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Monitoring and Governance of Illegal Urban Construction

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Illegal construction is not only a hot issue of growing concern to urban residents but also a key problem in daily urban management, which negatively impacts social harmony. This study focuses on the governance of illegal land use and construction (two violations) in urban areas. It addresses the technical challenges of hidden and diverse forms of “two violations”, easy recurrence, limited discovery channels, and difficult data collection. It also addresses the issues of weak business connectivity, poor standardization, difficult-to-use land after dismantling, and low utilization rate in the governance of “two violations”. In this study, we designed a closed-loop process for urban land spatial governance of “classification, demolition, land vacation, and utilization”, studied technologies such as integrated collection and intelligent identification of “star–sky–land network”, and coordinated on-site verification of internal and external industries. A spatial governance platform was developed, fundamentally changing the discovery, identification, monitoring, verification, and service modes in the original “two violations” governance work.

1. Introduction

In the governance of urban space, illegal land use and construction seriously erode urban public resources, including land and development space. They not only affect the image of urban and rural areas but also impact residents’ quality of life by substantially restricting the normal development of urban and rural planning and construction. Moreover, most illegal constructions pose safety hazards, thus indirectly causing instability to society and critically affecting the development of a harmonious society.(1) In the context of reduced development, there is a significant demand for the governance of megacity space in capital cities. In this study, we focused on the governance of illegal land use and illegal construction. In response to the difficulties in collecting data on illegal land use and illegal construction, low efficiency in manual identification and discovery, the lack of precise identification and technological

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processes, and strong government leadership but weak public participation, we designed a closed-loop urban spatial governance process of "classification–demolition–clearance–utilization". Specifically, we studied the intelligent identification and dynamic monitoring of illegal land use and illegal construction and applied the results of on-site verification through internal and external collaborations to the precise and intelligent management of "two violations" in Beijing. As a result, we achieved a full-process, traceable, and refined management of "two violations". The governance concept and mode of "two violations" were fundamentally changed, and the service level was improved, which, in turn, promoted the continuous improvement of the capital's functions, living environment, urban quality, and development level of the capital. Consequently, the urban spatial governance level and capacity of megacities in the context of reduced development was enhanced.

Many provinces and cities in China mainly use satellite photos and illegal construction records to carry out illegal demolition work. On this basis, some provinces and cities have introduced spatial data as the basic data to carry out illegal demolition work, with a relatively single data foundation. This study is based on monthly satellite images and other detection methods for "two violations", combined with multisource data technologies such as Baidu reports, 12345 public service hotlines, telephone calls, letters, and other public reports to form the "star–sky–land network" violation detection technology. It comprehensively improves the ability to monitor different types of illegal construction and achieves rapid and comprehensive acquisition of discovery data on "two violations" through multiple means.[(2)] In terms of accuracy and effectiveness in dismantling violations, similar technical means use only single methods and are inefficient. In some provinces in China, the assessment of demolition work is based on the information reported by street and township staff. There is a certain degree of uncertainty in the scale of demolition within the four dimensions of the demolition map and whether it is completely demolished. Corresponding software or tools have also appeared on the market, such as the "Land Survey Cloud", which meets the requirements of land survey, but lacks an audit process and does not meet the actual needs of the verification of "two violations". In this study, we introduce the pre- and postdemolition verification of illegal buildings, and governments at all levels confirm and determine the clues of "two violations" step by step: combining multidimensional data such as planning approval materials, real estate registration materials, "one-meeting three-letter materials" ("One meeting" refers to holding a collective deliberation and decision-making meeting, while "three letters" refer to the construction project work letter, design scheme review opinion letter, and construction opinion registration letter.), "two regulations" materials, and classified areas for proofreading and screening. In the verification process, it is required that each plot has a record of the spatial range and photos taken before and after demolition. By constructing a "double verification mechanism before and after rectification" and achieving "traceable verification of rectification and rectification", this method ensures the accuracy and effectiveness of data for each plot, effectively controlling the implementation of illegal demolition work and the land use situation after dismantling through strict technical measures. The domestic governance process for "two violations" mainly consists of the demolition process without considering land use after vacating and the assessment process without a unified and closed-loop governance process.[(3–5)] In this study, the Office for the Governance of Illegal Construction was established, and a closed-loop process for urban spatial governance was established, which includes "classification, demolition, vacating land, and utilization". The information platform was used to achieve "full coverage", "full process", and "full chain" of the governance of "two violations" in national land and space, effectively linking the ecological restoration of vacated land and nonconstruction land, and the supervision of construction land approval and utilization.

2. Research Methodology

A special action and information platform to crack down on illegal land use in Beijing was developed, and a three-level implementation and management system for the governance of illegal construction was established. In response to the challenges of rapid identification and precise governance of "two violations", we developed an intelligent identification and monitoring technology for "two violations", which combines remote sensing image interpretation with subject recognition and place name matching technology for grassroots reporting and immediate handling of data for complaints about "two violations". In terms of engineering applications for identifying "two violations", we constructed a closed-loop process design for urban spatial governance of "classification–demolition–clearance–utilization" that precisely identified and governed the "two violations".

2.1 Establishment of a three-level implementation and management system for the governance of illegal construction

On the basis of the special action and information platform to crack down on illegal land use in Beijing, policies were transformed into business processes, and a three-level system for investigating violations was established, thereby enabling subdistricts and townships, districts, and cities to fully participate in the investigation, as shown in Fig. 1. The mechanism of three-

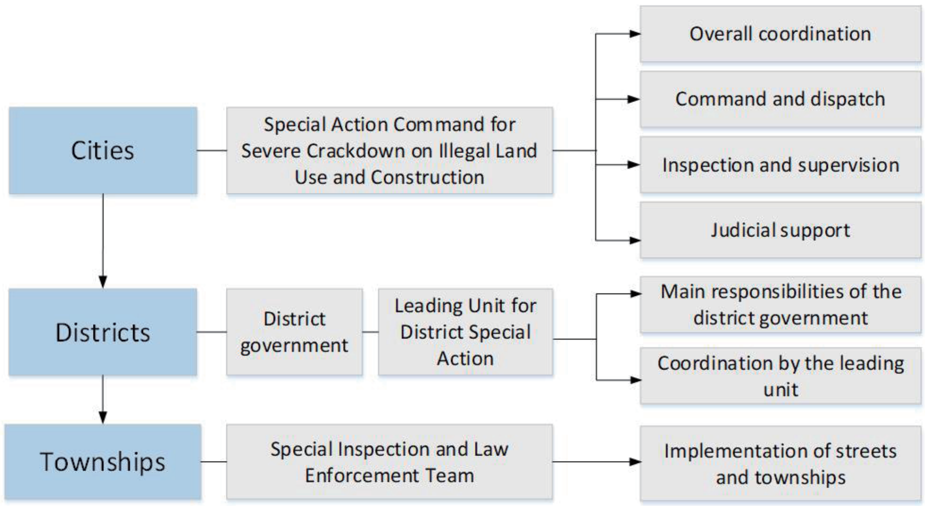

Fig. 1. (Color online) Establishment of a three-level implementation and management system for the governance of illegal construction.

level collaborative sharing of illegal construction information was realized at the city, district, and subdistrict (community) levels, making the platform a central hub for establishing contacts and carrying out violation investigation work among units at all levels. The construction process of the violation inspection platform was a process of gradually solidifying and refining the three-level system. During this process, the platform was used to carry out work, which led to the orderly implementation of violation inspection work for several years and achieved good results. The nature of the inspection work determined that the subdistrict (community) was the main body of the inspection work. The inspection platform enhanced the capacity for the grassroots governance of illegal construction through information and intelligent means and opened up the “last kilometer” of urban governance.

2.2 Establishment of the mechanism of detection of “two violations” by “star–sky–land network”

By utilizing information technology, we established a detection mechanism for “two violations” based on 3D remote sensing, street-view, and unmanned aerial vehicle, which includes automatic recognition, grassroots reporting, and public participation.

2.2.1 Intelligent identification of “two violations” based on multisource remote sensing data

The spectral characteristics of illegal construction and land use are similar to those of general buildings and construction land use. However, their locations are random, and their forms are hidden and diverse. Thus, it is difficult to quickly identify and accurately locate the “two violations”. With the widespread acquisition of high-resolution satellite images, aerial images, and point clouds, research on the recognition of “two violations” based on multisource remote sensing data has been carried out, opening up the possibility for the intelligent recognition of “two violations”.(6,7)

Satellite remote sensing imaging can objectively and realistically record surface features. High-resolution remote sensing images from two different periods can be employed to detect changes in cities, and comparing satellite images from different periods can provide refined monitoring results for illegal construction. The satellite remote sensing image data used in the study was divided into two categories. One was the monthly satellite image data, which was high-resolution remote sensing image data of the entire city with a data accuracy of 1 m and an update frequency of once a month. Additionally, to further improve the precision and accuracy of satellite detection of violations, high-resolution remote sensing image data with a resolution of 0.2 m and an update frequency of once a year was applied. The combination of the two types of remote sensing image data can guarantee both the accuracy of illegal construction detection and the frequency of illegal construction monitoring. The main idea of deep learning technology is based on neural networks for information recognition. Through training and learning with a large number of samples, the optimal parameters of the network are obtained, and then the network is applied to obtain the optimal category judgment from the input data. The method based on deep learning considerably improves the accuracy and generalization capability of building and construction land information extraction.[8] After applying this technology to the platform for illegal construction, users can conduct deep learning based on high-resolution image data to extract housing change data, combined with planning approval, current land use, and current housing information, to extract suspected illegal buildings, and use the illegal building management platform to enter corresponding basic information of illegal construction, such as the location of the illegal construction, construction location, project name, construction status, construction time, and name of the construction unit. Thereafter, units at all levels (city, district, subdistrict, and township) can carry out review, confirmation, and demolition to govern illegal construction, as shown in Figs. 2 and 3.

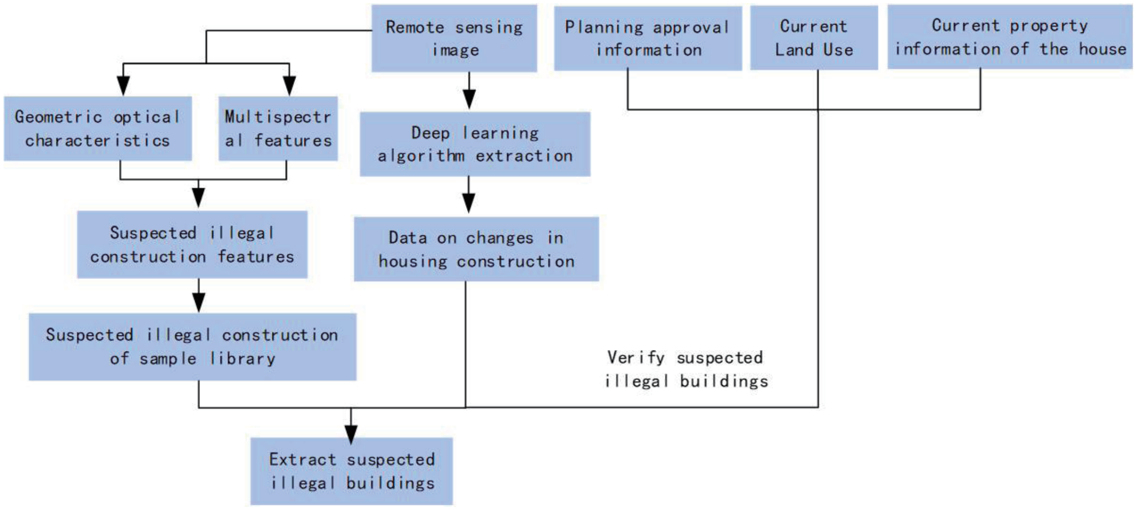

Fig. 2. (Color online) Remote sensing image of suspected illegal building detection technology process.

(a) (b)

Fig. 3. (Color online) Examples of change. (a) Early stage images. (b) Later stage images.

2.2.2 Street-view acquisition and violation identification based on multisensor in vehicle

A multisensor integrated mobile measurement system is used to measure the movement along the road, integrating various sensors such as panoramic cameras, laser scanners, GPS (Global positioning system), and IMU (Inertial Measurement Unit), as shown in Fig. 4. It can complete real-time positioning/pose calculation of the carrier and collect street-view image data, with high update speed and wide update range. The high-precision positioning/attitude determination system provides high-precision position and attitude information. GPS has high positioning accuracy and global coverage, but satellite signals can affect the positioning results when obstructed. Therefore, GPS + IMU + wheel encoder combination positioning is adopted to compensate for the shortcomings of GPS positioning and pose determination, making positioning and navigation information more accurate. The street-view image plane accuracy is 10 cm and the elevation accuracy is 10 cm. The laser scanner measures in a range of 300 m on both sides of the distance, with a collection frequency of 200 KHz. The panoramic camera has a resolution of 30 million pixels and an acquisition interval of 10–15 m. The resolution of the array camera is 20 million pixels (6 units), with an acquisition interval of 10–15 m. The GPS acquisition frequency is 10 Hz. By comparing street-view images at different stages, the process of illegal construction was restored, and the efficiency of illegal construction investigation and punishment implmentation was improved.

Using buildings as the main matching objects for street-view images, we used the Harris algorithm for building feature recognition to match street-view images from different periods. The Harris algorithm is a signal-based point feature extraction algorithm applied by Yuan[9] using the nearest neighbor distance ratio matching method for street-view image matching, outputting street-view images that are judged to be in the same location, and returning street-view images that are not in the same location to the database for rematching process. On the basis of street-view image matching, a regional convolutional neural network is used for feature

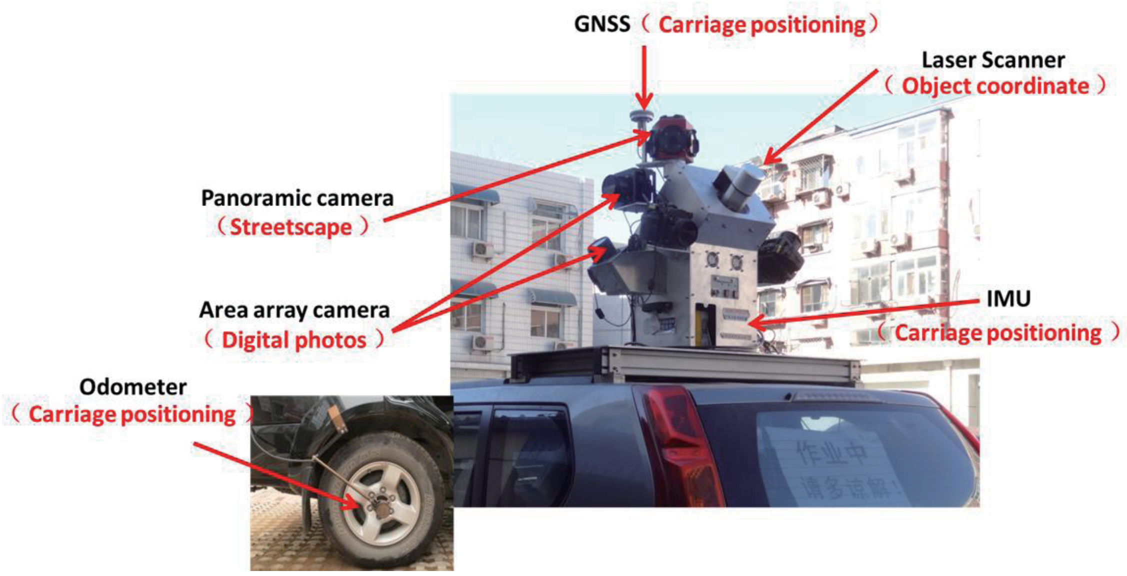

Fig. 4. (Color online) Multisensor integration - external hardware.

extraction to classify image features into buildings, greenery, vehicles, people, and so forth for comparative analysis, output images with significant changes in buildings, and automatically extract street-view images containing suspected new illegal constructions, as shown in Figs. 5 and 6.

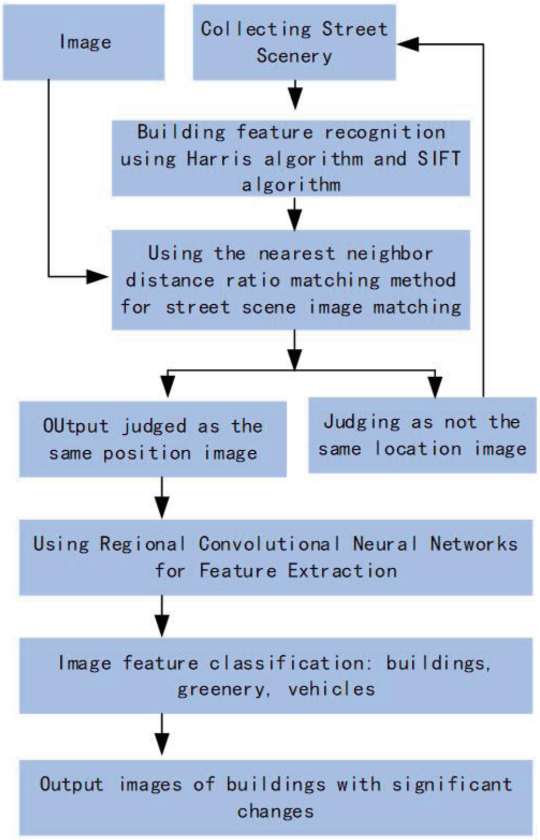

Fig. 5. (Color online) Automatic extraction flowchart of suspected new illegal building using street scenery.

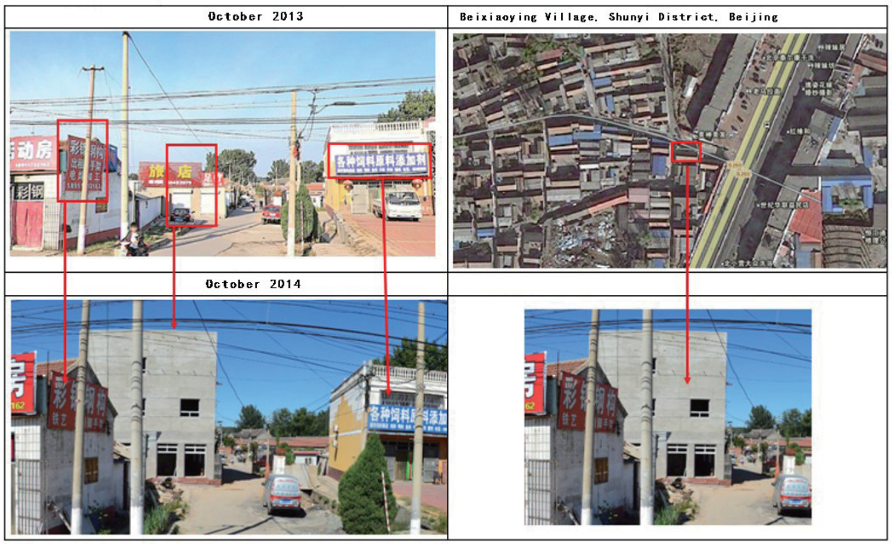

Fig. 6. (Color online) Using street scenery for illegal building identification.

2.2.3 Identification of "two violations" based on drone flight

For residential communities and industrial parks that are not located along the street, especially in areas with complex terrain, airborne LiDAR aerial photography technology is used to monitor illegal constructions. Aerial photography is used to obtain aerial digital images and laser point cloud data with a ground resolution better than 0.1 m/0.05 m. A tilted 3D model is constructed to generate the most realistic 3D scene, which can clearly show the original appearance of illegal constructions on the first floor and rooftop. The modeling steps of the tilted model include image data preprocessing, tilted data spatial processing, resetting framework settings, tilted model production, and scene integration. As shown in Fig. 7, the model can truly restore the spatial position, shape, color, and texture of the ground objects, and express the detailed features of the building.[10] For suspected illegal construction, after analysis and review, the clue will be generated into a work order and passed to the violation investigation platform.

After the addition of drone supervision, on the basis of the original image and ground street-view perspectives, non-on-site law enforcement aerial perspectives were added to identify the illegal construction facts, achieve intelligent recognition of illegal behavior, expand the new digital non-on-site law enforcement model, considerably reduce human intervention and labor costs, and improve the intelligence level of urban management, as shown in Fig. 8.

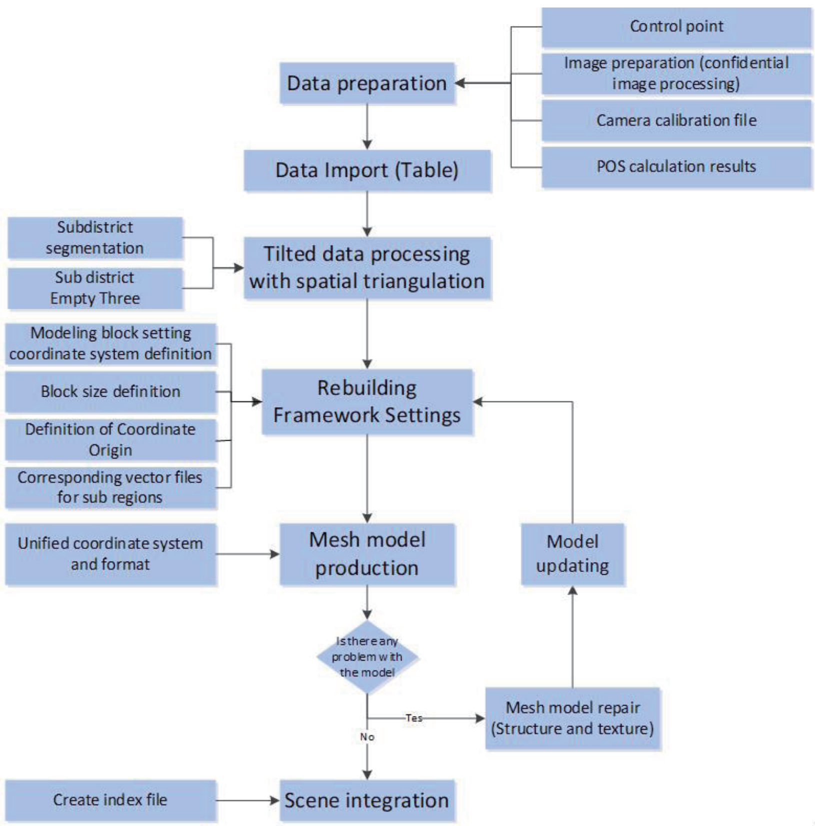

Fig. 7. (Color online) Mesh production technology flowchart.

(a) (b)

Fig. 8. (Color online) Identification of "two violations" based on drone flight. (a) First floor illegal construction and (b) illegal construction on the roof.

2.2.4 Special standing account for grassroots reporting

For the grassroots reporting standing account business, each district or subdistrict office or township discovers and verifies illegal construction and land use within their jurisdiction and then reports infractions to the City Command Office. After confirmation by the Command Office, the reporting unit is tasked with carrying out the demolition of illegal structures. The reporting standing account must be closed after a period after the district's unified entry, and re-entry requires making an official request to the City Command Office. Through the grassroots reporting account, the basic situation of illegal construction in the city is understood. After the rectification and demolition of illegal structures, the information is written off, as shown in Fig. 9.

2.2.5 Theme recognition and place name matching for immediate handling of complaints against "two violations"

Since the implementation of the work of handling complaints immediately, over 4.4 million citizens in Beijing have voiced their demands and participated in the reform of "handling complaints immediately" and the governance of the capital. Urban and rural construction has been one of the top ten hot topics among citizens, whereas illegal construction, as a sub-item of urban and rural construction, has consistently ranked high in the number of reports. To strengthen public participation in urban governance, Beijing has endeavoured to promote the immediate handling of complaints using the 12345 service hotline. Public reports are an important source of information on "two violations". Public reports are collected from multiple sources, including the Internet, telephone calls, and letters. The main channels for public reporting include Baidu reporting, the 12345 service hotline, calling relevant departments, and writing letters. Owing to Beijing's grassroots governance of 'immediate handling of complaints', the work order dispatch mechanism of the 12345 platform has been optimized. With the classification standard system and judgement method based on semantic analysis, a set of working methods and processes were formed for rapid access to work orders of illegal construction complaints, internal summary and analysis, external investigation and sampling,

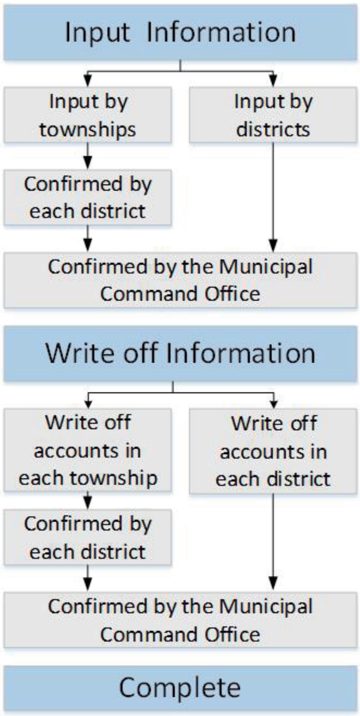

Fig. 9. (Color online) Special standing account process for grassroots reporting.

and timely warning to provide data support and decision-making basis for Beijing's regular and long-term governance of illegal construction. The sources of immediate handling of complaint information are complex and the formats are diverse. We conducted research on theme recognition and place name matching technology for handling complaints of "two violations". On the basis of natural language processing (NLP) technology and place name matching technology, we achieved theme recognition, intelligent positioning, pattern matching, duplicate information merging, cleaning, and so forth, generated illegal construction clues, and designed an information verification and processing system. On the basis of big data of the 12345 service hotline, the policy mechanisms of dismantling violations and information technologies were combined to achieve the full-process, informationized, refined, and traceable management of illegal construction and land use. A long-term mechanism for the governance of illegal land use and construction was established, ensuring the scientific and objective nature of governance work, as shown in Fig. 10.

2.2.5.1 Topic recognition of 'handling complaints immediately' based on NLP technology

NLP can quantitatively study language information with the support of computers and provide language descriptions that can be used by both humans and computers. Chinese NLP mainly includes Chinese word segmentation, text classification, and text tendency analysis. Owing to the diverse sources and varying text content formats of immediate handling of the

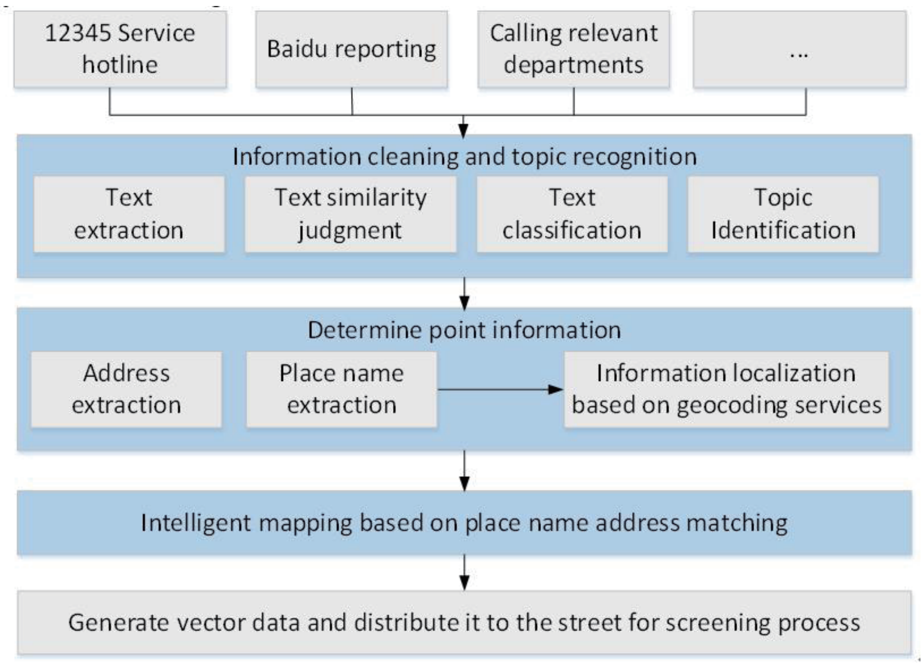

Fig. 10. (Color online) Technical process.

complaint information, we established a thesaurus of "two violations", on the basis of which text classification and recognition were carried out.

2.2.5.2 Information localization based on geocoding services

On the basis of part of the address or name information in the immediate handling of complaint information, geocoding services of Internet maps were used for information localization and location mapping. Using the search function of the Internet map, the name or address information of the point can be geocoded to obtain the point coordinates. After converting the coordinates, the localization of immediate handling of complaints information can be conducted.

2.2.5.3 Information mapping based on the place name and address matching

The Levenshtein distance algorithm was deployed to fully utilize the address information of the immediate handling of complaint cases or the aforementioned information. Then the similarity between the two was calculated on the basis of patch addresses from the database of non-illegal construction in the city. The geographical location information from the 12345 service hotline was extracted from the database without illegal construction, and a heat map of 12345 service hotline reports on illegal constructions throughout the city by mapping their locations was generated.

2.3 Closed-loop process design for urban space management: 'classification–demolition–clearance–utilization'

We established a closed-loop process of urban spatial governance of "classification–demolition–clearance–utilization" and made use of the special action and information platform to crack down on illegal land use in Beijing to achieve "full coverage" of illegal construction governance in Beijing's territorial space, "full-chain" intelligent monitoring and assessment, and "full-process" reduced development. An effective spatial governance system for megacities was built.

2.3.1 Classified governance

On the basis of national geoinformation survey data and national spatial planning (e.g., district planning and the "two lines and three zones" policy of Beijing), we repeatedly verified and refined the scientific classification system tailored to the characteristics of "two violations" in Beijing. As shown in Table 1, the "two violations" were divided into seven primary categories (i.e., rectification within a certain deadline, not included in the categories, homestead, certified, to be refined, continuous governance, and data correction), 17 subcategories, and 74 three-level categories. On the basis of this classification, classified governance was carried out. Depending on the classification, different information was reported and different processes were implemented on the basis of different classifications, including the demolition, batch submission, and evidence presentation, as shown in the Fig. 11.

2.3.1.1 Demolition process

For illegal structures that required rectification within a specified period, the subdistrict, township, and district governments confirmed the recorded information on the illegal construction and started the process of demolition and rectification.

2.3.1.2 Bulk submission process

For those not included in the categories and for homesteads, each district government uploaded red-headed documents and detailed attachments for batch submission. Acceptance was completed at the municipal level.

2.3.1.3 Evidence presentation process

For categories that were not included, certified, or those needing to be refined, basic information was provided by the subdistricts and townships, and the supporting materials were uploaded for review by the responsible department, followed by confirmation review at the district level and completion of acceptance at the city level. The required evidence materials varied depending on the type of evidence provided. Evidence materials were prepared on the basis of the names of classified patterns.

Table 1
Classification system for the establishment of ‘basically no illegal construction zones’ in Beijing.

#	Category	Subcategory	Third-level category	Process
1	Rectification within a certain deadline	—	—	Demolition
2	Not included in the categories	Projects constructed before 1 April 1990	Projects constructed before 1 April 1990	Batch submission
		Military, national defense, confidential, judicially controlled construction projects	Military, national defense, and confidential construction projects	Batch submission
			Judicially controlled construction project	Evidence presentation
		Construction projects for which the state or the city has special policy regulations	Support building for protected agriculture	Evidence presentation
			Building for forest land management	
			Building for forest fire prevention	
			Building for emergency relief reserve	
			Disaster relief donation reserve	
			Emergency shelter	
			Long-term shelter	
			Building for flood control and management	
			Directly managed public housing	
		Embassy and consulate projects	Embassy and consulate projects	
3	Homestead	Homestead	Within the boundaries of the homesteads from the Third National Land Survey	Batch submission
			Outside the boundaries of the homesteads from the Third National Land Survey	
4	Certified	Certified	Real estate registration certificate (property ownership certificate)	Evidence presentation
			Qualified opinion on construction project planning verification	
			Planning permit for construction project (including rural construction permit and temporary rural construction permit)	
			Renovation and expansion of villa areas	
5	To be refined	Projects in the approval process	One meeting and three letters	Evidence presentation
			Response to planning opinions	
			Land planning permit	
			Planning condition	
			Opinion on-site selection	
			Integration of multiple regulations	
			Project initiation, approval, opinions, and meeting minutes from the government at or above the district level or relevant departments at the city level	
		Projects within the scope of primary land development and shantytown renovation	Primary land development	
			Shantytown renovation	
		National and municipal key projects	Energy, transport, water conservancy, and other national and municipal key projects	
		Other financial support above the municipal level	Other financial support above the municipal level	

Table 1
(Continued) Classification system for the establishment of 'basically no illegal construction zones' in Beijing.

		Office building for government agencies and public institutions	Office buildings for various levels of administrative, legislative, judicial, security, and other state organs and public institutions	Evidence presentation
		Production and office buildings of state-owned enterprises	Production and office buildings of state-owned enterprises	Evidence presentation
		Municipal infrastructure	Building for road traffic facility	Evidence presentation
			Building for water supply	
			Building for drainage	
			Building for gas	
			Building for heating	
			Building for power	
			Building for communication	
			Building for sanitation	
			Building for waste disposal	
			Building for water conservancy	
			Building for postal service	
			Building for firefighting	
			Building for public facility maintenance	
6	Continuous governance	Building for public service	Public and private educational institutions	Evidence presentation
			Building for health care	
			Building for social welfare	
			Building for cultural facility	
			Building for sports facility	
			Building for funeral and interment	
			Building for religion	
			Building for community management	
			Building for convenient service facilities in residential areas	
			Building for public welfare river and lake management	
			Building for research institutions	
			Building for parkland management	
			Building for village committee management and service	
			Public toilet	
		Projects that are in line with land use for high-grade, precision, and advanced structures	Industrial projects that are in line with the orientation of high-grade, precision, and advanced indicators	Evidence presentation
		One project, one discussion	Mine	Evidence presentation
			Tourism facility	
			Houses on railway land	
			Houses with limited property rights	
			Valley economy	
			Collective industry	
			Enterprises in Farmer Employment Industrial Bases (Parks) and industrial enterprises outside of Farmer Employment Industrial Bases (Parks)	
			Historic areas to be demolished (non-shantytown renovation, primary development)	
			Concrete mixing plant	
			Single-story residential compound	
7	Data correction	Data correction	Non-individual building	Evidence presentation
			Data overlap (only data groups are classifiable)	
			The house does not exist	
			Out-of-province patches	

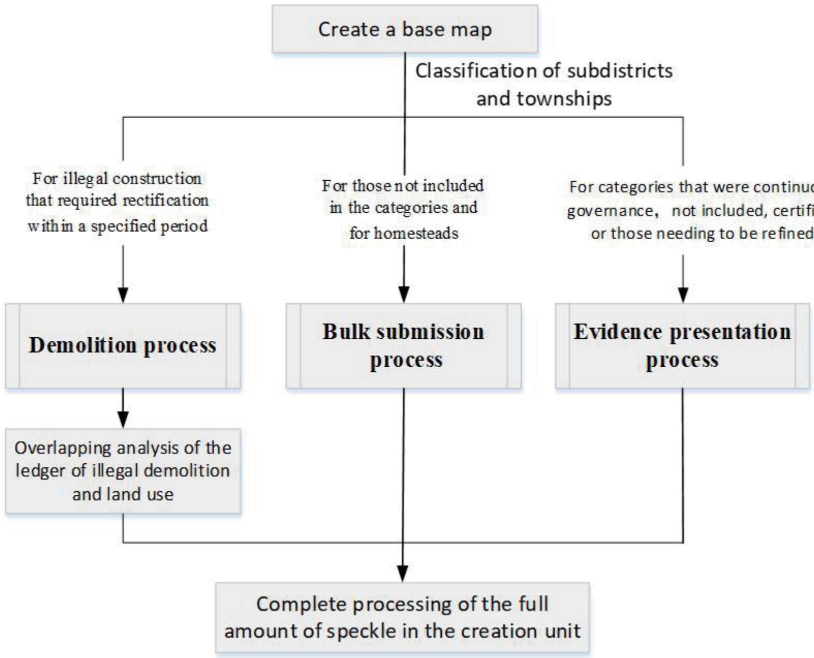

Fig. 11. Creating a base map process.

For the continuous governance category, the subdistrict and township were responsible for providing basic information, uploading rectification plans and public announcement materials, and filling in the governance path, governance time limit, and responsible department. After a review by the responsible department, the district level confirmed the review and designated the regulatory department. Regulatory authorities are responsible for regulatory work.

2.3.2 Demolition violations

According to the classification system of "two violations" in Beijing, illegal structures under different categories are dismantled in an orderly manner. For example, for the "rectification within a certain deadline" category, unconditional demolition within a certain deadline is carried out. The "continuous governance" category references "municipal infrastructure" and "public service buildings" that cannot be demolished in the short term. Combined with subsequent planning, reasonable scheduling and continuous governance should instead be carried out.

In the process of dismantling illegal structures, a collaborative approach between internal and external work was adopted. The platform was used for the three-level scheduling of "city–district–subdistrict and township", and intelligent monitoring and evaluation of "two violations" were conducted. The self-developed field verification app was used to assist law enforcement and verification personnel in precise positioning. In this way, the precise dismantling of illegal structures was achieved.

2.3.2.1 Double verification mechanism before and after dismantling

The multichannel “two violations” clues (e.g., satellite images, street views, videos, grassroots reporting, and public tip-offs) were used in combination with the mobile and geographic information systems (GIS) technology to achieve the predismantling verification of illegal construction clues with law enforcement personnel on site. This included identifying and recording the location of the clues, the size of the building, the nature of the land, and the site images and videos. Additionally, on-site postdemolition verification with law enforcement personnel was conducted to ensure that the illegal structure had been eliminated. In this way, the precision of the city’s crackdown on “two violations” was ensured and the goal of ‘demolishing existing ones and controlling new ones’ was achieved.

2.3.2.2 Mobile devices for fast and accurate on-site verification

A custom index grid was constructed using a seed algorithm. On the basis of the partition range of the constructed index grid and the coordinate values of the features, the grid where the features are located can be determined, thus solving the problems of low efficiency and easy memory overflow of spatial query services through traditional GIS platforms. We achieved rapid spatial queries, statistics, analysis, and editing of over a million pieces of multisource data related to “two violations”, including GIS, planning and national land; satellite, street-view, and image data; and Baidu reporting information. This led to efficient retrieval, automatic calculation, precise positioning, and collaborative operation for the on-site verification of “two violations” on mobile devices, thus considerably improving the efficiency of on-site verification.

An indoor and outdoor collaborative verification platform was developed for “two violations”. The mobile mapping technology and the seed algorithm were utilized to achieve spatial indexing and data synchronization of multisource heterogeneous data for the field mobile platform and the internal management platform. The field verification platform dynamically called for basic geographic references, image maps, and housing spatial data for on-site photo data verification, real-time positioning, trajectory point recording, and so forth. A verification confirmation form was generated on site, which was signed and confirmed by grassroots staff and relevant law enforcement personnel from multiple parties. Illegal construction clues were identified, and the verification results were returned to the exchange area in real time. The platform read the exchange area data in real time and displayed them on the platform.

2.3.3 Land clearance

After the demolition of illegal structures, on the basis of satellite images, the deep learning technology was deployed for the continuous intelligent monitoring of the state of the land after demolition to achieve a “clean site” and a “clear situation” after demolition. In this way, postdemolition management was strengthened to achieve the unified management of the postdemolition plots of illegal structures from 2018 to 2023. At the same time, various types of statistical analysis were carried out, with reports delivered to relevant government agencies. Moreover, classic cases of the districts were summarized and publicized on the platform.

2.3.4 Utilization

The spatial and attribute data formed in the governance of “two violations” were integrated with various planning data to clarify the direction of utilization of the postdemolition plots. The platform set up corresponding management modules to assist local planning bureaus to plan and utilize the postdemolition plots. Nonconstruction land was generally repurposed for “replanting and regreening”, while construction land was reused in various forms. Local planning bureaus can upload the corresponding certificates on the platform, which can be examined and approved at the district level to carry out the utilization of postdemolition plots.

3. Governance Effectiveness

3.1 Support for the “dismantling, rectifying, and promoting enhancement” work

On the basis of the above research methodology, a successful case of Beijing’s special action to crack down on illegal land use and illegal construction was demonstrated. It has been widely applied in practice in more than 330 subdistricts and townships of the city’s 16 districts, with remarkable results in the past few years. Specifically, a closed-loop process technology system for urban space governance of “classification–demolition–clearance–utilization” was constructed, and a complete set of processes, including the classification of stock illegal buildings, demolition verification, and rapid identification and extraction of new illegal buildings in postdemolition plots was established. The goal of effectively supervising the basic situation, demolition, and utilization of each plot of land was achieved to create a clear and accurate database of illegal buildings and illegal land use in the city. Consequently, the number and area of illegal structures demolished in Beijing have reached a record high. The effectiveness of land use after dismantling has gradually emerged, improving the capacity and modernization level of spatial governance in megacities.

3.2 Regulation of postdemolition utilization

3.2.1 “Leaving blank space and increasing green space” for construction sites

“Leaving blank space” refers to leaving a space for the future development of the city, while “increasing green space” denotes expanding a green space. “Leaving blank space and increasing green space” aim to create a harmonious and beautiful urban pattern by planting greenery after an urban space is vacated, and they have been well explained in the special action for Beijing’s relief and rectification to promote improvement. As shown in Fig. 12, through the demolition of illegal structures, the idle land can be used for green landscapes and parks. In this way, green spaces have been developed and the urban environment has improved considerably, creating a good living environment for residents.[11]

Fig. 12. (Color online) Image before illegal building demolitions in the urban area of Miyun District: the ‘Chinese Rose Park’ constructed after demolition.

3.2.2 Reclamation of nonconstruction land after demolition

While carrying out demolition and relocation work, the future land use was planned actively, considering factors such as surrounding conditions and planning. Reclamation and replanting of postdemolition land were promoted, which can effectively increase the area of arable land, further optimize the structure and layout of land use, and realize the economical and intensive use of land. At the same time, efforts were made to improve the utilization rate of arable land, promote centralized contiguous development, enhance the quality of arable land, and fully leverage economies of scale, as shown in Fig. 13.

3.2.3 Improvement of the quality of livelihood services

With the implementation of the “dismantling, rectifying, and promoting enhancement” work, we faced the problem of how to meet residents’ demands for living services after the closure of living service facilities. Achieving seamless integration and leaving no gaps in timelines were also of utmost importance in this work. To ensure that residents’ daily lives were not affected, supplementary alternative measures were planned and implemented in advance during relief and rectification, in close connection with the “seven accesses and five expectations” and the ‘handling complaints immediately’ programmes, as shown in the Fig. 14. Through a comprehensive understanding of the current situation of the region, regional issues were analyzed, and planning and development suggestions were proposed. It was suggested to adhere to planning guidance, make up for urban shortcomings, and achieve the full coverage of “15-minute community service circle” as soon as possible to ensure that residents’ daily lives and public services were not affected. At the same time, the site for the demolished land was scientifically and reasonably selected. By complying with the principles of historical preservation and renovation, we could comprehensively solve the problems related to the livelihood and environment and create a better ecological and living environment for the city. By meeting the people’s needs and enhancing their sense of well-being as the starting and ending points, governance enhancement in people’s livelihoods has been gradually refined.[12]

Fig. 13. (Color online) Reclamation of Cangtou Village in Zhangjiawan, Tongzhou.

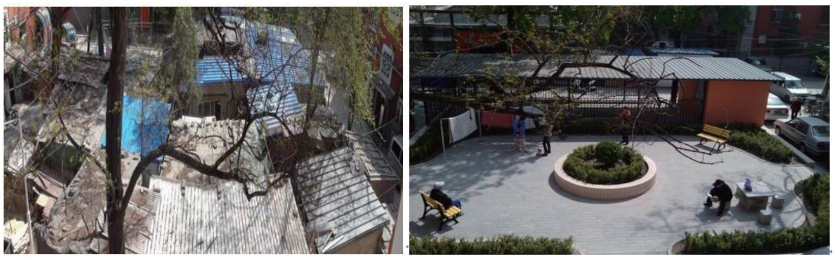

Fig. 14. (Color online) Public space renovation of the postdemolition neighborhood environment, and the construction of public service facilities such as green squares and fitness equipment.

3.3 Ensuring the implementation of planning

According to the planning requirements, it is necessary to fully leverage the strategic guidance and rigid control roles of the overall planning and district planning. On the base map, the platform automatically matched and assigned planning attributes to all patches, including district planning, two lines and three zones, farmland protection space, and ecological protection red lines. Meanwhile, through comparison and classification, classified guidance was provided to subdistricts. First-level reminders were provided for patches on permanent basic and current farmland. It was suggested that subdistricts should prioritize demolition. For patches that violated the district planning and were located on nonconstruction land, it was recommended that the subdistrict demolish them as soon as possible. Prompts were provided according to the urgency level of the system design to achieve the orderly demolition of illegal structures. As a result, the implementation of planning guidance for illegal structure demolition improved the quality of subdistrict demolition. The platform can be displayed in two modes of spatial location and account attributes. Users at the subdistrict, district, and sub-bureau levels have full access to information related to planning, which can help with the classification and review of patches. The rectification work has been deeply integrated with planning guidance to achieve precision operations.

3.4 Control of scale flows

On the basis of the governance of illegal construction, the scale flow indicator pool system was explored. The construction land and building scale increment were incorporated into the flow pool. Within the constraint framework of the urban development boundaries determined by overall planning and district planning, the indicator flowed in an orderly manner to achieve the flow control of building scale and land-use scale. Through the dynamic flow process, the scale of construction land and buildings was established, effectively enhancing the efficiency of land resource allocation and realizing the reactivation of spatial resources and the reutilization of scale indicators. This method was coordinated with the allocation of urban and rural spatial resources, matched with recent development and construction needs, and adapted to intensive, efficient, and high-quality development.

4. Concluding Remarks

In this paper, we took surveying and mapping geographic information space technology as the core, comprehensively discovered and monitored the process of illegal land use and illegal construction governance, and developed a special action and information platform to crack down on illegal land use and construction in Beijing. Specifically, we linked the governance of illegal construction with reduced development to achieve full coverage of illegal construction governance in the entire land space, full-chain intelligent monitoring and evaluation, and full-process reduced development. Thus, the implementation of the Beijing Urban Master Plan (2016–2035) can be guaranteed. The study results aid in promoting the optimization of urban functions and spatial layout, solving urban and rural governance problems, using vacated space for renovation and enhancement, and enhancing the urban living environment.

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