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## **THE NEGATIVE EFFECTS OF NON-MOTORIZED LANE MANAGEMENT REGULATORY TOLERANCE IN CHENGDU, CHINA**

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### **Abstract**

The expansion of Non-Motorized Lanes (NML) is a cornerstone of urban sustainable development. However, spatial encroachment often undermines the practical effectiveness of NMLs. This study examines how regulatory tolerance may interact with roadside obstruction and facility design to affect the spatial integrity of NMLs in Chengdu, China. Based on field data and secondary literature, the study conducted direct effective width assessments on four pre-selected road segments. The Space Loss Index ( $L_s$ ) quantifies the proportion of designated NML space that is unusable under documented obstruction conditions. Research reveals contrasting combinations of facility design, observed roadside occupation, and implementation conditions. The physically separated segment on Jianshe Road retained its delineated travel space, whereas the other cases showed varying degrees of space loss with motor vehicle stopping or parking within the Non-Motorized space. These findings suggest that physical separation can offer more reliable protection of NML than administrative controls alone. They also indicate that the effects of roadside management should be assessed together with facility design and local access needs, rather than being attributed to single enforcement factor. The study therefore proposes differentiated spatial management that combines context-sensitive regulation with physical measures to safeguard Non-Motorized users.

**Keywords:** Non-Motorized Lane, Spatial Encoachment, Space Loss Index ( $L_s$ ), Regulatory Tolerance, Sustainable Development

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## INTRODUCTION

It seems there are countless proposals for urban transportation planning, enhancement, and modification. From an urban planning perspective, these initiatives all aim to improve residents' quality of life. However, during implementation, unforeseen obstacles often arise (Zakka et al., 2017). Chengdu, as a megacity in central-western China, is undergoing continuous dynamic adjustments in its spatial utilization (Miao, 2019; Schneider et al., 2005). Regulatory frameworks and physical design can both influence these spatial forms.

In recent years, Chengdu has undergone a dramatic urban transformation (Srinivasan et al., 2020; Jing Zhao et al., 2025). This shift is evident not only in the renewal of its architecture but also in the friction between new regulations and old ways of life. On one hand, the Chengdu municipal government is committed to enhancing transportation efficiency and sustainability through high-standard Non-Motorized Traffic (NMT) planning. On the other hand, the established logic of daily life and the dimensions of roads in the older districts still possess powerful inertia.

Regulatory tolerance may arise when transportation planning encounters complex public needs. In this study, regulatory tolerance refers to the flexible or inconsistent implementation of formal road management rules in response to actual traffic, parking, or livelihood needs. This interpretation stems from the operational model of grassroots bureaucracy, where frontline implementers may possess a degree of discretion in the face of conflicting public needs (Lipsky, 2010). Research on street commerce governance in Chengdu and local policy documents on inclusive and prudent regulation also demonstrate the actual tension between formal regulation and daily livelihood activities (Jin & Zhao, 2022; Sichuan Provincial People's Government Website, 2022). This tolerance may be related to the gap between formal regulations and actual street conditions, but it is not the only reason for road encroachment.

Existing design guidelines emphasize providing continuous and unobstructed space for non-motorized travel, including sufficient road width and measures to prevent motorized vehicle intrusion (National Association of City Transportation Officials, 2011). Multimodal traffic analysis also recognizes that the configuration and operation of road facilities affect the space available to road users. Therefore, this study compares four pre-defined road segments in Chengdu. The study uses the Space Loss Index ( $L_s$ ) to quantify the proportion of designated non-motorized space that is unusable under recorded obstruction conditions and examines the correlation between observed space loss and road facility configuration, as well as existing roadside management and enforcement evidence. This analysis aims to identify correlations between different cases, rather than to establish independent causal effects of regulatory tolerance.

## **METHODS**

To address the research questions, this study employs a mixed-methods approach. Through policy text analysis, Field observation, and quantitative calculations, it systematically investigates right of way conflicts on Non-Motorized Lanes (NML) in Chengdu.

### **Site Selection**

As a populous province in western China (with approximately 90.605 million residents), Sichuan's provincial capital, Chengdu, exhibits a typical radial loop structure. As Roberts (1995) aptly described the provincial capital Chengdu, it resembles a dartboard—a highly vivid analogy.

To represent different urban environments in Chengdu, this study compares the physical road separation, roadside parking pressure, and development environment along Chengdu's southward development axis. This study adopts the Urban Transect strategy as outlined in the Chengdu Territorial Spatial Master Plan (2024), which guides the Transect Strategy (Talen, 2002). The author selected four road corridors. Within each corridor, a clearly defined section was demarcated for on-site measurement and analysis. The analysis boundaries are marked A-B in Figure 1.

1. Jianshe Road: authors selected a 270 meter analysis segment. The NML on this segment is 3.97 meters wide and physically restricts motor vehicle access.

2. Ximianqiao Street: a 375 meter analysis segment was selected, with a width of 3.00 meters. Intermittent parking was observed within the designated curb space.

3. Jinxiu Road: a 60 meter section with a partial curb entrance was selected, with a width of 1.92 meters.

4. Haichang Road: a 170 meter designated NML was selected, with a width of 2.28 meters. Adjacent parking areas outside the boundaries were excluded from the analysis.

These four segments represent different configurations in terms of physical protection, roadside parking interference, and facility continuity. Measurements and spatial loss calculations were performed only for segments A-B.

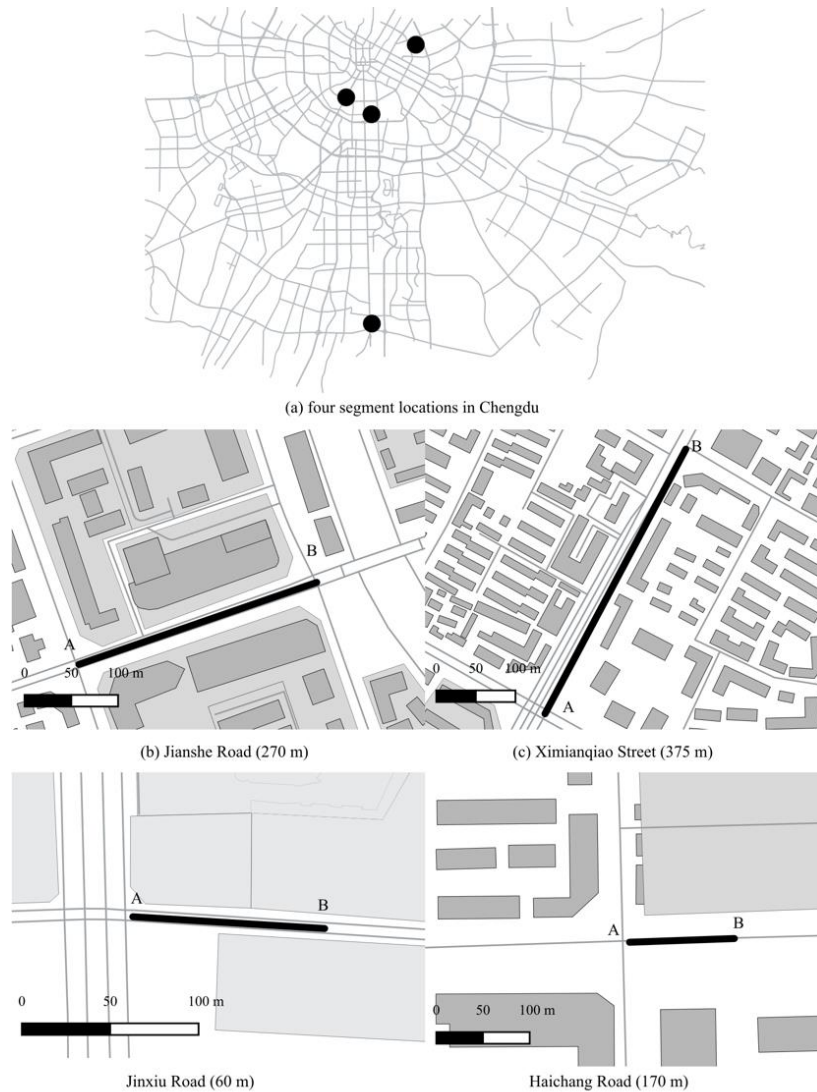


**Figure 1:** Locations and boundaries of the four segments in Chengdu  
 Source: Authors' compilation based on OpenStreetMap and field investigation

### Data Collection and Quantitative Assessment

Field data collection comprised two components. First, a single on site measurement campaign was conducted to verify the physical dimensions of the four pre defined A–B study segments. Designated NML width ( $W_d$ ) and the remaining traversable width under the recorded obstruction condition ( $W_e$ ) were

measured using a tape measure; a laser distance meter was used where site conditions allowed.

Second, repeated visual observations of roadside conditions were undertaken by the authors during separate, no scheduled site visits between 2024 and 2026, covering spring and summer. These visits recorded visible roadside conditions, including vehicle stopping or parking, informal tricycle or vendor activity, access activity, and facility configuration. Photographs were taken as contemporaneous field records.

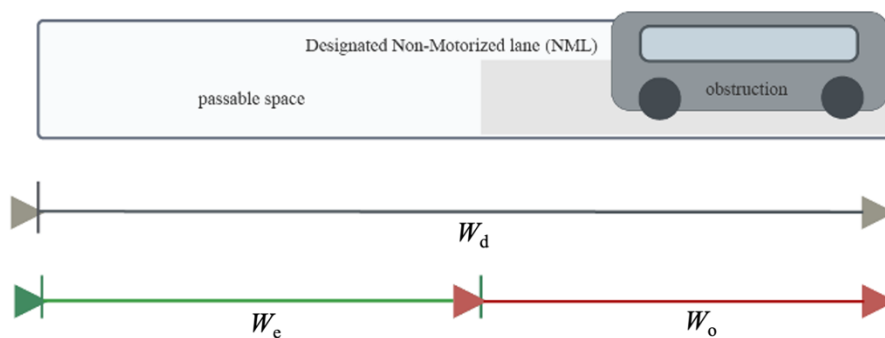


**Figure 2:** Direct measurement logic for the Space Loss Index

*Source: Authors' illustration*

Existing bicycle facility guidelines emphasize the importance of continuous, unobstructed passageways and physical measures to limit motor vehicle intrusion (National Association of City Transportation Officials, 2011). This study was designed based on these guidelines, recording directly observed occupancy widths; no additional buffer coefficients based on capacity or perception were applied when calculating  $L_s$ .

The direct measurement results are summarized using the spatial loss index ( $L_s$ ), which is defined as follows.

The Space Loss Index ( $L_s$ ) measures the proportion of designated NML space that is unusable under the recorded obstacle conditions in each A-B study segment. To quantify this reduction, the study recorded three geometric variables: designated width ( $W_d$ ), remaining usable width ( $W_e$ ), and occupied width ( $W_o$ ).  $W_d$  represents the designated NML width under obstacle free conditions,  $W_e$  represents the remaining traversable width under the recorded obstacle conditions, and  $W_o$  is calculated as  $W_d - W_e$  (figure 2). The calculation is performed in two steps:

$$W_e = W_d - W_o$$

$$L_s = \left(1 - \frac{W_e}{W_d}\right) \times 100\%$$

where

$L_s$  = Space Loss Index (%)  
 $W_e$  = Effective Width (m)  
 $W_d$  = Delineated Width (m)  
 $W_o$  = Occupied Width (m)

These formulas are applied in sequence: this paper record the remaining usable width under the recorded obstacle conditions, and then  $L_s$  represents the resulting space loss as a percentage of  $W_d$ .  $W_d$  and  $W_e$  are obtained through field validation on each predefined study segment, and  $W_o$  is calculated as  $W_d - W_e$ . A higher  $L_s$  value indicates a larger proportion of usable space in the defined NML space under the recorded conditions.

## FINDINGS AND DISCUSSION

This study compared the spatial conditions of four pre-selected road sections in Chengdu, revolves around three dimensions: structural design, traffic control, and enforcement implementation. Within each dimension, the observed spatial loss results are interpreted in conjunction with the specific road section conditions, rather than being treated as evidence of a single causal factor.

**Table 1:** Measured geometry and Space Loss Index ( $L_s$ ) in the analysed road segments

| Road Segment      | Analysed Length(m) | $W_d$ (m) | $W_e$ under observed obstruction (m) | $L_s$ (%) |
|-------------------|--------------------|-----------|--------------------------------------|-----------|
| Jianshe Road      | 270                | 3.97      | 3.97                                 | 0.0       |
| Ximianqiao Street | 375                | 3.00      | 0.20                                 | 93.3      |
| Jinxu Road        | 60                 | 1.92      | 0.00                                 | 100.0     |
| Haichang Road     | 170                | 2.28      | 0.20-0.40                            | 82.5-91.2 |

*Source: Field verification and authors' calculations*

Table 1 summarizes the measured geometry and space loss index ( $L_s$ ) of the four road segments analyzed. Under the recorded conditions, the physically isolated section of Jianshe Road maintained its full designated width, and no space loss was recorded. In contrast, the effective NML was reduced on Ximianqiao Street, Jinxu Road, and Haichang Road due to vehicles occupying the designated areas.

**Table 2:** Cross-case comparison of facility configuration and observed condition

| Road Segment      | Facility Configuration                                 | Primary Observed Constraint                 | Functional Outcome            |
|-------------------|--------------------------------------------------------|---------------------------------------------|-------------------------------|
| Jianshe Road      | Physically separated NML                               | No vehicle intrusion observed               | Continuous passage maintained |
| Ximianqiao Street | Delineated curbside NML                                | Intermittent vehicle stopping               | Bicycle passage disrupted     |
| Jinxiu Road       | Short approach NML segment                             | Parked vehicles despite no-parking controls | Bicycle passage blocked       |
| Haichang Road     | Delineated NML section within a discontinuous corridor | Irregular vehicle parking                   | Bicycle passage disrupted     |

*Source: Field verification and authors' analysis*

### Structural Design and Space Loss Observation

These four case studies demonstrate how facility configurations correspond to varying levels of observed Non-Motorized Traffic (NMT) space availability (table 2). The following discussion interprets the recorded geometry in conjunction with structural design, traffic control, and existing enforcement evidence

The 270 meter section of Jianshe Road analyzed includes physical barriers, including green medians and pillars. On site verification revealed no motorized car encroachment on the designated NML. Therefore, its designated width and effective width are both 3.97 meters, with a space loss rate ( $L_s$ ) of 0.0%.

while lane markings were drawn on the 375 meter long A-B section of Ximianqiao Street, continuous physical separation was not achieved. During recorded instances of intermittent vehicle parking, the actual effective width was only 0.20 meters, compared to the marked width of 3.00 meters ( $L_s = 93.3\%$ ). This situation obstructed bicycle traffic, forcing cyclists to detour or merge into adjacent motorized lanes.

In the 60 meter section of Jinxiu Road analyzed, the lane marking width was 1.92 meters. Despite the presence of no-parking signs nearby, vehicles were still parked in this section. Under the observed conditions, the NML within the markings had no effective width, resulting in a capacity ( $L_s$ ) value of 100%. The presence of parking tickets indicates that enforcement action was taken; therefore, this case is interpreted as a challenge in enforcement rather than a complete lack of evidence.

In the 170 meter section of Haichang Road analyzed, the lane marking width was 2.28 meters. Improperly parked motor vehicles within the NML resulted in an effective width of only 0.20 to 0.40 meters, with  $L_s$  values ranging from 82.5% to 91.2%.

In summary, the sampled segments differ in configuration and functional role, and these differences are associated with varying observed conditions of NML right.

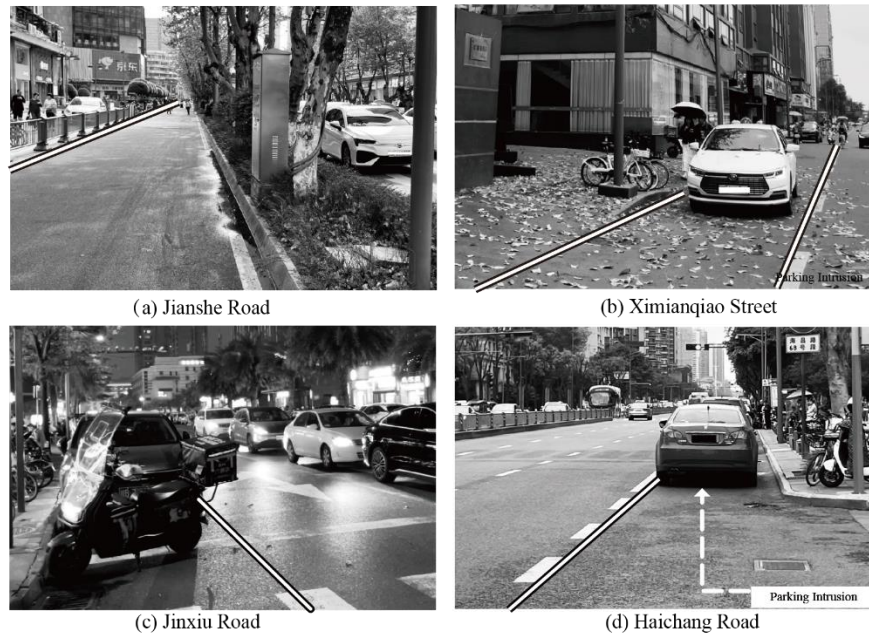


**Figure 3:** Observed roadside conditions in the four analysed road segments  
 Source: Field photographs by the Author (2025-2026)

As shown in table 1, the four analysed segments exhibit different observed levels of space loss. This suggests that, this phenomenon demonstrates that merely increasing road width does not directly guarantee the rational use of road rights. Space allocation is profoundly influenced by grassroots livelihood logic and individual opportunism (Lipsky, 2010; Ogunyemi et al., 2024).

### Transportation Policy and Regulatory Dimensions

Transportation policy is not merely a set of static regulations; it is also the institutional adjustments made by policymakers to balance traffic efficiency with social needs.

The implementation of preventive policies can reduce the need for subsequent regulation, the most notable achievement of Jianshe Road lies in its low-maintenance nature. Orderly traffic flow has reduced the need for daily enforcement by traffic management authorities. This defensive regulatory approach has replaced the long-term costs of regulation. This case suggests that robust physical boundaries may reduce reliance on frequent on-site enforcement.

Policies must be tailored to local conditions, Ximianqiao Street exemplifies the conflict between the continuous flow of non-motorized traffic (NMT) and the daily need for roadside access. Its dashed markings and roadside layout seem designed to accommodate short-term activities such as hotel pick-ups and dropoff, and store deliveries. This design detail reflects urban micro-tolerance toward street-side commercial activities. This tolerance does not stem from institutional gaps but rather represents a conscious institutional trade off. However, on site observations show that this flexibility reduces the continuity of NMT access space when motor vehicles are parked or stopped. whose spatial impact requires careful assessment.

This study conducted an indepth analysis of 10 representative complaint samples sourced from the “Sichuan Government Inquiry” platform. Qualitative analysis of these unstructured texts revealed a high degree of consistency in citizens' grievances, with 80% of complaints centering on the core issue of de facto reduction of NML due to informal operations (tricycles) or street vendors occupying roadways.

To identify the temporal distribution characteristics of bicycle lane conflicts on Haichang Road, this study conducted statistical analysis on the collected citizen appeals:

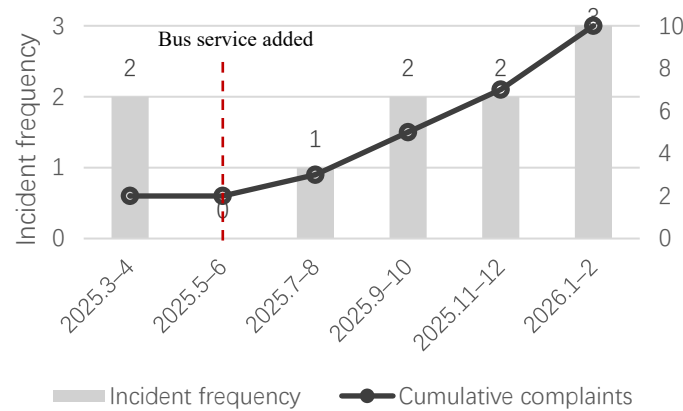


**Figure 4:** Monthly recorded roadside incidents and cumulative public complaints on Haichang road

Source: Authors' compilation of 10 public Records from the Sichuan Government (2025 to Feb.2026)

As shown in Figure 4, local residents have complaints with the street vendors on Haichang Road and the shuttle buses that occupy the road.

To address this governance challenge, Chengdu's transportation authorities implemented proactive intervention measures on April 17, 2025, introducing a short-distance shuttle bus connecting the eastern end of Haichang

Road to the Haichang Road subway station (Cover News, 2025). This initiative aimed to squeeze out informal tricycle services by providing safer, more formal public transportation, enhancing residents' convenience in commuting home, and increasing utilization of NML.

Preliminary data analysis indicates that this initiative significantly alleviated social tensions in the short term, with citizen complaints declining in the months following the intervention. However, long-term tracking of complaint records on government websites reveals that since September 2025, starting in July 2025, related complaints began to surface, intensifying by December. This exposes the limitations of formal systems when replacing informal shuttle services. The door-to-door convenience and low barriers offered by tricycles demonstrated remarkable informal resilience in competing with fixed-schedule public transit services.

In recent years, Chengdu has introduced a series of measures to improve the utilization of limited road space, including setting up straight ahead waiting areas, connecting dead end alleys, and allowing residents to report violations (2022). The Haichang Road shuttle service embodies this precise traffic management approach, providing local residents with a formal last mile travel option. While these measures may improve operational efficiency, their spatial impact on NMT users still needs to be assessed.

### **The Law Enforcement and Regulatory Dimension**

If policy provides the space for tolerance, then law enforcement determines the degree of tolerance. This research finds that regulatory boundaries exhibit a significant tendency to retreat amid the tension between social anxiety and administrative costs.

To further explore the institutional logic underlying responses to spatial conflicts, this study developed a standardized flowchart for the handling of complaints regarding NML in Chengdu (see Figure 5).

This flowchart illustrates how initial complaints submitted through the 12345 Mayor's Hotline and the Sichuan Government Inquiry platform undergo administrative triage (Zhao et al., 2025), ultimately balancing between rigid enforcement and flexible persuasion. This institutionalized triage process is the underlying reason for the weariness effect observed in Haichang Road's governance outcomes.

According to figure 4 of the Chengdu 12345 Hotline Platform, the platform is defined as the city's central customer service hub and a key reference for government decision making (2023). This confirms that the complaint data selected for this study is not marginal social discourse, but an indicator of public sentiment formally incorporated into the city's governance monitoring system (Wang et al., 2025).

Chengdu's governance approach is not solely reliant on tolerance. On the law enforcement front, the government implements both static, strict street management systems and introduces drone patrols and executes to address blind spots (2026), which caused by insufficient police resources. Regarding road rights, the city enforces a strict access system for bus only lanes on its Second Ring Road, featuring heavy penalties with no upper limit on the number of offenses, demonstrating rigid rule enforcement.

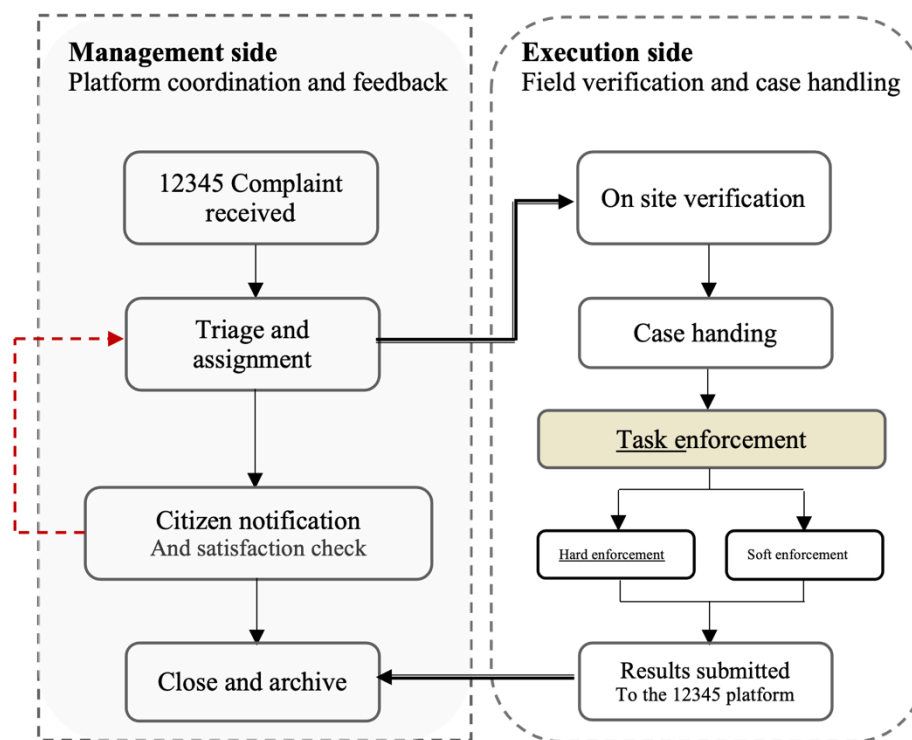


**Figure 5.** Enforcement and regulatory dimensions

Source: Author' illustration based on the Chengdu 12345 hotline Platform work measures (2023)

Meanwhile, the Haichang Road case illustrates a different logic—a social buffer zone created by flexible law enforcement. In this section of the road, the proactive withdrawal of administrative deterrence stems not from a lack of governance capacity, but rather from a form of benevolent tolerance toward informal employment and the essential transportation needs of nearby residents.

### **Why Regulatory Tolerance Needs?**

Although Jianshe Road demonstrates the exceptional effectiveness of physical separation in protecting road rights, below structural reasons pose significant challenges to its large scale citywide implementation:

Streets are not merely transportation corridors but also conduits for social activities. Before 2020, Chengdu imposed strict restrictions on street-level commerce. To counter economic downturn pressures, the city pioneered the “street vendor economy” pilot program, revitalizing streets' social functions to safeguard livelihoods, an initiative that garnered high praise at the national level (Jin & Zhao, 2022). For groups reliant on this policy, the forced physical isolation implemented on Jianshe Road risks severing primary income streams and informal connections (such as tricycle services), potentially causing severe impacts on the livelihoods of vulnerable populations.

Chengdu's implementation of soft enforcement essentially serves as a dynamic adjustment mechanism addressing the tension between physical space constraints in the city and the demands of social life.

Since 2018, Chengdu's traffic management authorities have consciously moved beyond rigid, black and white enforcement frameworks (Jin & Zhao, 2022). By introducing flexible measures such as adding temporary parking spaces, implementing first offense warnings, and replacing penalties with persuasion.

The notifications in figure 6 are example records received by the authors, not a system sample; they show that the observed law enforcement communications included both immediate penalties and expedited reminders or exemptions. These practices may create a temporary buffer for everyday social and livelihood activities. This zone provides a vital buffer before fully adapt for urban infrastructure, to the explosive growth in public needs.

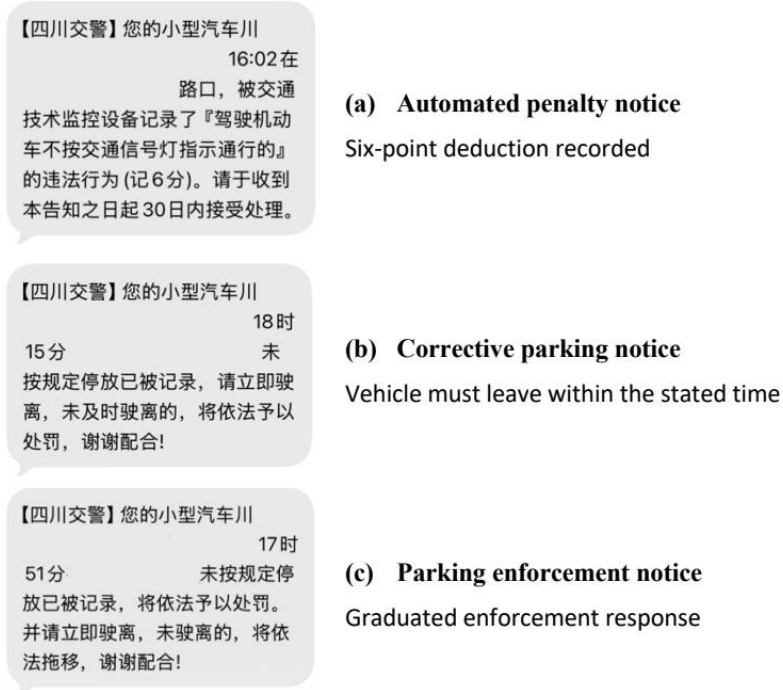


**Figure 6.** Examples of differentiated traffic violation notice received by the author  
*Source:* Author's personal traffic records: identifying information redacted. *English translations by the authors*

Within this context, Chengdu's law enforcement officers are not mere tools of administrative execution, but street-level bureaucrats with discretionary authority (Lipsky, 2010). They not only enforce legal provisions, but also uphold community consensus and warmth. A widely circulated social media case documented a touching moment, when Chengdu traffic police addressing illegal street vending, spontaneously purchased an elderly vegetable vendor's remaining produce to ensure she could return home earlier.

This act transcended traditional administrative boundaries, embodying empathy based governance within law enforcement. Such compassionate policing does not condone violations but represents a socially just balancing act, when confronting vulnerable informal economy participants, guiding them back to order through administrative care, which often garners greater public acceptance and cooperation than mere economic penalties. This warm community touch builds trust between enforcers and those being managed, thereby reducing overall social governance costs at the macro level and achieving a paradigm shift from adversarial enforcement to collaborative governance.

However, this discretion based compassion also poses challenges to governance consistency. When compassion is misinterpreted as permanent exemption, the spatial integrity of NML risks prolonged erosion. Therefore, how to maintain this administrative warmth while establishing clear legal boundaries is a critical challenge for Chengdu, it must overcome to advance toward high-level, refined governance.

Considerations of fairness are central to interpreting regulatory tolerance. Informal transportation providers, street vendors, service workers, and residents without private vehicles may rely on short-term roadside access and low cost last mile travel. Therefore, flexible management approaches can meet their reasonable livelihood and mobility needs. However, if these activities are restricted to designated NML, the resulting burden may shift to cyclists and other vulnerable road users, who may be forced to take detours or merge into motorized traffic. A more equitable approach combines affordable last mile transportation, designated loading/unloading or short-term parking spaces, and time limited management, while maintaining the continuity of NMT flow.

## **ACKNOWLEDGEMENT**

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## **CONCLUSION**

This study selected four predetermined road segments in Chengdu to examine the relationship between road facility design, roadside obstacles, traffic control conditions, and the spatial integrity of NMLs. The physically separated section on Jianshe Road maintained its designated passage space, whereas the segments on Ximianqiao Street, Jinxiu Road, and Haichang Road experienced a significant reduction in effective width when blocked by vehicles. These differences suggest that road facility design, roadside passage demands, traffic control measures, and enforcement conditions should be considered comprehensively, rather than attributed to a single enforcement factor.

In this study, regulatory tolerance is not a uniform or inherently negative policy, but rather a form of discretionary enforcement tailored to local conditions. Its spatial impact becomes particularly pronounced when a lack of flexibility or deterrence leads to vehicles stopping or parking within designated non-motorized lane spaces without alternative parking locations being provided.

The Space Loss Index ( $L_s$ ) provides a transparent and reproducible metric for measuring the proportion of space that is unavailable within designated NML areas under documented obstacle conditions. By standardizing the designated width, effective width, and occupied width, this index enables direct comparisons of space loss across road segments with different roadside management environments. Consequently, this index can serve as a common benchmark for

repeated field observations, before and after evaluations of street interventions, and cross city comparative studies. Its advantage is its ability to present information clearly and repeatably.

The contribution of this study lies in linking measured spatial losses to the structure of potential regulatory tolerance, as well as the regulatory and enforcement environment; where continuous NML passage is necessary, physical separation provides the most reliable protection. At the same time, flexible management can accommodate legitimate livelihood, freight transport, and last-mile access needs. A more equitable approach is not to shift these needs onto NML, but rather to combine protected bicycle space with designated loading and unloading zones or short term parking areas, affordable last mile alternatives, and clearly communicated time limited traffic controls.

This study has limitations. It documented conditions only on four relatively short, pre selected road segments and does not provide a representative assessment of Chengdu's entire road network. The observations describe the documented presence of obstacles, rather than systematic, round-the-clock parking frequencies or the long term effects of enforcement. Qualitative evidence regarding policies and enforcement provides contextual explanations but does not establish independent causal relationships.

Future research could apply the  $L_s$  measurement protocol to road segments with larger sample sizes and conduct repeated observations at different times and seasons. By combining parking records, bike-sharing trajectory data, or where ethical and legal requirements permit, intersection observations, this method can build a longitudinal evidence base for assessing how physical separation, roadside management, and local travel demand interact over time.

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