Assessment of Bicycle Lane Infrastructure in Metro Manila Using the Bikeway Segment Index (BSI)

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Abstract: The expansion of bicycle lane infrastructure in Metro Manila has improved the accessibility of cycling as a mode of urban transportation. However, limited information exists on the latest available condition of existing bicycle lane infrastructure. This study addresses this gap by assessing changes in bicycle lane conditions across 14 cities in Metro Manila through a comparison of baseline images collected in 2022 and the latest available Google Street View imagery from 2024 to 2026. The Bikeway Segment Index was used to evaluate infrastructure changes and assess compliance with the Department of Public Works and Highways Department Order No. 263, Series of 2022. Findings show that the assessed bicycle lane infrastructure has been characterized mainly by maintenance and preservation rather than substantial infrastructure improvements. While most bicycle lanes remain operational, recurring deficiencies limit compliance with current standards. The framework offers a practical approach for monitoring bicycle lane infrastructure, identifying priority areas for improvement, and supporting evidence-based planning and maintenance by national agencies and local government units.

Keywords: Bike lane network, Bicycle lane infrastructure, Google Street View, Bikeway Segment Index (BSI)

1. INTRODUCTION

In 2020, during the COVID-19 pandemic, the Philippine government implemented an "enhanced community quarantine" (ECQ), which imposed severe mobility restrictions affecting the entire public transport system, suspending all public transport during this time (Sunio & Mateo-Babiano, 2021). Due to this, cycling became an increasingly important mode of transportation and gained popularity during the COVID-19 lockdowns (Lorenzo, 2024). With the growth of cycling during the pandemic and the promotion of active transport, adequate bicycle infrastructure became increasingly important.

In response to this, the bike lane construction project of the Department of Transportation (DOTr) was allocated a budget of ₱ 1.316 billion under the Bayanihan to Recover as One Act of 2020. This aimed to promote cycling as an effective alternative mode of transportation through establishing several bike lanes in metropolitan areas (Metro Manila, Metro Cebu, and Metro Davao) and the implementation of bike-sharing programs (Ramos, 2020). As of the first quarter of 2026, under the Active Transport and Safe Pathways Program (ATSPP), a total of 1,100 kilometers of bike lanes were constructed around the Philippines, halfway through the target of 2,400 kilometers by 2028 (Barro II, 2026). On the other hand, a free bike-sharing service, located in Quezon City and Manila, was launched by the Metropolitan Manila Development Authority (MMDA) in 2026 (Caluag, 2026).

The development of active transport in the Philippines shows a positive shift towards sustainable urban mobility and equitable road space allocation. This includes the newly inspected network in Angeles City, Pampanga, and the expansion of the bike lane network in Quezon City. Additionally, Quezon City serves as a blueprint for local government units (LGUs) by highlighting and prioritizing active transportation. After expanding its protected bike lane network to 206.85 kilometers, the city was recognized at the Mobility Awards. The most notable addition in the network was the bike paths that allowed counterflows in major routes like Commonwealth, Katipunan, and Quezon Avenue.

With the collaboration between DOTr and the United Nations Development Programme (UNDP) in 2022, a Bike Lane Master Plan (BMP) was jointly developed that serves as a guide for the LGUs in Metro Manila, Metro Cebu, and Metro Davao toward a comprehensive, inclusive, and equitable cycling network. This plan investigated the current state of the constructed bike lanes from 2020 in the three metropolitan areas. Also, this highlighted the current gaps in the planning, design, implementation, operations, and maintenance of the bike lane network and other facilities such as parking and end-of-trip facilities, as well as integration with public transportation (Halil & Regidor, 2026).

Since the Bike Lane Master Plan was established in 2022, there is limited information on the latest available conditions of the established bike lane networks. This paper addresses this gap through two objectives: (1) to assess the changes in the condition of bicycle lane infrastructure in Metro Manila between 2022 and the present, and (2) to assess the compliance of the current bicycle lane infrastructure in Metro Manila with DPWH Department Order No. 263, Series of 2022 (DPWH, 2022).

The study is limited to selected roadways in Metro Manila. Current bicycle lane conditions were assessed using the latest available Google Street View imagery corresponding to the 2022 baseline locations. As the availability of Google Street View imagery varies by location, images from 2024 to 2026 were used depending on the latest imagery available for each assessment segment.

2. REVIEW OF RELATED LITERATURE

2.1 Evolution of Bicycle Infrastructure

Cycling in the Philippines has never been mainstream during pre-pandemic times. As estimated in the year 2018, only 2% of the total trips in Metropolitan Manila were made by bicycles (Bakker *et al*., 2018). Several factors contributed as a hindrance to bicycle use, such as poor implementation of bicycle commuting infrastructure, lack of secure parking at trip destinations, and overall climate (Castro & Josef, 2020). In relation to this, before the global pandemic, the bicycle infrastructure in the Philippines was limited to certain areas, specifically around Metro

Manila. In 2012, under the Bike Sharing Program, the MMDA opened the first bike lane spanning 2.92 kilometers along Commonwealth Avenue, Quezon City. Two more bike lanes were opened: 4.58 kilometers along Marcos Highway in Marikina City and a 1.755-km bicycle lane along M. Adriatico Street in Manila (Frialde, 2015). However, due to improper maintenance of the bicycle lanes, the program was halted in 2017 (Medina, 2018). Outside the Metro, Iloilo City's Esplanade bike lane is considered well-designed: a walkable, bikeable, and open space along a riverside (Sunio *et al*., 2024).

The pandemic served as an opportunity for cycling to grow in Metropolitan Manila. When the pandemic began, the Philippine government stopped all public transport, affecting 81% of the families in Metro Manila (Sunio *et al*., 2023). With only 11.5% of Metro Manila households owning a car, this left most Filipinos dependent on active transportation such as walking and cycling as public transport was disrupted (Peña, 2020). As a response to this, the Philippine government under the Republic Act No. 11494 or the Bayanihan to Recover As One Act provided ₱1.1 billion in funding for the establishment of 522.73-kilometer bicycle lane networks around the metropolitan areas such as Metro Manila, Metro Cebu, and Metro Davao, and ₱200 million for bike sharing. In addition, the DOTr and the Department of Public Works and Highways (DPWH) consulted with stakeholders and organizations in the development of the design guidelines for the bicycle lanes (Cuyco *et al*., 2022). Simultaneously, several LGUs are using their resources within their area to provide bike-related infrastructure, ordinances, and programs (Sunio *et al.*, 2024). As of April 2022, the DOTr announced that 379.1 kilometers of bicycle lanes were completed in NCR. Aside from that, other LGUs such as Quezon City also opened 93 kilometers of bicycle lanes within their locality (Abadilla, 2021).

2.2 Methods for Assessing Bicycle Infrastructure

Cycling infrastructure assessment is a research field directly linked to sustainable mobility and urban design (Mitropoulos *et al*., 2023). To assess different infrastructures, researchers have developed several methods, such as the dynamic comfort index (DCI), level of service (LOS), level of traffic stress (LTS), bikeability index (BI), and the bicycle safety index rating (BSIR) (Ahmed, T. *et al*., 2024). The dynamic comfort index assesses road surface quality through the Roughness or Vibration Index, focusing on vertical acceleration and bicycle vibration (Nuñez, J. Y., *et al.*, 2020). Meanwhile, the level of service and the level of traffic stress evaluate infrastructure, geometric design, traffic conditions, and traffic stress to assess the comfort and safety of a roadway network (Bai, L. *et al.*, 2017). Lastly, the bikeability index and bicycle safety index rating measure an infrastructure's sustainability for cycling, focusing on safety, comfort, attractiveness, directness, and coherence (Porter, A. K., *et al.*, 2020). These methods mostly rely on indices, focusing on the cyclist's perceptions through interviews (Ana, S. *et al.*, 2014).

Modern advancements like auditing techniques and usage of Geographic Information Systems (GIS) are critical and systematic instruments that evaluate bicycle infrastructure. Auditing techniques assess how built environments support walking and cycling, such as instruments like the Systematic Pedestrian and Cycling Environment Scan, which essentially gathers objective infrastructure data to identify areas for improvement (Gullón *et al*., 2015; Pikora *et al*., 2002). Meanwhile, the usage of GIS gives researchers leverage to integrate urban infrastructure data and advanced spatial analysis (Rossetti, 2024; Mitropoulos *et al*., 2023). Using these geospatial tools allows for comprehensive mapping and comparison of diverse indicators like topography, land use, safety, and accessibility across different areas (Krenn *et al*., 2014; Valenzuela *et al*., 2022).

At the segment level, Tsavala *et al*. (2026) developed a multicriteria framework for evaluating urban cycling infrastructure based on compliance with design guidelines. The framework assesses bicycle infrastructure using multiple criteria and indicators and demonstrates how individual bikeway segments can be systematically evaluated to identify infrastructure deficiencies. Similarly, Ahmed *et al*. (2025) developed a framework for assessing micro-level bicycle infrastructure design elements for the development of a bikeability index. These studies demonstrate the use of structured, indicator-based approaches for evaluating bicycle infrastructure. However, the indicators and assessment methods used in such frameworks depend on the objectives of the assessment, applicable design standards, and available data.

2.3 Bicycle Master Plans and Infrastructure Implementation

Bicycle master plans have become a foundational instrument in urban transportation policy, providing governments with a structured framework for coordinating cycling network development, design standards, funding strategies, and implementation timelines. Most research supports a positive relationship between bikeway networks and cycling levels, with preferences consistently favoring infrastructure that physically separates cyclists from motor vehicles over shared roadways, particularly in areas with high volumes of fast-moving traffic (Buehler & Dill, 2016). The practice of providing cycling facilities has likewise evolved from designing individual lanes toward planning for entire interconnected networks, reflecting a broader recognition that coherent network coverage is more effective than isolated infrastructure interventions (Buehler & Dill, 2016). In the Philippine context, the DOTr and UNDP jointly developed the 2022 Bike Lane Master Plan to rationalize the rapid but uneven bike lane expansion that occurred during the pandemic period, providing local government units in Metro Manila, Metro Cebu, and Metro Davao with a unified planning framework oriented toward a more comprehensive, inclusive, and equitable cycling network (UNDP Philippines, 2022).

However, the existence of a master plan does not in itself ensure quality or consistency in implementation, and the Philippine experience reflects patterns that have been widely documented in the broader literature on transport policy in developing country contexts. Metropolitan bike lane development in the Philippines identified six recurring systemic challenges across the network, namely safety, connectivity, end-of-trip facilities, integration with public transport, inclusion in new road and bridge projects, and enforcement, concluding that weaknesses in one dimension frequently cascade into others and thereby reinforce safety risks while limiting sustained cycling uptake (Halil & Regidor, 2026). Moreover, the documented number of bike lanes fell significantly below prescribed minimum width standards, and enforcement of lane use regulations remained inconsistent across local government units, with cycling facilities frequently obstructed by illegally parked vehicles and encroaching motorists (Halil & Regidor, 2026). These findings collectively point to a substantive gap between the standards and intentions articulated in the Bike Lane Master Plan and the conditions that have materialized in practice, which constitutes the central concern that this study seeks to investigate.

2.4 Synthesis of the Review of Related Literature

The literature reviewed in the preceding sections shows that bicycle infrastructure in the Philippines has developed significantly since the pandemic, with researchers establishing frameworks for evaluating cycling facilities based on safety, comfort, connectivity, and

physical quality. The literature also consistently points out that having a master plan does not automatically lead to proper implementation on the ground, especially in settings where multiple agencies are involved, enforcement is lacking, and funding is not always stable.

Additionally, there is still limited research that directly examines changes in the condition of Metro Manila's existing bicycle lanes and their compliance with applicable national bicycle facility standards. This study addresses that gap by evaluating observable bicycle lane conditions across selected roadways in Metro Manila, comparing their latest available conditions with the 2022 baseline, and assessing their compliance with DPWH Department Order No. 263, Series of 2022 (DPWH, 2022).

3. METHODOLOGY

3.1 Study Area

This study evaluates the existing and proposed bicycle lanes along selected roadways across 14 cities in Metro Manila, namely: Caloocan, Las Piñas, Makati, Mandaluyong, Manila, Marikina, Muntinlupa, Parañaque, Pasay, Pasig, Quezon City, San Juan, Taguig, and Valenzuela. The selected roadways assessed in each city are listed in Table 1. Figure 1 presents the bicycle lane network map of the study area, illustrating the locations of the assessed roadways and bicycle lane segments.

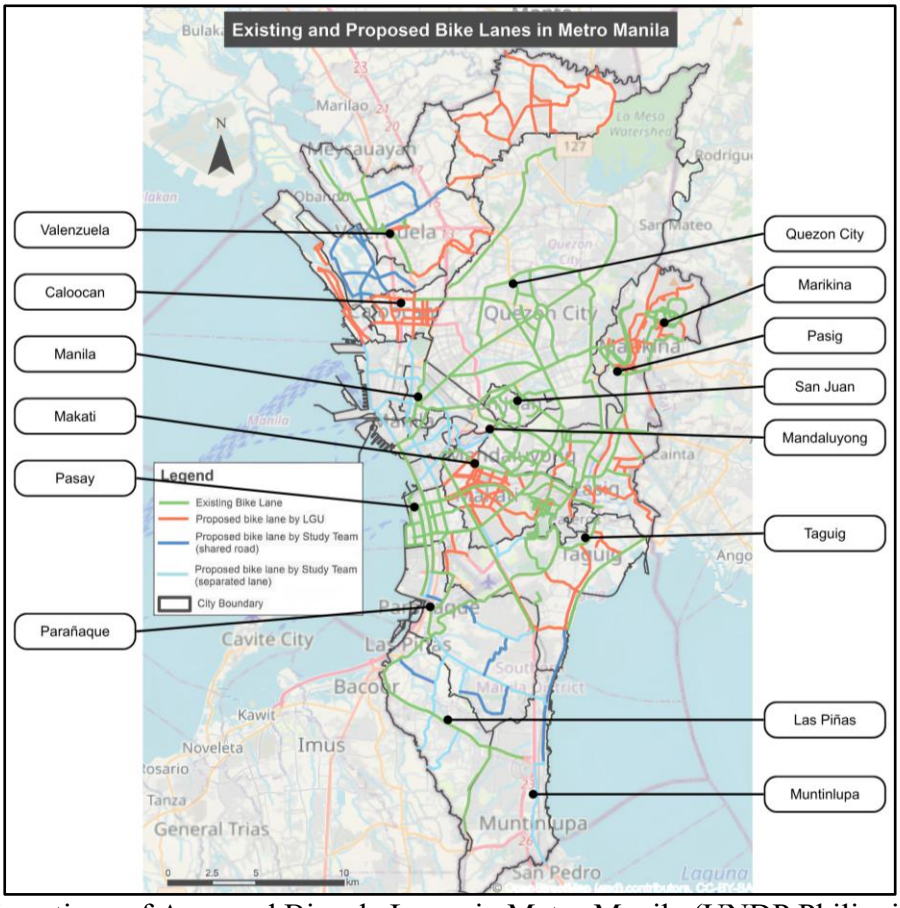


Figure 1. Locations of Assessed Bicycle Lanes in Metro Manila (UNDP Philippines, 2022)

Table 1. Summary of Assessed Roadways and Assessment Segments

City	Assessed Roadway(s)	No. of Assessment Segments
Caloocan	EDSA and Tullahan Road	6
Las Piñas	Daang Hari and Alabang Zapote Road	8
Makati	Jose P. Rizal Avenue	8
Mandaluyong	New Panaderos Extension and F. Blumentritt St.	7
Manila	R-8	7
Marikina	Bayan-Bayanan Avenue and General Ordoñez Avenue	7
Muntinlupa	Alabang-Zapote Road and National Road	6
Parañaque	Ninoy Aquino Avenue and C-5	5
Pasay	J. W. Diokno Boulevard	4
Pasig	Marcos Highway and Amang-Rodriguez Avenue	10
Quezon City	Mindanao Avenue and Agham Road	8
San Juan	Pinaglabanan Road and Santolan Road	22
Taguig	Cayetano Boulevard and C-6 Bike Lane	8
Valenzuela	A. Pablo St. and MacArthur Highway	5
	Total	**111**

An assessment segment refers to a portion of an assessed roadway exhibiting relatively uniform bicycle lane conditions. During the 2022 baseline survey, photographs were taken to represent portions of each roadway where bicycle lane conditions remained generally consistent, while additional photographs were taken when a noticeable change in condition was observed. Thus, the assessment segments were condition-based rather than defined using predetermined fixed-distance intervals. For the present study, each 2022 baseline photograph was matched with the latest available Google Street View (GSV) image representing the same or nearest corresponding location. A total of 111 assessment segments across the 14 cities were evaluated. Each matched image pair was subsequently evaluated as one assessment segment using the BSCS and BSCompS criteria described in Section 3.3.

The study focuses on selected roadways within each city rather than the entire road network. The assessed roadways include major arterial and collector roads where bicycle lane infrastructure is present or proposed. The selection provides a practical and focused basis for evaluating bicycle lane infrastructure across the selected cities. Accordingly, the findings represent the assessed roadways and should not be interpreted as a comprehensive assessment of the entire bicycle lane network of each city.

3.2 Data Sources

The study used two sets of photographic data for the assessment. Baseline images were obtained during the 2022 bicycle lane survey conducted across the 14 selected cities in Metro Manila.

For the current conditions, the latest available Google Street View (GSV) imagery corresponding to the baseline locations was used, with image dates ranging from 2024 to 2026.

3.3 Bikeway Segment Index (BSI) Assessment Framework

This study employs an indicator-based assessment framework to evaluate bicycle lane infrastructure along selected road segments in Metro Manila using the 2022 baseline images and the latest available Google Street View images from 2024 to 2026. Previous studies, including Ahmed *et al*. (2025) and Tsavala *et al*. (2026), demonstrate the application of structured, multicriteria approaches for evaluating bicycle infrastructure using various design and infrastructure characteristics. Building on this general approach, the present study developed the Bikeway Segment Index (BSI) specifically for the objectives, Philippine design context, and available visual data of the study.

Unlike conventional infrastructure indices that generate a single numerical value, the proposed BSI consists of two complementary assessment components that independently evaluate different aspects of bicycle lane infrastructure. The first component, the Bikeway Segment Change Score (BSCS), evaluates the direction of change in bicycle lane infrastructure by comparing the baseline images and the latest available Google Street View images. The second component, the Bikeway Segment Compliance Score (BSCompS), evaluates the current level of compliance with applicable national bicycle infrastructure standards. The two assessment components are interpreted independently to provide a more comprehensive evaluation of bicycle lane infrastructure. The overall assessment framework adopted in this study is presented in Figure 2.

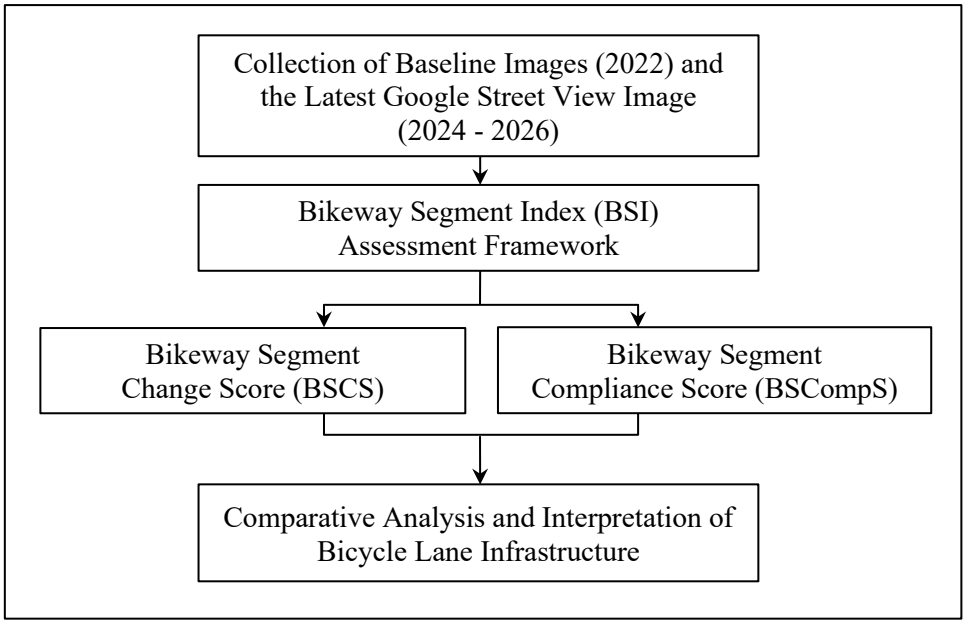


Figure 2. Bikeway Segment Index (BSI) Assessment Framework

Baseline images of bicycle lanes captured in 2022 and the latest available Google Street View images were collected for each assessment segment. The corresponding baseline and latest images were then compared to determine changes in bicycle lane infrastructure over time. The assessment criteria were derived primarily from applicable bicycle facility provisions of DPWH Department Order No. 263, Series of 2022 (DPWH, 2022). While the Department Order contains a broader range of design and operational provisions for bicycle facilities, the study selected characteristics that could be consistently assessed using the available photographic

imagery. Characteristics requiring field measurements, geometric measurements, nighttime observations, user perception, or other information that could not be reliably determined from the images were excluded from the assessment.

Based on these considerations, the BSCS evaluates lane continuity, pavement markings, physical protection, and encroachment to determine observable changes relative to the 2022 baseline. The BSCompS evaluates pavement condition, pavement markings, physical protection, and encroachment to determine the current level of compliance with applicable bicycle facility provisions. The difference in criteria reflects the distinct purpose of each component: the BSCS assesses the direction of infrastructure change, while the BSCompS assesses the latest available condition against applicable standards. The two components are interpreted independently because change over time and compliance with current standards represent different dimensions of bicycle lane infrastructure. An assessment segment may remain unchanged while meeting the applicable standards, while another may show improvement relative to its 2022 condition but still fall short of the applicable standards.

3.3.1 Assessment of Changes in Bicycle Lane Infrastructure

The first component addresses the first objective of the study, which is to determine the changes in bicycle lane infrastructure by comparing its condition in the baseline images and the latest available images. A three-point ordinal scoring system was developed to evaluate the direction of change for each assessment criterion. A score of 2 indicates an improved condition, 1 indicates no significant change, and 0 indicates a worsened condition relative to the baseline. The descriptions presented in Table 2 operationalize these three directions of change for each criterion based on observable differences between the paired images.

Table 2. Operational Scoring Criteria for the Bikeway Segment Change Score (BSCS)

Criterion	2 (Improved)	1 (No Significant Change)	0 (Worsened)
Lane Continuity	Gaps eliminated or lane extended	Continuity unchanged	New gaps or discontinuities introduced
Pavement Markings	Markings repainted or enhanced	Markings remain unchanged	Markings faded, removed, or no longer visible
Physical Protection	New or improved bollards/barriers installed	Protection unchanged	Bollards/barriers removed or damaged
Encroachment	Fewer obstructions than in 2022	Similar level of encroachment	Increased parked vehicles, vendors, or other obstructions

The scores obtained from all assessment criteria are added to obtain the Bikeway Segment Change Score (BSCS) for each road segment.

$$BSCS = \Sigma_{i=1}^{n} S_i \quad (1)$$

where,

BSCS : Bikeway Segment Change Score
S_i : score for each assessment criterion
n : total number of assessment criteria

Since four (4) assessment criteria were evaluated using the three-point scoring system, the maximum possible BSCS is eight, while the minimum possible score is zero. Similar to the

approach of Ahmed *et al*. (2025), the BSCS is converted into a percentage to facilitate comparison and interpretation among bicycle lane segments using Equation 2.

$$BSCS(\%) = \frac{BSCS}{BSCS_{MP}} \times 100\% \quad (2)$$

where,

$BSCS_{MP}$: maximum possible Bikeway Segment Change Score

The resulting percentages are classified into five levels to provide a more interpretable assessment of the overall direction of change in bicycle lane infrastructure. The interpretation of the BSCS is presented in Table 3.

Table 3. Interpretation of Bikeway Segment Change Score (BSCS)

Percentage	Interpretation
>80% - 100%	Highly Improved
>60% - 80%	Moderately Improved
>40% - 60%	Minimal to No Significant Change
>20% - 40%	Moderately Worsened
0 – 20%	Highly Worsened

3.3.2 Assessment of Compliance with DPWH Department Order No. 263

The second component addresses the second objective of the study, which is to assess the compliance of the existing bicycle lane infrastructure with DPWH Department Order No. 263, Series of 2022 (DPWH, 2022). Unlike the BSCS, which evaluates changes relative to the 2022 baseline, the BSCompS evaluates the latest available condition of each assessment segment against applicable provisions of the Department Order.

Certain assessment criteria vary depending on the classification of the bicycle lane. Therefore, each bicycle lane segment was first classified according to the bicycle lane classifications specified in the DPWH guidelines before the corresponding compliance criteria were applied. The three bicycle lane classifications used in this study are presented in Table 4. Afterwards, a three-point compliance scoring system was used to evaluate each assessment criterion, wherein a score of 2 indicates full compliance, 1 for partial compliance, and 0 for non-compliance.

Table 4. Bike Lane Classification (DPWH, 2022)

Class	Definitions
Class I (Shared Use Path or Bike Path)	A designated path, completely separated from the roadway; typically separated from motor vehicle roadway.
Class II (Separated Bike Lane)	A portion of roadway normally distinguished by a paint stripe, curb or barrier.
Class III (Shared Roadway)	Part of the roadway that has been officially designated and marked as a bicycle route but can also be used by motor vehicles where there is limited carriageway width.

The compliance criteria were derived from applicable provisions of DPWH Department Order No. 263, Series of 2022 (DPWH, 2022). While the Department Order contains a broader range of provisions for bicycle facilities, the study selected four criteria that could be consistently assessed using the available photographic imagery: pavement condition, pavement

markings, physical protection, and encroachment. The corresponding provisions presented in Table 5 served as the guide for evaluating the compliance of each assessment segment. Other requirements that could not be reliably determined from the available images were not included in the assessment.

Table 5. Compliance Criteria based on DPWH Department Order No. 263, s. 2022

Criterion	Applicable Provisions/Definitions
Pavement Condition	Bike lanes must be paved with a smooth, skid-resistant, and well-drained surface. The pavement must be free of hazards like potholes, utility covers, or abrupt unevenness.
Pavement Markings	Class I: Shall be separated with solid line pavement markings with appropriate informatory signs. Class II: Pavement markings or combination of concrete curb (precast concrete delineator) with flexible bollard posts shall be used. Class III: Roadway markings shall be placed in the center of designated shared travel lane and shall be applied at intervals frequent enough; four main components of a shared roadway markings should have bike symbols, arrows, text indicating "share the road or share the lane," and an optional shared bike lane using broken white lines.
Physical Protection	Class I and II: Presence and condition of approved physical separation devices (e.g., bollards, curbs, planters, raised separators) that protect cyclists from adjacent motor vehicle traffic where applicable.
Encroachment	A clear and unobstructed passage shall be maintained at all times along bike path, shared use path and bike lane to be undertaken by the District Engineering Offices (DEOS).

The individual compliance scores are summed to obtain the Bikeway Segment Compliance Score (BSCompS).

$$BSCompS = \Sigma_{i=1}^{n} C_i \quad (3)$$

where,

BSCompS : Bikeway Segment Compliance Score
C_i : compliance score for each criterion

Four (4) assessment criteria were evaluated using the three-point compliance scoring system, which can result in a maximum possible BSCompS of eight, while a minimum possible score of zero. Similar to the BSCS, the BSCompS is converted into a percentage to standardize the evaluation and facilitate comparison among bicycle lane segments. The BSCompS percentage is obtained using Equation 4.

$$BSCompS(\%) = \frac{BSCompS}{BSCompS_{MP}} \times 100\% \quad (4)$$

where,

$BSCompS_{MP}$: maximum possible Bikeway Segment Compliance Score

The interpretation of the compliance levels is presented in Table 6.

Table 6. Interpretation of Bikeway Segment Compliance Score (BSCompS)

Percentage	Interpretation
>80% - 100%	Highly Compliant
>60% - 80%	Moderately Compliant
>40% - 60%	Partially Compliant
>20% - 40%	Minimally Compliant
0 – 20%	Non-compliant

Although both BSI components use a three-point ordinal scale, the scores represent different assessment dimensions. For the BSCS, scores of 2, 1, and 0 indicate improved, no significant change, and worsened conditions, respectively, whereas for the BSCompS, the same scores indicate full compliance, partial compliance, and non-compliance, respectively. Accordingly, the two component scores are interpreted independently and are not combined into a single overall BSI score. In addition, the percentages reported in the study were not visually estimated. Visual assessment was used only to assign the corresponding ordinal score (0, 1, or 2) for each criterion, while the percentage scores were mathematically calculated using Equations 2 and 4.

For the city-level assessment, the scores for each criterion were averaged across all assessment segments within each city and expressed as percentages. The overall BSCS and BSCompS were obtained by averaging the corresponding percentage scores of all assessment segments within each city. Each assessment segment was assigned equal weight in the calculation. The aggregation was not weighted according to physical segment length because the assessment segments were condition-based and their lengths were not measured during the 2022 baseline survey. Accordingly, the city-level scores represent unweighted averages of the assessed segments and should not be interpreted as length-weighted estimates of bicycle lane conditions.

4. RESULTS AND DISCUSSION

4.1 Changes in Bicycle Lane Infrastructure

Table 7 and Figure 3 present the city-level BSCS results. The BSCS percentage was first calculated for each assessment segment, after which the percentage scores of all assessment segments within each city were averaged to obtain the city-level BSCS.

Table 7. Summary of Bikeway Segment Change Score (BSCS) Results

City	Lane Continuity	Pavement Markings	Physical Protection	Encroach-ment	Overall Score	Interpretation
Caloocan	50.00	33.33	33.33	50.00	41.67	Minimal to No Significant Change
Las Piñas	37.50	43.75	50.00	50.00	45.31	Minimal to No Significant Change
Makati	37.50	31.25	50.00	43.75	40.63	Minimal to No Significant Change
Mandaluyong	50.00	50.00	50.00	64.29	53.57	Minimal to No Significant Change
Manila	42.86	57.14	50.00	35.71	46.43	Minimal to No Significant Change
Marikina	50.00	50.00	50.00	42.86	48.21	Minimal to No Significant Change
Muntinlupa	83.33	83.33	50.00	50.00	66.67	Moderately Improved
Parañaque	40.00	40.00	50.00	50.00	45.00	Minimal to No Significant Change

City	Lane Continuity	Pavement Markings	Physical Protection	Encroach-ment	Overall Score	Interpretation
Pasay	37.50	37.50	25.00	50.00	37.50	Moderately Worsened
Pasig	55.00	55.00	50.00	50.00	52.50	Minimal to No Significant Change
Quezon City	50.00	25.00	37.50	50.00	40.63	Minimal to No Significant Change
San Juan	47.73	38.64	43.18	43.18	43.18	Minimal to No Significant Change
Taguig	43.75	56.25	25.00	37.50	40.63	Minimal to No Significant Change
Valenzuela	50.00	10.00	50.00	50.00	40.00	Moderately Worsened



Figure 3. Bikeway Segment Change Score (BSCS) Results

From the results, 11 of the 14 assessed cities, namely Caloocan, Las Piñas, Makati, Mandaluyong, Manila, Marikina, Parañaque, Pasig, Quezon City, San Juan, and Taguig, were classified as having minimal to no significant change in bicycle lane infrastructure as shown in Figure 4.



Figure 4. Sample Comparison of Minimal to No Significant Change in Bicycle Lane Infrastructure, Mandaluyong City

Meanwhile, Muntinlupa City was the only city classified as moderately improved, with a total BSCS of 66.67%. Compared with the 2022 baseline images shown in Figure 5, the city showed notable improvements in lane continuity and pavement markings, primarily due to the construction of new bicycle lane segments along Alabang-Zapote Road under the South Manila Bike Lane Network. However, physical protection and encroachment remained largely unchanged, indicating that cyclist safety still requires further improvement.



Figure 5. Sample Segment of Moderately Improved Bicycle Lane Infrastructure, Muntinlupa City

In contrast, Pasay and Valenzuela were classified as moderately worsened as observed in Figure 6. Valenzuela recorded a notably low score for pavement markings (10.00%) due to visibly faded lane markings, resulting in an overall BSCS of 40.00%. Similarly, Pasay obtained low scores for pavement markings (37.50%) and physical protection (25.00%). The deterioration in Pasay's physical protection is consistent with observations that lane separators and barriers previously present in the baseline images had been removed. This observation also supports the findings of the Bike Lane Master Plan (UNDP Philippines, 2022) which reported that several bicycle lanes along major roads in Pasay required repainting following DPWH asphalt overlay works.



Figure 6. Sample Segments of Moderately Worsened Bicycle Lane Infrastructure, Valenzuela City (Top) and Pasay City (Bottom)

4.2 Compliance with DPWH Department Order No. 263

Table 8 and Figure 7 present the city-level BSCompS results. The BSCompS percentage was first calculated for each assessment segment, after which the percentage scores of all assessment segments within each city were averaged to obtain the city-level BSCompS.

Table 8. Summary of Bikeway Segment Compliance Score (BSCompS) Results

City	Pavement Condition	Pavement Markings	Physical Protection	Encroach-ment	Total Score	Conclusion
Caloocan	58.33	33.33	0.00	83.33	43.75	Partially Compliant
Las Piñas	87.50	68.75	12.50	93.75	65.63	Moderately Compliant
Makati	62.50	50.00	87.50	68.75	67.19	Moderately Compliant
Mandaluyong	50.00	64.29	0.00	64.29	44.64	Partially Compliant
Manila	50.00	57.14	0.00	35.71	35.71	Minimally Compliant
Marikina	42.86	50.00	50.00	42.86	46.43	Partially Compliant
Muntinlupa	100.00	50.00	0.00	100.00	62.50	Moderately Compliant
Parañaque	60.00	50.00	30.00	70.00	52.50	Partially Compliant
Pasay	75.00	0.00	50.00	75.00	50.00	Partially Compliant
Pasig	45.00	40.00	20.00	75.00	45.00	Partially Compliant
Quezon City	87.50	62.50	56.25	93.75	75.00	Moderately Compliant
San Juan	70.45	50.00	4.55	50.00	43.75	Partially Compliant
Taguig	68.75	75.00	75.00	93.75	78.13	Moderately Compliant
Valenzuela	70.00	50.00	40.00	60.00	55.00	Partially Compliant

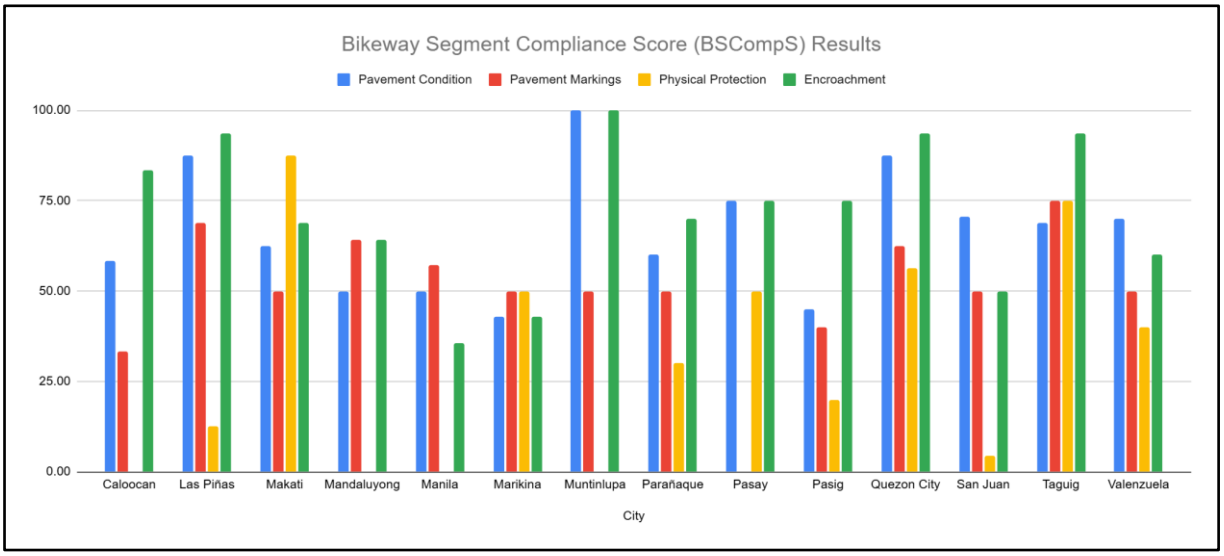


Figure 7. Bikeway Segment Compliance Score (BSCompS) Results

Based on the BSCompS results, eight cities were classified as Partially Compliant with DPWH Department Order No. 263, s. 2022, namely Caloocan, Mandaluyong, Marikina, Parañaque, Pasay, Pasig, San Juan, and Valenzuela. Five cities, namely Las Piñas, Makati, Muntinlupa, Quezon City, and Taguig, were classified as Moderately Compliant, while Manila was classified as Minimally Compliant.

Among the assessed cities, Taguig obtained the highest overall compliance score of 78.13%. As shown in Figure 8, its Class I and Class II bicycle lanes generally have adequate pavement markings, signage, and physical separation, particularly along major corridors such as the Laguna Lake Highway (Caliwan, 2020). Muntinlupa also demonstrated strong performance, achieving perfect scores for pavement condition and encroachment, indicating good infrastructure quality and unobstructed bicycle lanes. However, the absence of physical protection resulted in a non-compliant score for that criterion.

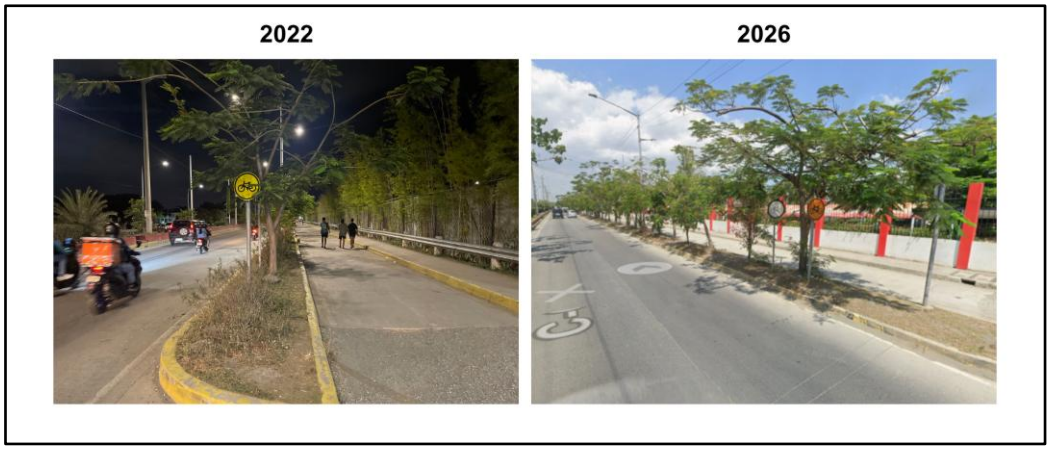


Figure 8. Sample Segment of Bicycle Lane Infrastructure with Highest Overall Compliance, Taguig City

In contrast, Caloocan and San Juan obtained the lowest overall compliance scores of 43.75%. Although San Juan achieved a relatively high score for pavement condition, most of its Class II bicycle lanes lacked the physical separation devices required under the DPWH guidelines, as shown in Figure 9. A possible reason is the San Juan City Government's 2023 initiative to remove plastic bollards along selected bicycle lanes to improve traffic flow on narrow roads (Garcia, 2023). Similar observations were made in other cities where Class II bicycle lanes lacked physical barriers, resulting in non-compliance with the DPWH requirements.

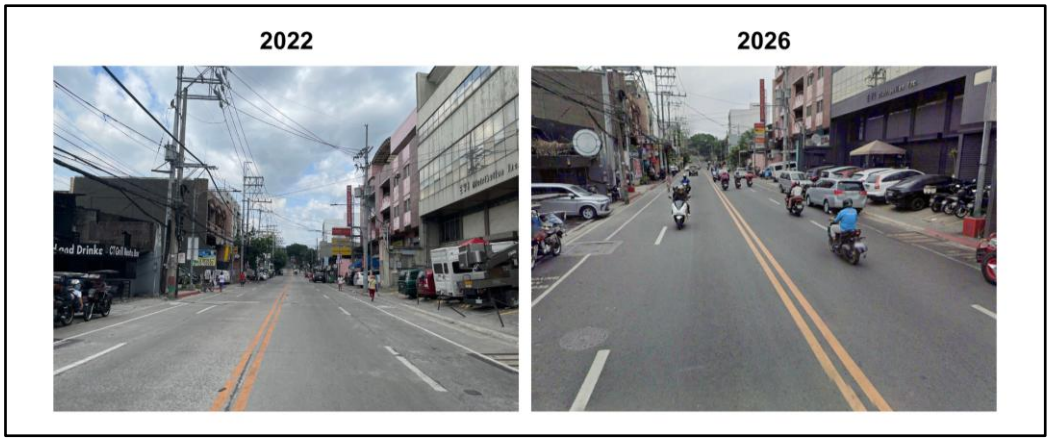


Figure 9. Sample Segment of Relatively High Score for Pavement Condition, San Juan City

4.3 Synthesis

Table 9 presents the combined results of the overall Bikeway Segment Change Score (BSCS) and the Bikeway Segment Compliance Score (BSCompS) by each city.

Table 9. Summary of Bikeway Segment Index (BSI) Assessment Results

City	Total BSCS Score	Total BSCompS Score	Overall Conclusion
Caloocan	41.67	43.75	Minimal to No Significant Change and Partially Compliant
Las Piñas	45.31	65.63	Minimal to No Significant Change and Moderately Compliant
Makati	40.63	67.19	Minimal to No Significant Change and Moderately Compliant
Mandaluyong	53.57	44.64	Minimal to No Significant Change and Partially Compliant
Manila	46.43	35.71	Minimal to No Significant Change and Minimally Compliant
Marikina	48.21	46.43	Minimal to No Significant Change and Partially Compliant
Muntinlupa	66.67	62.50	Moderately Improved and Moderately Compliant
Parañaque	45.00	52.50	Minimal to No Significant Change and Partially Compliant
Pasay	37.50	50.00	Moderately Worsened and Partially Compliant
Pasig	52.50	45.00	Minimal to No Significant Change and Partially Compliant
Quezon City	40.63	75.00	Minimal to No Significant Change and Moderately Compliant
San Juan	43.18	43.75	Minimal to No Significant Change and Partially Compliant
Taguig	40.63	78.13	Minimal to No Significant Change and Moderately Compliant
Valenzuela	40.00	55.00	Moderately Worsened and Partially Compliant

The comparison of the BSCS and BSCompS results shows that infrastructure change does not necessarily correspond to compliance with bicycle facility standards. For instance, Quezon City and Taguig exhibited minimal to no significant changes while achieving relatively high compliance scores, suggesting that their existing bicycle lane infrastructure already satisfied many of the prescribed standards. In contrast, the cities of San Juan, Manila, and Caloocan also showed little change but obtained lower compliance scores, indicating that existing deficiencies, particularly in physical protection and pavement markings, have remained unaddressed.

Overall, the findings suggest that the assessed bicycle lane infrastructure in Metro Manila has been characterized more by maintenance and preservation than by substantial infrastructure improvements. While most bicycle lanes remain operational, recurring deficiencies continue to limit compliance with current standards, highlighting the need for continuous maintenance and consistent implementation of the bicycle facility standards prescribed under DPWH Department Order No. 263, s. 2022.

The combined use of the BSCS and BSCompS through the Bikeway Segment Index (BSI) provided a multidimensional evaluation of bicycle lane infrastructure. By assessing both infrastructure change and standards compliance independently, the framework demonstrates that infrastructure improvements do not necessarily indicate compliance with established standards, emphasizing the importance of considering both aspects when evaluating bicycle lane performance.

5. CONCLUSION AND RECOMMENDATIONS

To assess the bicycle lane infrastructure in Metro Manila using the latest available Google Street View images, this study developed the Bikeway Segment Index (BSI). The BSI comprises two assessment components: the Bikeway Segment Change Score (BSCS), which evaluates infrastructure changes, and the Bikeway Segment Compliance Score (BSCompS), which assesses compliance with DPWH Department Order No. 263, Series of 2022 (DPWH, 2022). The BSCS results indicate that bicycle lane infrastructure in Metro Manila has generally been maintained rather than substantially improved since 2022. Among the assessed cities, Muntinlupa City was the only city classified as Moderately Improved, while Pasay City and Valenzuela City exhibited deterioration, particularly in terms of pavement markings and physical protection. In terms of compliance, none of the 14 assessed cities was classified as Highly Compliant based on the four photographically observable criteria derived from DPWH Department Order No. 263, s. 2022. Eight cities were classified as Partially Compliant, five as Moderately Compliant, and one as Minimally Compliant, with physical protection being the most common deficiency among the assessed segments. These findings indicate persistent gaps between the presence of bicycle lane infrastructure and its compliance with applicable bicycle facility standards.

The use of the Bikeway Segment Index (BSI) demonstrated that evaluating infrastructure change and standards compliance separately provides a more comprehensive assessment of bicycle lane infrastructure. The findings showed that infrastructure improvements do not necessarily correspond to higher standards compliance, while minimal infrastructure changes do not always indicate poor performance. By considering both assessment components together while interpreting them independently, the proposed framework offers a practical approach for monitoring bicycle lane infrastructure, identifying priority areas for improvement, and supporting evidence-based planning and maintenance by national agencies and local government units.

Based on the findings and limitations of the study, the following are recommended for future research and bicycle infrastructure assessment:

- Collecting primary field data and photographs to supplement Google Street View imagery and capture infrastructure characteristics that cannot be reliably assessed through secondary imagery;
- Measuring and georeferencing the physical boundaries of assessment segments in future surveys to better capture spatial variations in bicycle lane conditions, enable length-weighted aggregation, and improve the spatial representativeness of city-level scores;
- Expanding roadway coverage within each city to improve the representativeness and generalizability of the findings;
- Incorporating cyclists' perspectives to complement the infrastructure-based assessment with measures of perceived safety and comfort; and
- Applying appropriate statistical analyses to examine relationships among environmental, infrastructural, and demographic variables.

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