Practitioner feedback can continually improve the graph and dynamically display rigid conflicts, flexible adjustment ranges, and applicable rules, thereby forming an implementation feedback loop.

5 Conclusion

The shift toward spatial governance has strengthened the relationship between territorial spatial planning and policy formulation and implementation. This study develops a semantic–element perspective on implementation and transmission, analyzes the *Guidelines*, and uses interviews and planning practice in Changsha to identify municipal control elements and pathways.

The findings show that a clear element system and clear regulatory semantics are foundational to effective use-control transmission. In current practice, however, both remain insufficiently explicit, reducing efficiency and accuracy. Defining elements more precisely and deepening understanding of the semantics of control rules should therefore be priorities for policy improvement. Doing so can improve the accuracy and effectiveness of transmission, ensure that planning intentions are implemented, strengthen decision support, and promote efficient and sustainable use of territorial space.

Notes

① Primary materials for the municipal master–sectoral–detailed "semantic–element" analysis include the *Guidelines for the Preparation of Municipal Territorial Spatial Master Plans (Trial)*; the *Notice of the Hunan Department of Natural Resources and the Hunan Development and Reform Commission on Issuing the Catalogue of Territorial Spatial Sectoral Plans* (Xiang Zi Zi Fa [2021] No. 38); and the *Notice of the Ministry of Natural Resources on Strengthening Territorial Spatial Detailed Planning*.

② Materials include the *Guidelines*; the public version of the *Changsha Territorial Spatial Master Plan (2021–2035)*; the *Changsha Regulations on the Management of Regulatory Detailed Planning*; the *Planning and Design Specifications for Land Consolidation Projects* (TD/T 1012–2016); the *Technical Outline for Village Planning in Hunan Province (Revised)*; the public draft of the *Changsha Urban Renewal Sectoral Plan (2021–2035)*; Changsha's checklist for sectoral-plan results; and relevant Hunan review, approval, and major-function-zone guidance documents.

③ **Rigidity** in territorial spatial planning means constructing an authoritative spatial-development framework on the basis of ecological, social, and economic laws; territorial carrying capacity and suitability; and past, present, and future development. It establishes effective functional constraints and orderly development. **Flexibility** means using strategic reserve space, mixed-function modes, and mixed-use mechanisms to respond to socioeconomic dynamism and uncertainty, enhance resilience and efficiency, coordinate functions, and adaptively resolve conflicts. Source: JIAO Sheng, HAN Zongwei, JIN Rui, et al. Coordinating rigidity and flexibility in territorial spatial planning under informatization [J]. *China Land Science*, 2021, 35(11): 19–26.

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