



## Roundtable 2: Standardization of the Equipment Used and Its Maintenance Facilities



# Seoul's Experience in Bike Path Installation and LOS Evaluation

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**Road mobility projects in urban regions and their Impact on the environment**

**15-17 May 2023, Buenos Aires, Argentina**

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2. Seoul Bikeway Infrastructure
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# 1. Background

## 1.1 Questions

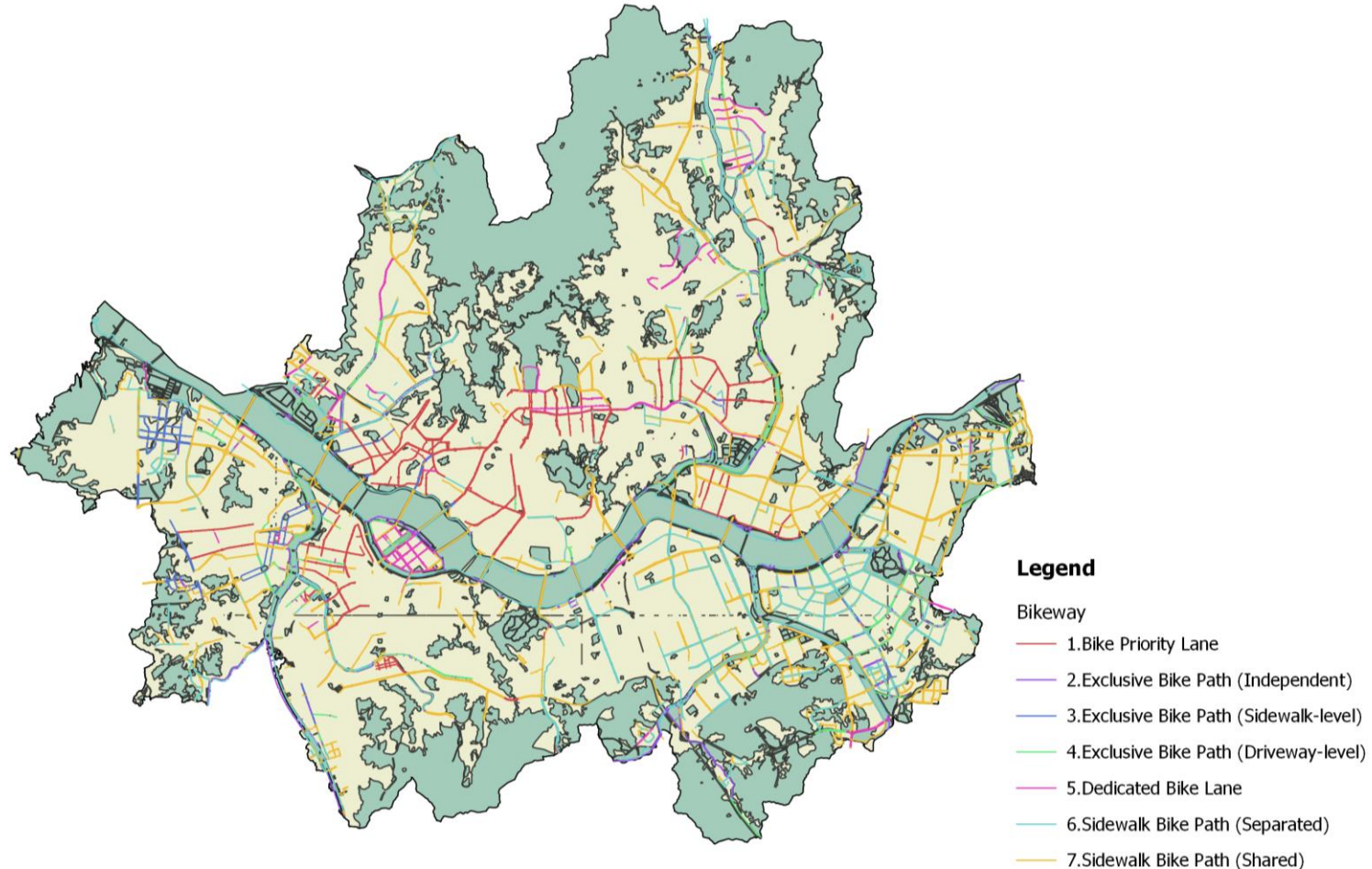
- How to classify bike infrastructure in Seoul?
- How to evaluate bike path's Level Of Service (LOS) in Seoul?

## 1.2 Why is the *Standardization* of Bike Infrastructure and LOS Important?

- To understand the patterns of using bike infrastructure
- To prioritize the sections to invest budget first and decide the types of investment

## 2. Seoul's Bike Infrastructure

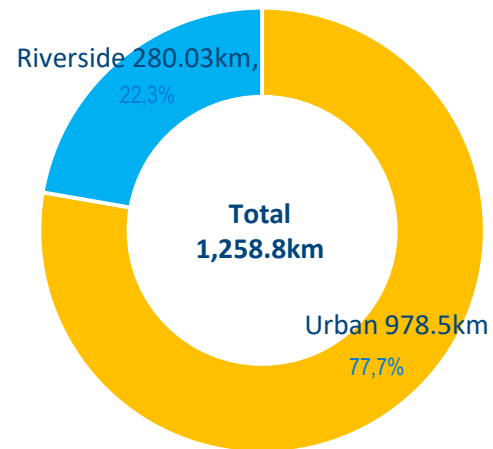
### 2.1 Bikeway Networks (2020)



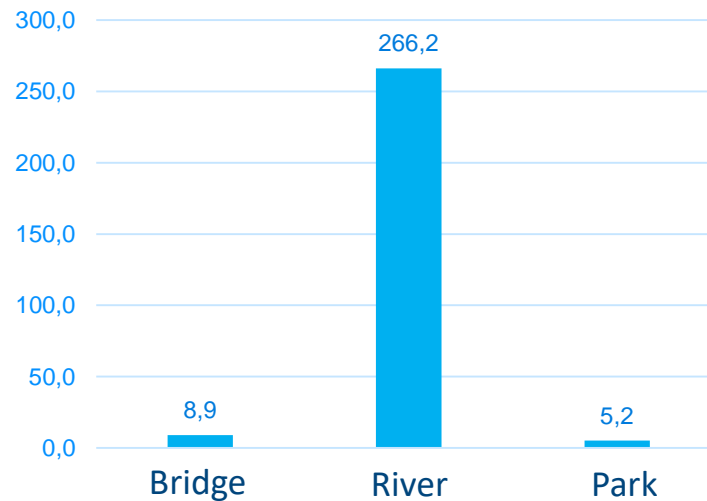
## 2. Seoul's Bike Infrastructure

### 2.2 Bikeway Lengths (2020)

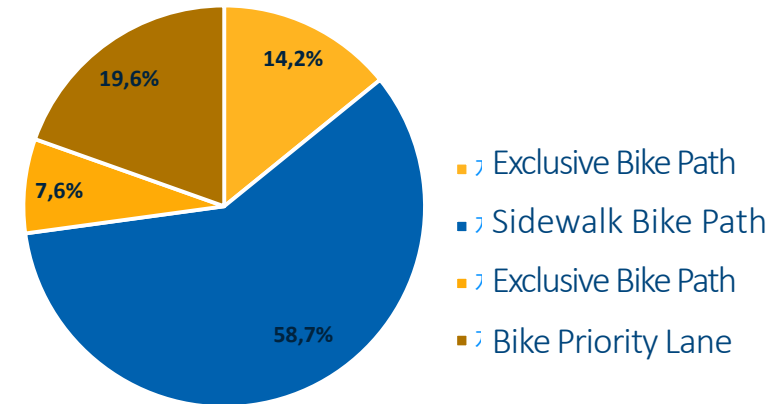
#### ► Bikeway Length in Seoul



<Bikeway Length by Location (Km)>



<Bikeway Length along Riverside (km)>

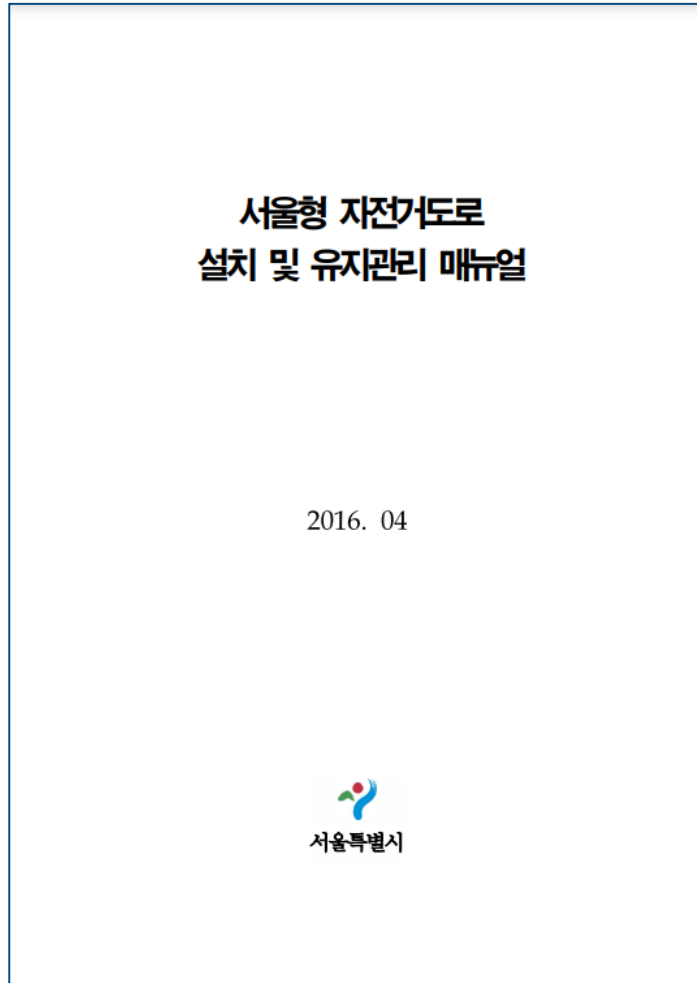


<Bikeway Length by Type (Km)>

\* Source: Seoul Bikeway Installation Status (2020), Seoul Open Data Plaza

## 3. Seoul's Bike Infrastructure Installation

### 3.1 Bikeway Installation and Maintenance Manual




Seoul City Government (2017), Seoul Bikeway Installation Maintenance Manual.



# 3. Seoul's Bike Infrastructure Classification

## 3.2 Bikeway

[A01. Bike Priority Lane]	[A02. Exclusive Bike]	[A03. Exclusive Bike]	[A04. Exclusive Bike]	[A05. Dedicated Bike Lane]	[A06. Sidewalk Bikeway]	[A07. Sidewalk Bikeway]
<p>Shared</p>  <p>: Driveway shared together with vehicles, motorcycles and bicycles</p>	<p>Independent</p>  <p>: Exclusive path only for cycling</p>	<p>Sidewalk-level</p>  <p>: Make use of the part of sidewalk space. Physical separation from pedestrians</p>	<p>Driveway-level</p>  <p>: Make use of the part of driveway. Physical separation from cars</p>	<p>Bike Lane</p>  <p>: Make use of the part of driveway. Not physical but Visual separation from cars</p>	<p>Separated</p>  <p>: Visual separation form pedestrians using pavement marking, etc.</p>	<p>Shared</p>  <p>: Sidewalk shared together with pedestrians, e-scooters and bicycles</p>
<p>◆ Signage</p>  <p>자전거 우선도로</p>	 <p>자전거 전용</p>	 <p>자전거 전용</p>	 <p>자전거 전용</p>	 <p>자전거 전용</p>		
<p>◆ Road Marking</p> 						

## 3. Seoul's Bike Infrastructure Classification

### 3.3 Bikeway Barriers



[B01. Steps]



[B02. Street Trees]

Other examples  
+ uncovered manhole  
+ truncated trees  
+ frayed cables  
+ illegal parking

### 3.4 Bikeway Separation Facilities



[C01. Landscape Buffer Strip]



[C02. Tubular Markers]



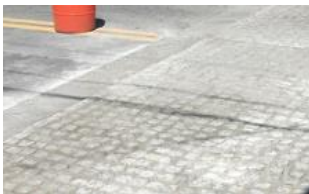
[C03. Curbstone]



[C04. Fence/Guardrail]



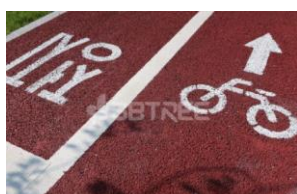
[C05. Raised Pavement Marker]



[C06. Cube Stone]



[C07. U-shaped Bollard]



[C08. Pavement Marking]



[C09. Landscape Strip]



## 3. Seoul's Bike Infrastructure Classification

### 3.5 NYC's Bikeway Classification

- Length: 1000 miles (1600 km)



#### Protected Bike Lane

On-street protected bike lanes are protected from traffic by parked cars or physical barriers. Off-street bike paths exist along much of the City's waterfront and in many parks.



#### Bike Lane

Bike lanes are painted onto the road, often next to a parking lane, and are marked with bike symbols. Some lanes have a painted buffer to further separate cyclists from traffic.



#### Shared Lane

Shared lanes are used by cyclists and motorists. They are marked by "sharrows" (bike symbols with chevrons) and signs.



#### Signed Route

Signed Routes are unmarked streets designated by "Bike Route" signage or a greenway medallion. Following the signs helps guide cyclists along a pre-established route.

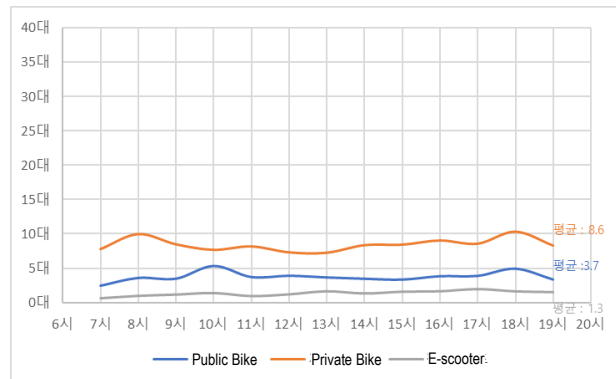
**NYC's Bikeway Classification is Different From Seoul's!!**

# 3. Seoul's Bike Infrastructure Classification

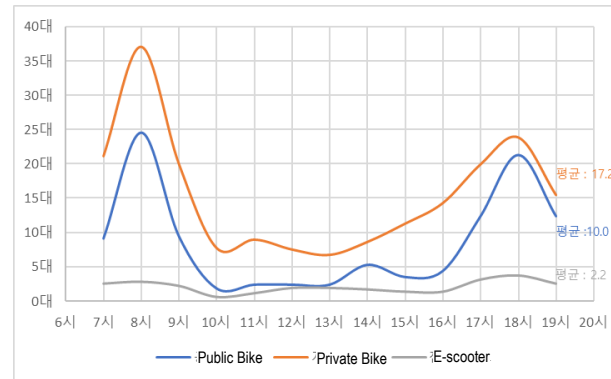
## 3.6 Travel Patterns by Type of Bikeway Facility

### ◆ Bike Traffic Volume (by Time of Day)

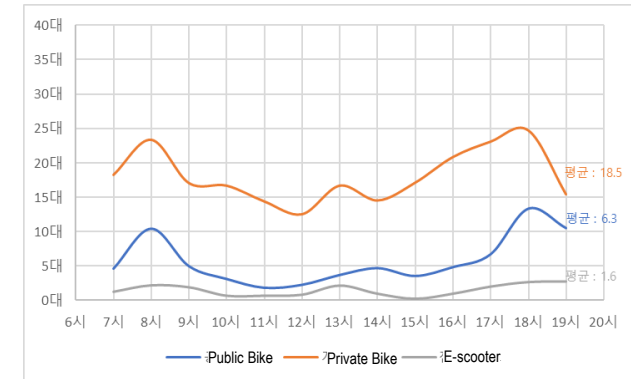
- ▶ In Exclusive Bike Path, the multimodal distribution whose traffic volumes during AM/PM Peaks and Lunch Time are peaked
- ▶ Public Bike users prefer Exclusive Bike Path, especially during weekday AM/PM peak hours (for commuting)



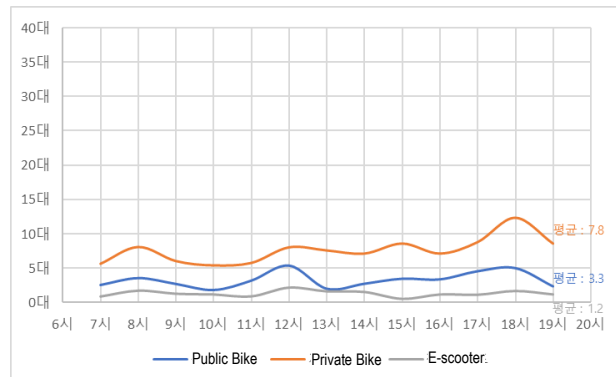
<Bike Priority Lane>



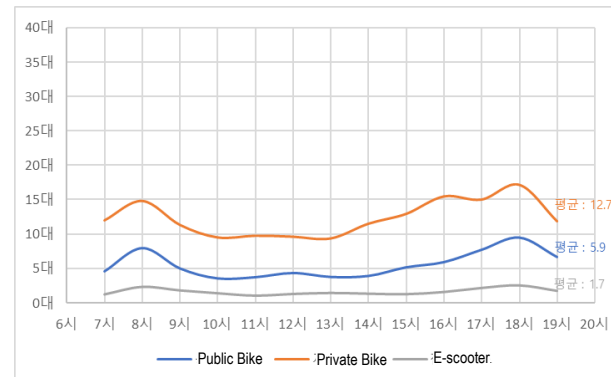
<Exclusive Bike Path (Sidewalk-level)>



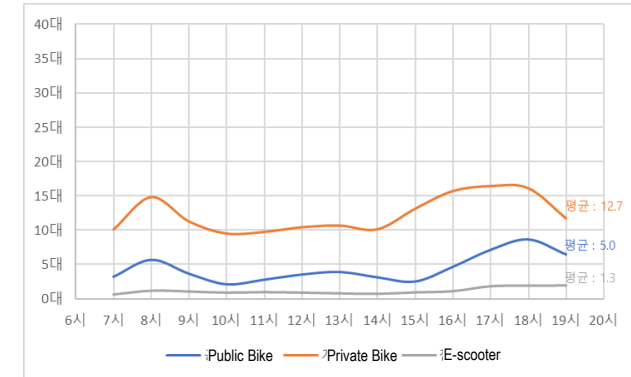
< Exclusive Bike Path (Driveway-level)>



<Dedicate Bike Lane>



<Sidewalk Bikeway (Separated)>



<Sidewalk Bikeway (Shared)>

# 4. Seoul's Bikeway LOS Evaluation

## 4.1 Bikeway LOS Manual

### ▶ HCM (2010) - TRB

- Two-lane highway  $BLOS = 0.507LN(v) + 0.1999S(1 + 10.38HV)^2 + 7.066\left(\frac{1}{P}\right) - 0.005(W)^2 + 0.706$
- Link-Based  $BLOS = 0.760 + Fw + Fv + Fs + Fp$

Grade	BLOS
A	≤ 1.5
B	1.5-2.5
C	2.5-3.5
D	3.5-4.5
E	4.5-5.5
F	> 5.5

### ▶ KHCM (2013)

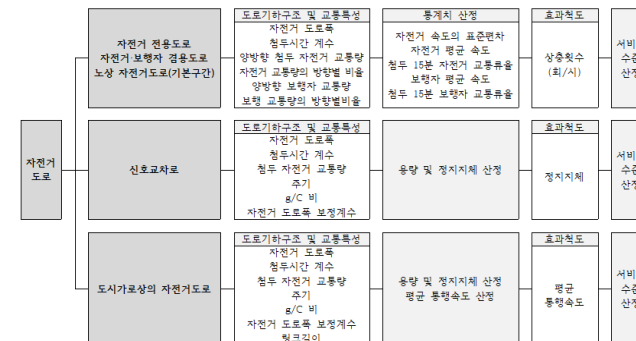
Exclusive Bike Path (one-way)

$$\text{The Number of Conflicts} = \frac{2 \times \text{Bike Volume} \times \text{Standard Deviation of Bike Speed}}{\text{Average Bike Speed} \sqrt{\pi}}$$

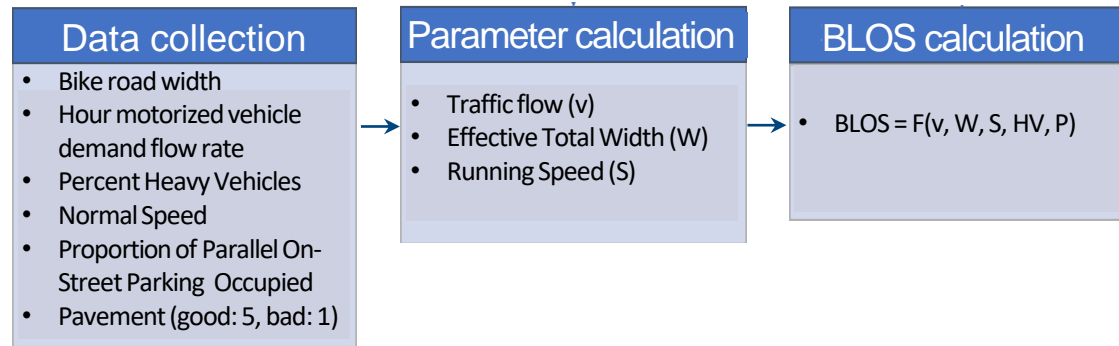
- Bike Lanes/Path along Urban Road Network:

$$\text{Average Speed} = \frac{\text{Length of Section}}{\frac{\text{Length of Subsection}}{\sum \text{Crusing Speed in the section}} + \frac{\text{Average Bike Stop Delay at Intersection}}{3600}}$$

Grade	Exclusive Bike Path (One-way, Width 2m)		Bike Lanes/Paths along urban road network
	Number of Conflicts (numbers/h)	Traffic Volume (vph)	Average Speed (kph)
A	≤25	≤100	> 12
B	≤50	≤200	> 10
C	≤100	≤400	> 8
D	≤180	≤720	> 7
E	≤240	≤960	> 6
F	>240	>960	≤6



Source: KHCM (2013: 641)



출처: Highway Capacity Manual (2010), Transportation Research Board

- ✓ Possibility of **all** bikeways turning out to be **Grade A**
- ✓ Necessity to evaluate bikeways in accordance with **KHCM** which uses **riding indicators**

# 4. Seoul's Bikeway LOS Evaluation

## 4.2 Bikeway LOS Examination through Test Running

### ► Running Speed and Acceleration by Type of Bikeway

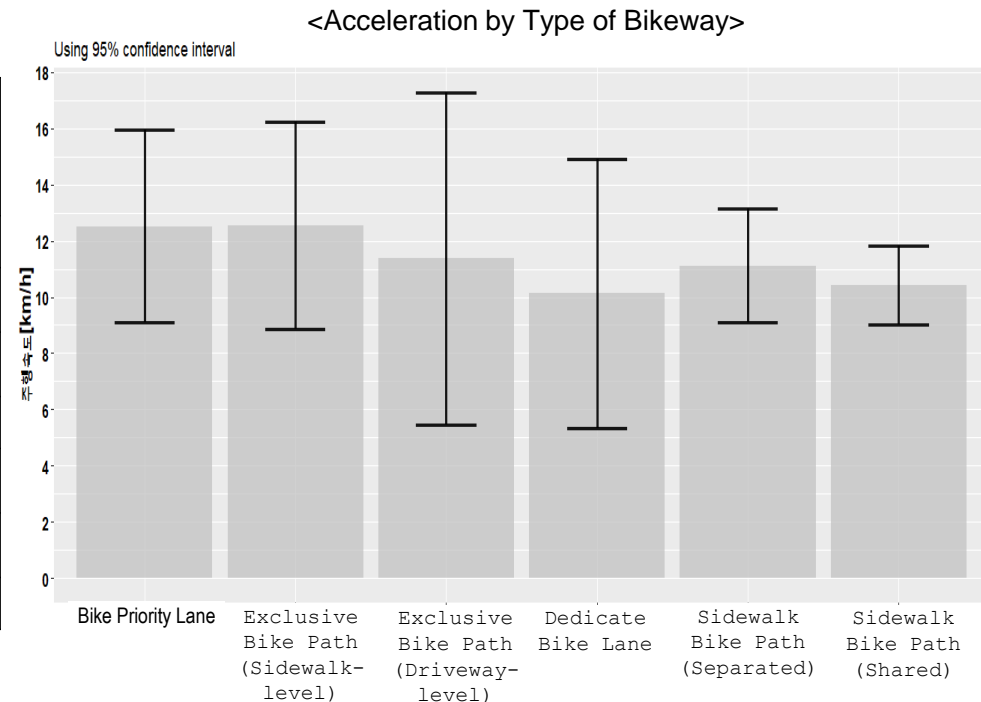
- Avg. Running Speed: *Exclusive Bike Path (sidewalk-level) > Bike Priority Lane > Exclusive Bike Path (Driveway-level) > Sidewalk Bike Path (Separated) > Sidewalk Bike Path (Shared) > Dedicated Bike Lane*
- Acceleration St. Dev: *Bike Priority Lane > Dedicated Bike Lane > ... > Sidewalk Bike Path (Separated)*
  - *Bike Priority Lane and Dedicated Bike Lane*: conflicts with motorized vehicles
  - *Sidewalk Bike Path (Shared)* : conflict with pedestrians

(Unit : km/h, km/h/s, km)

Type of Bikeway	Running speed (km/h)			Acceleration speed (km/h/s)				Total Length (km)
	Avg	St. Dev	Max	Avg*	St. Dev	Max	Min	
Bike Priority Lane	12.52	7.13	33.69	0.475	0.735	3.971	-4.288	16.9
Exclusive Bike Path (Sidewalk-level)	12.55	5.50	25.02	0.418	0.652	2.959	-3.071	59.6
Exclusive Bike Path (Driveway-level)	11.38	5.63	24.49	0.317	0.537	2.660	-2.930	4.3
Dedicate Bike Lane	10.13	6.69	27.50	0.430	0.683	2.657	-4.306	7.3
Sidewalk Bike Path (Separated)	11.12	5.21	26.43	0.305	0.474	2.668	-2.646	18.9
Sidewalk Bike Path (Shared)	10.42	5.19	29.13	0.339	0.543	2.480	-3.251	40.3
Average	11.35	5.89	27.71	0.381	0.604	2.899	-3.415	-

Note: All 100 sections were examined

\* To measure variance of acceleration, absolute value has been applied

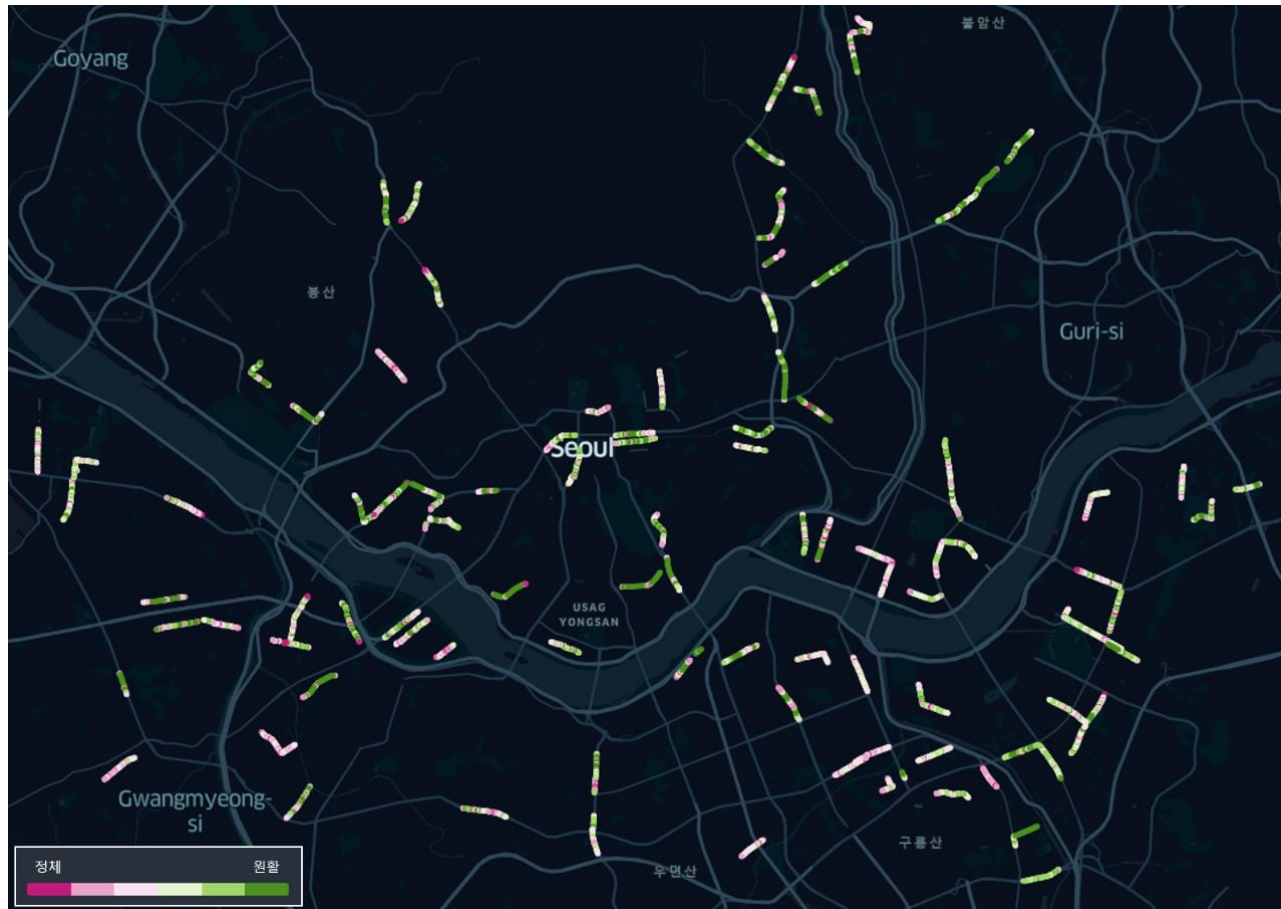




## 4. Seoul's Bikeway LOS Evaluation

### 4.2 Bikeway LOS Examination through Test Running

#### ▶ Running Speed Mapping



#### ▶ Seoul Bikeway Mapping (by Type)



## 4. Seoul's Bikeway LOS Evaluation

### 4.2 Bikeway LOS Examination through Test Running

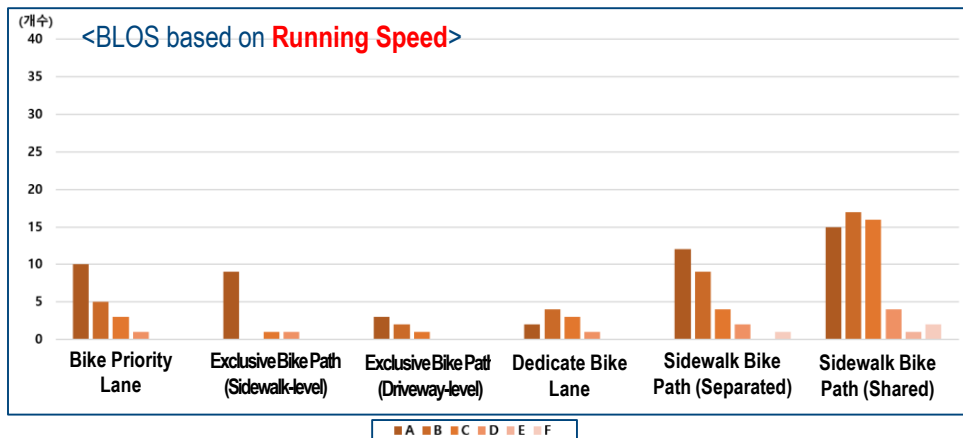
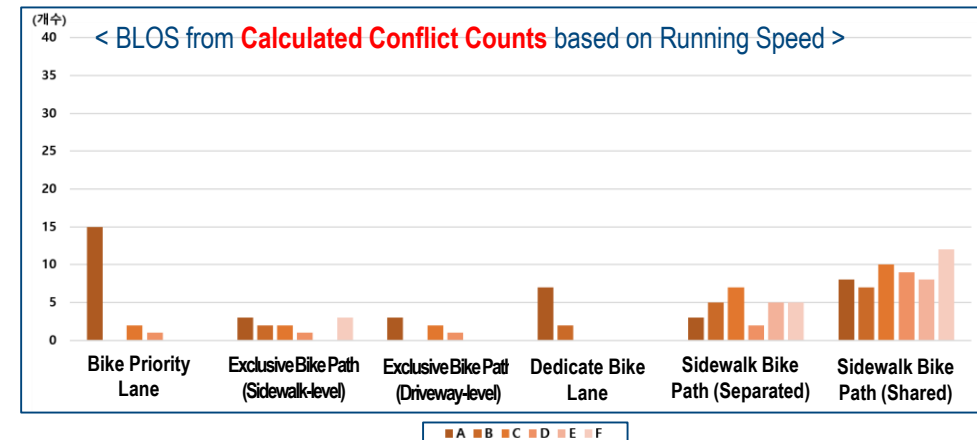
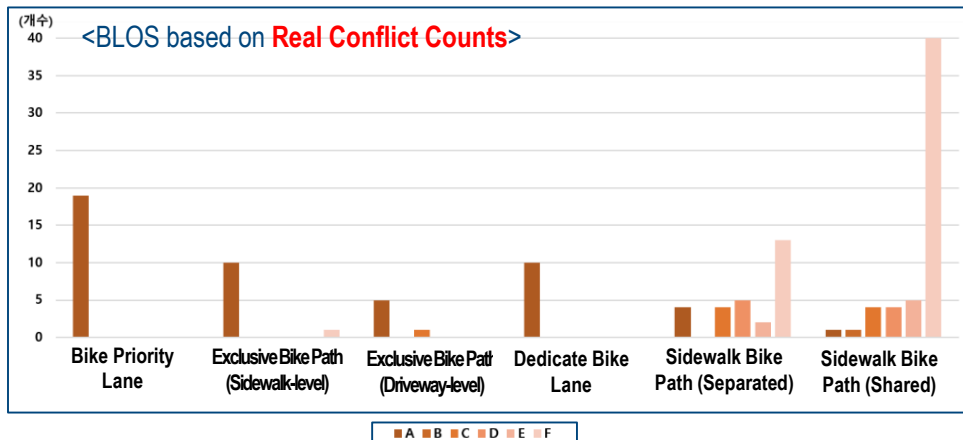
► Conflicts by Type of Bikeway

Type of Bikeway	Conflicts (counts/km)						Conflicts (counts/h)					
	Bike		Pedestrian		Vehicle		Bike		Pedestrian		Vehicle	
	Facing	Passing	Facing	Passing	Driving	Parking	Facing	Passing	Facing	Passing	Driving	Parking
Bike Priority Lane	0.1	0.4	0.1	0.0	5.2	4.7	1.1	4.8	1.4	0.7	63.8	56.3
Exclusive Bike Path (Sidewalk-level)	1.9	0.8	2.8	0.9	0	0	25.7	10.8	35.4	15.3	0	0
Exclusive Bike Path (Driveway-level)	1.1	1.8	0.4	0	0	2.7	13.0	23.4	4.9	0	0	33.5
Dedicate Bike Lane	0.1	0.5	1.7	1.0	1.3	2.4	0.9	3.9	15.2	8.6	15.9	24.9
Sidewalk Bike Path (Separated)	2.7	0.8	12.1	6.1	0	1.0	31.1	8.7	132.2	69.6	0	12.7
Sidewalk Bike Path (Shared)	1.2	0.5	35.6	15.1	0	1.0	11.8	5.1	357.3	158.3	0	10.8

# 4. Seoul's Bikeway LOS Evaluation

## 4.2 Bikeway LOS Examination through Test Running

### ► BLOS Outcomes



*Selective BLOS indicator application for the different types of Bikeway!*

## 5. Key Takeaways

- Standardization of **Bike Infrastructure** considering Local Context
- Make Use of Bikeway Types to Understand Bike Usage Patterns and Infrastructural Demands
- Standardization of **Bike LOS Indicators** considering Local Context
- **Bikeway GIS Map construction** and **Continuous Updates** should be Guaranteed



# Thank you for your attention!



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