

Interpretations of Downs-Thomson Paradox with Median Bus Lane (BRT) Operations



Outline

- I. Introduction**
- II. Downs-Thomson Paradox**
- III. Effective Analysis of Jong-Ro BRT Introduction**
- IV. Discussions**

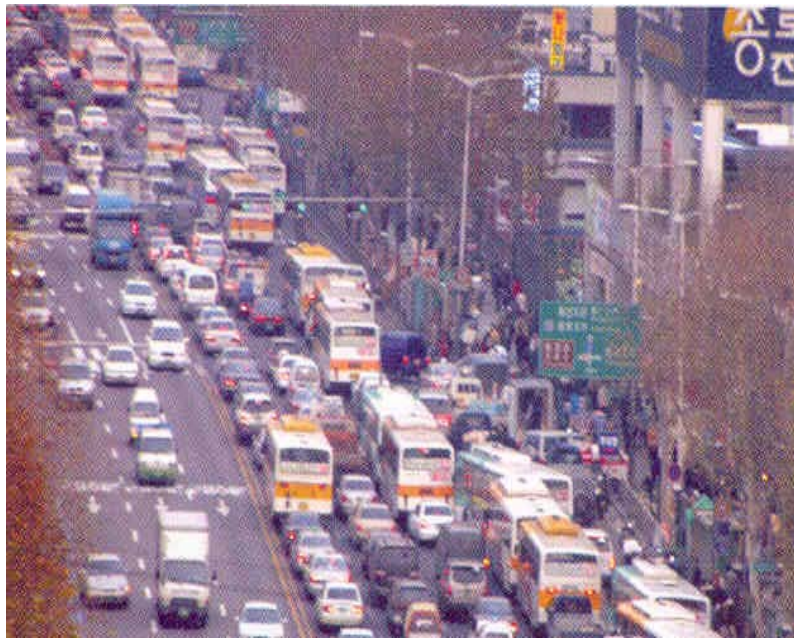


I. Introduction

Seoul's Public Transport Oriented Policies

- Severe Traffic Congestions in 1990s
- The Introduction of BRT (Bus Rapid Transit) to gain competitiveness against cars since 2002

Traffic congestion in Seoul(1990s)



Source : Seoul metro

BRT of Seoul since 2002



Source : <https://www.seoulsolution.kr/ko/content/647>

I. Introduction

Vision of Seoul Public Transport Renovation

- Greener City
- Competitive Public Transport against Cars by Hierarchical PT Design

- Greener Transport Systems

- * 30 passenger car's capacity = 1 bus

- Economize on energy

- Reducing air pollution

- Competitive public transport

- (Public transport > private vehicles)

- * speed

- * convenience

- * safety

- * social fair



World Best Public
Transport City
“Seoul”

“ 75% by PT”

I. Introduction

Hierarchical Bus Design as Corridor and Feeder Systems

- Construct Efficient Public Transport Systems by Hierarchical Design as Corridor and Feeder systems
- However, Travel Time Saving Benefit is not large
- Wider Impacts such as Health Improvement Benefits are required

Previous Seoul Bus System

Bus routes design
according to
bus companies interest

Slow, unscheduled bus

Poor service

Insolvent management

Hierarchical Bus Systems

- Complement with Metro Systems
- Convenient in connection & transfer

- Corridor and Feeder Bus Service
- Predictable in arrival time
- Fast and convenient as subway

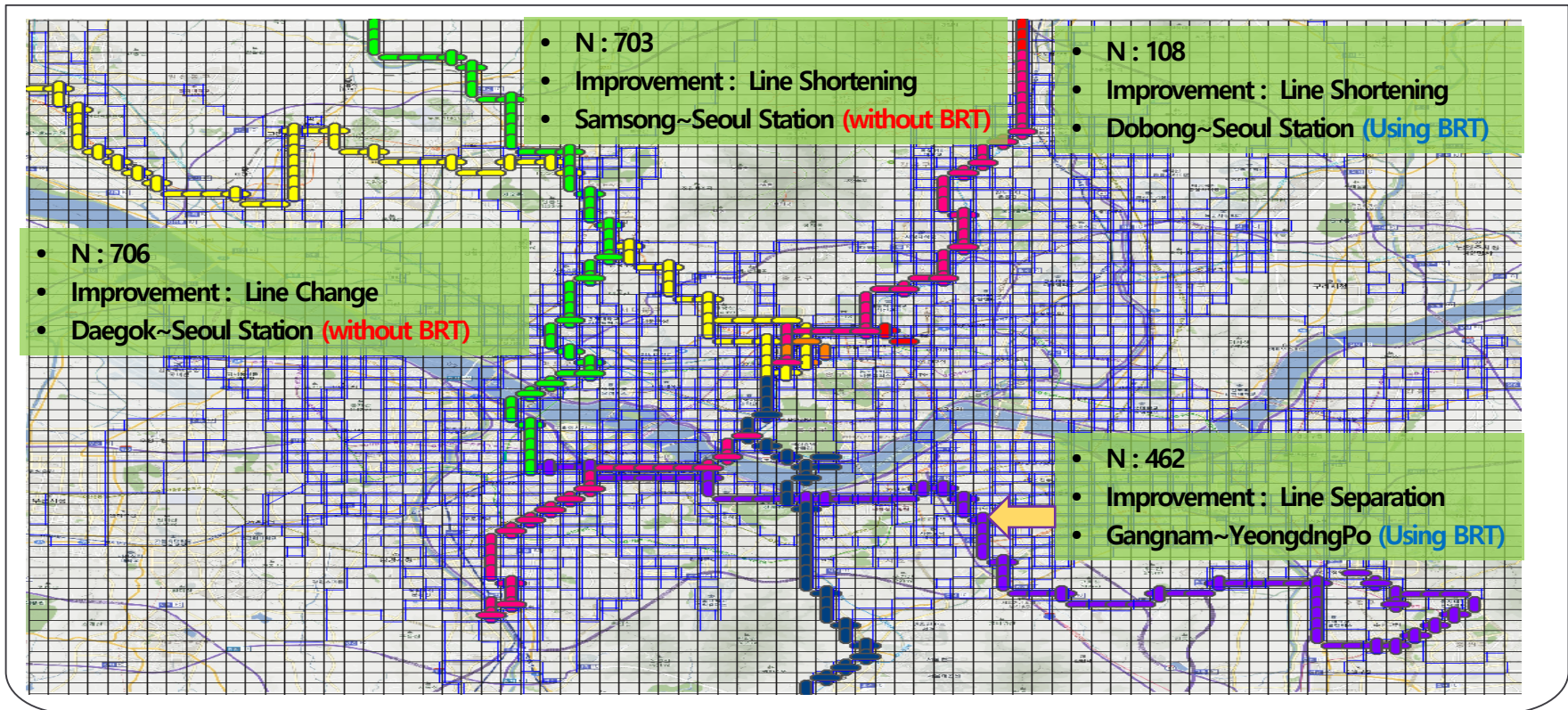
- Friendly and safe bus
- Approachable operation system
- Pleasant and environment-friendly bus

- Transparent and reliable bus management
- Securing public interest

I. Introduction

Adjustments of Bus Routes based on Grid Network Configurations

- Reformation of Bus Routes based on Hierarchical Systems of Corridor and Feeder lines
- Compatible Adjustments of Land Use and Public Transport (Metro and Corridor and Feeder lines of Buses)



- **BRT Lines in 2002**
- **To secure competitiveness in buses**
 - **36.1km and 5 Lines**



I. Introduction

BRT of Seoul (36.1km in 2002 to 130.8km in 2019)

- BRT Lines in 2009
- To secure competitiveness in buses
 - 92.6km and 8 Lines

2009



Total
92.6km
(2009)

I. Introduction

BRT of Seoul (36.1km in 2002 to 130.8km in 2019)

- BRT Lines in 2014
- To secure competitiveness in buses
 - 117.5km and 11 Lines

2014



Total
117.5km
(2014)

I. Introduction

BRT of Seoul (36.1km in 2002 to 130.8km in 2019)

- BRT Lines in 2019
- To secure competitiveness in buses
 - 130.8km and 13 Lines

2019

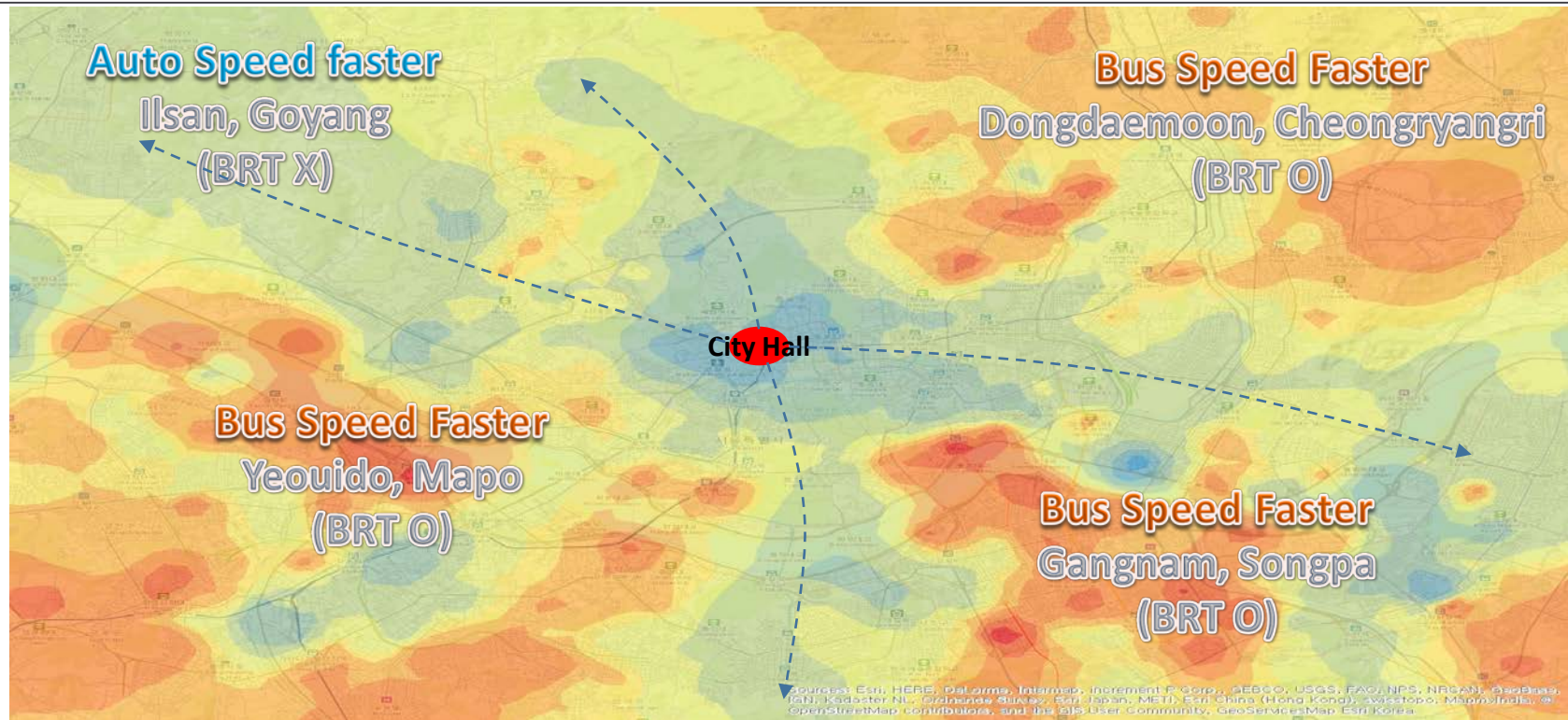


Total
130.8km
(2019)

I. Introduction

Comparison of Automobile and Bus Speed from City Hall

- Improved Bus Speed in BRT areas
 - Improve the Competitiveness of Public Transportation
 - Red color areas have higher bus speeds than auto speeds

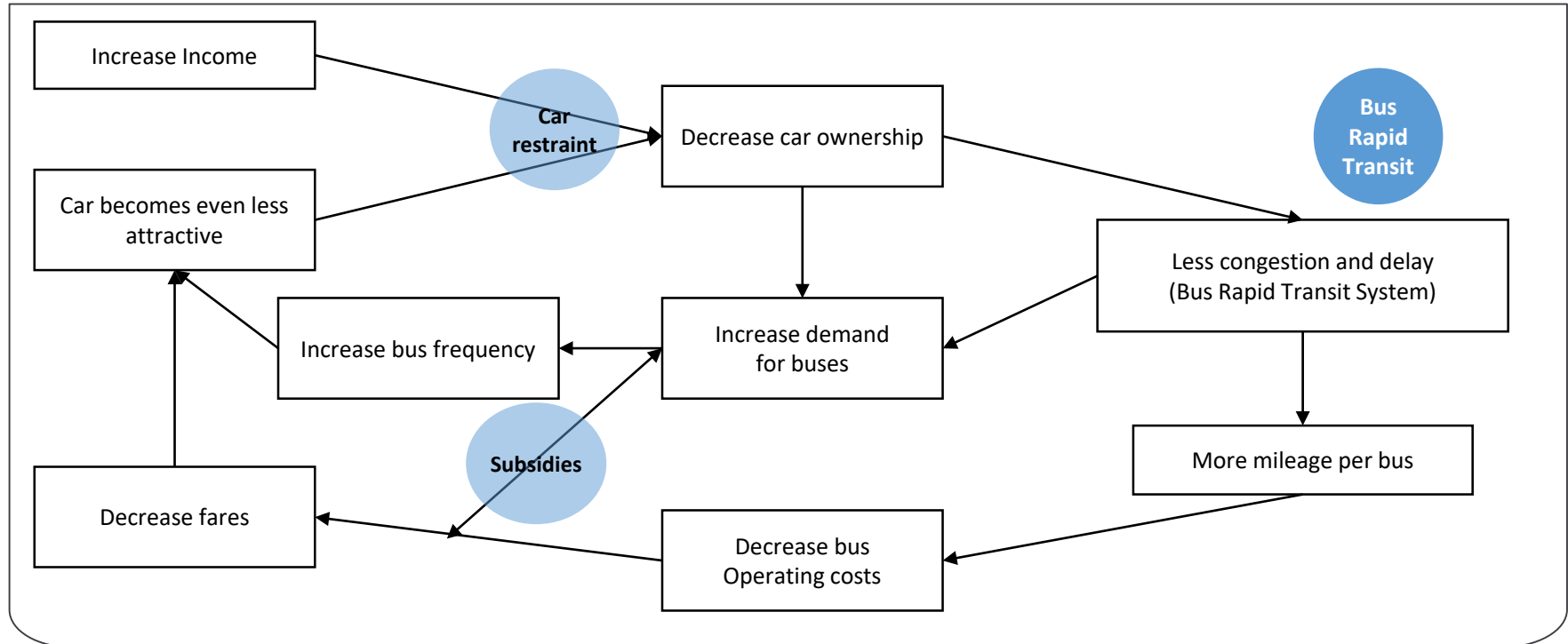


II. Downs-Thomson Paradox

Relations of Automobile and Public transport

- Modal changes from Public Transport to Automobiles due to economic growth
- A vicious cycle can be occurred in this framework

Breaking Vicious Circle of Private Car and Public Transport

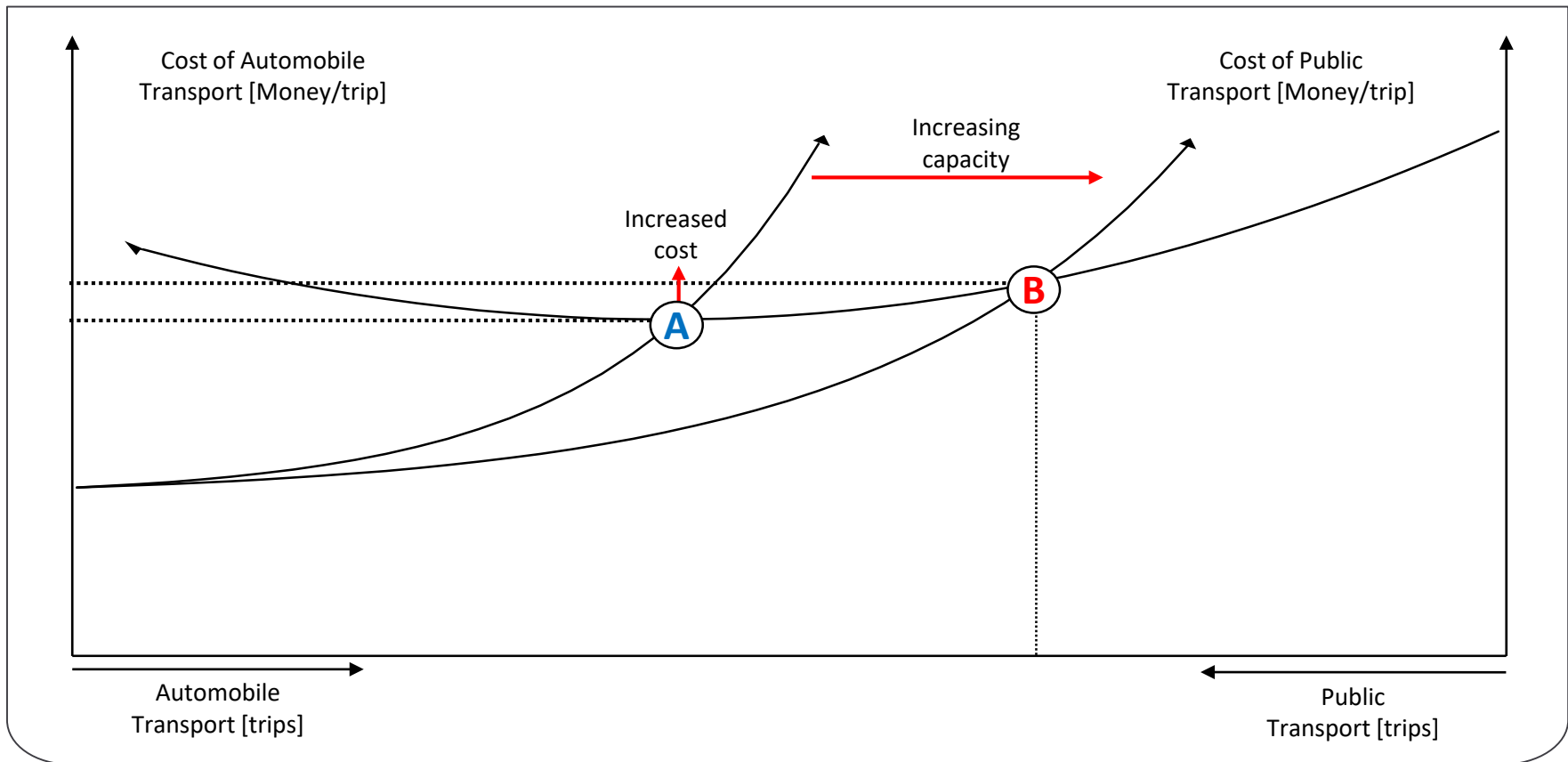


Breaking the car/public-transport vicious circle (Ortuzar and Willumsen 1990)

II. Downs-Thomson Paradox

Concept of the Downs-Thomson Paradox (Bi-modal equilibrium)

- When road capacity is increased, the intersection point(A) moves(adversely) to new intersection point(B)
- Consequently, generalized costs of both automobile and public transport are increased

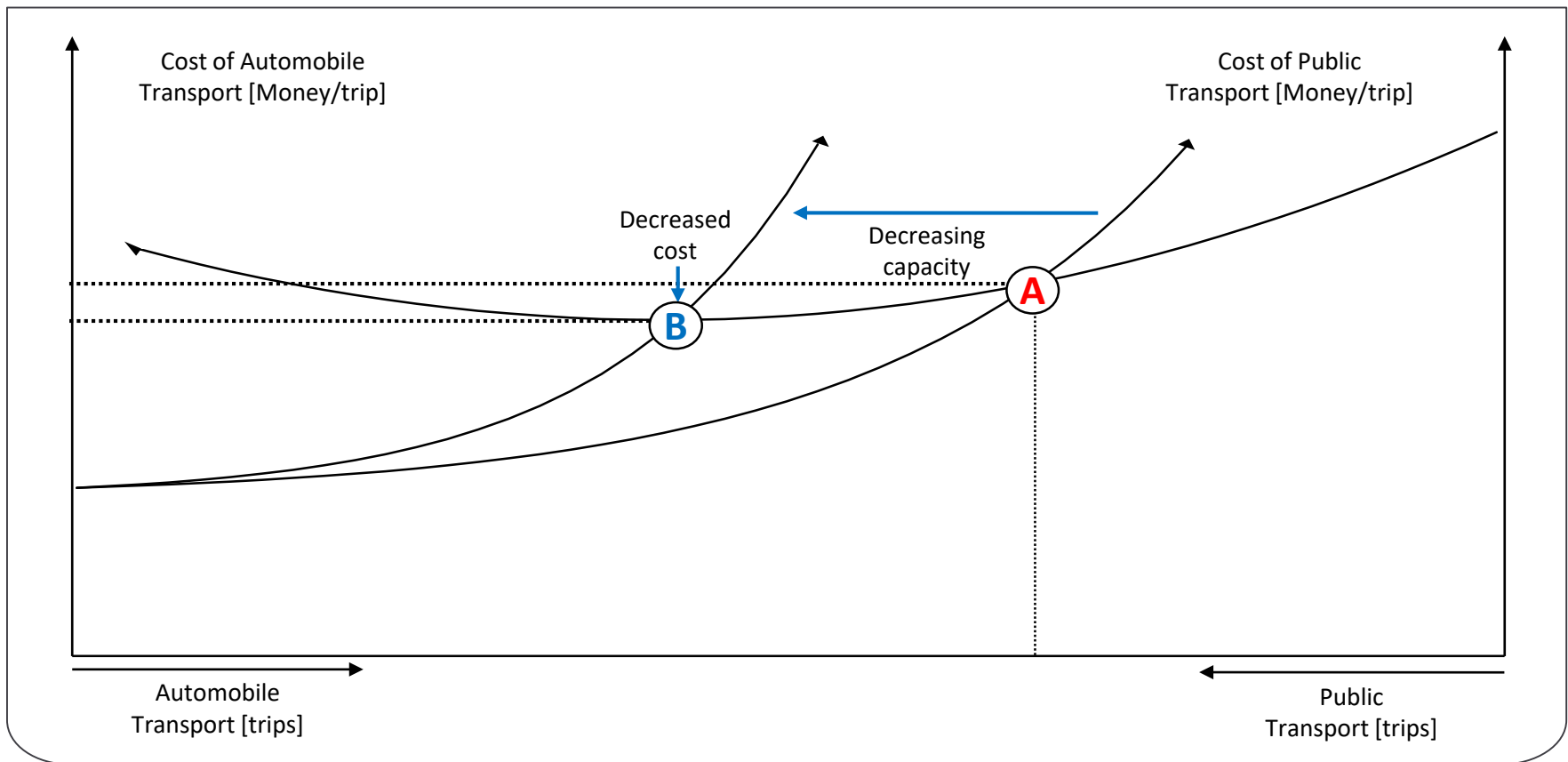


DOWN AND THOMSON PARADOX (BELL AND IIDA, 1997)

II. Downs-Thomson Paradox

Concept of the Downs-Thomson-Lee Paradox (Bi-modal equilibrium)

- When road capacity is decreased, the intersection point(A) moves(positively) to new intersection point(B)
- Consequently, **Win-Win** situations of both automobile and public transport are reached



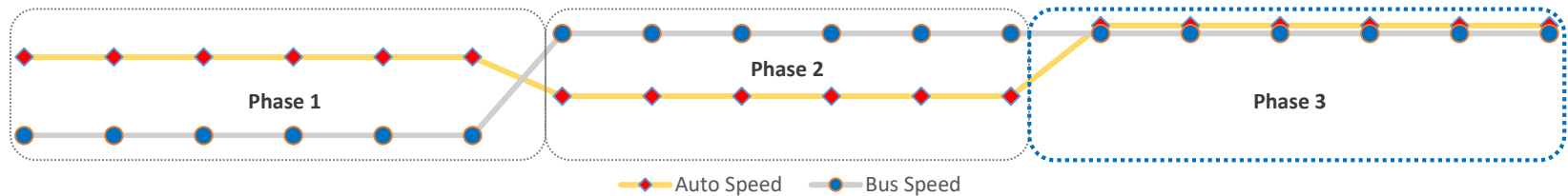
LEE PARADOX (2005)

II. Downs-Thomson Paradox

Phases of Private and Public transport Speed Changes

- Prioritize BRT lines to lead a good circle of Win-Win Situation of higher bus and car speeds
- After the transitional period, the speed of private car and the speed of public transit are equilibrated

Speed Dynamics after BRT introduction



Phase 1
(before)

Before Bus Rapid Transit Operation

Auto Speed > Bus Speed

Phase 2
(After)

After Bus Rapid Transit Operation

Auto Speed(↓) < Bus Speed(↑)

Phase 3
(Equilibrated)

Bi-Modal Equilibrium

Auto Speed = Bus Speed
Auto volume↓, Bus Volume↑
Total Benefits ↑

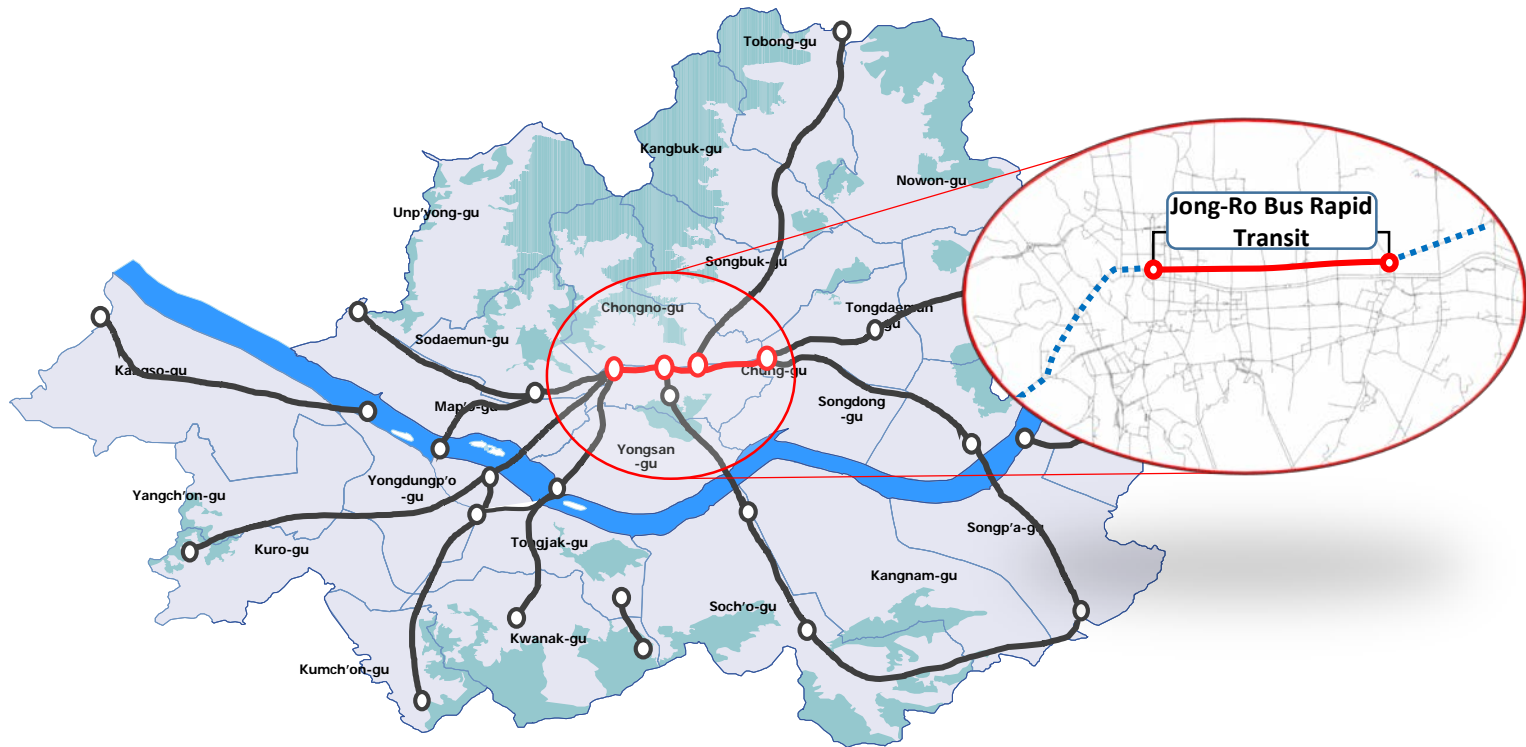
Rebound
Effect

Phase 3 → Phase 1

III. Effect Analysis of Jong-Ro BRT Introduction

Location of Jong-Ro BRT Line

- Introducing debatable 2.8km from Jong-Ro BRT Line in core downtown areas
- To complement east to west bound movements in core downtown areas

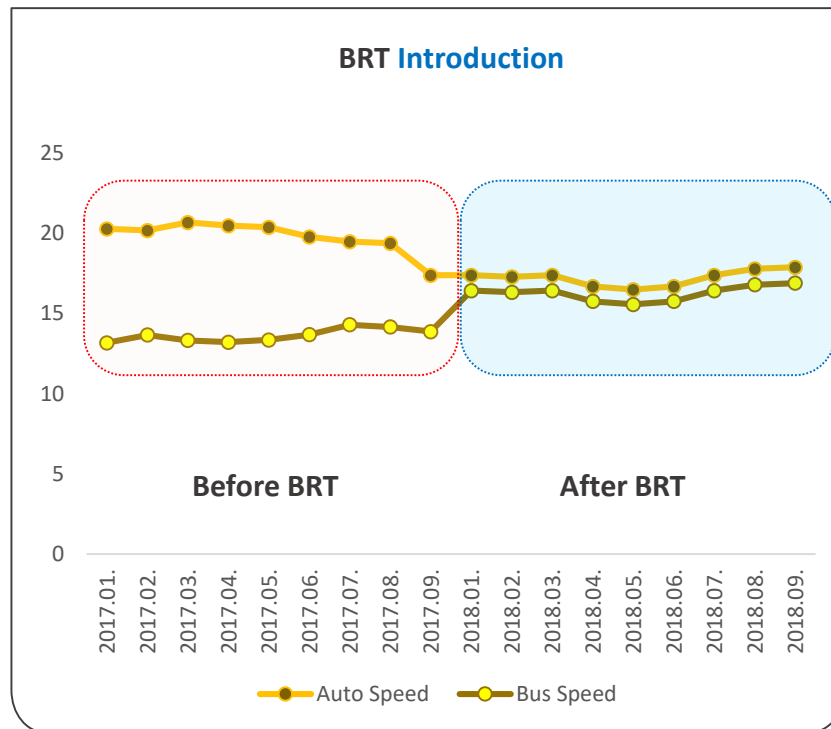


III. Effect Analysis of Jong-Ro BRT Introduction

Statistical analysis of speed gap between Automobiles and Buses

- To verify whether the speeds between Automobiles and Buses are reached to the Bi-modal Equilibrium

Dynamical speeds change in phases between Automobiles and Buses

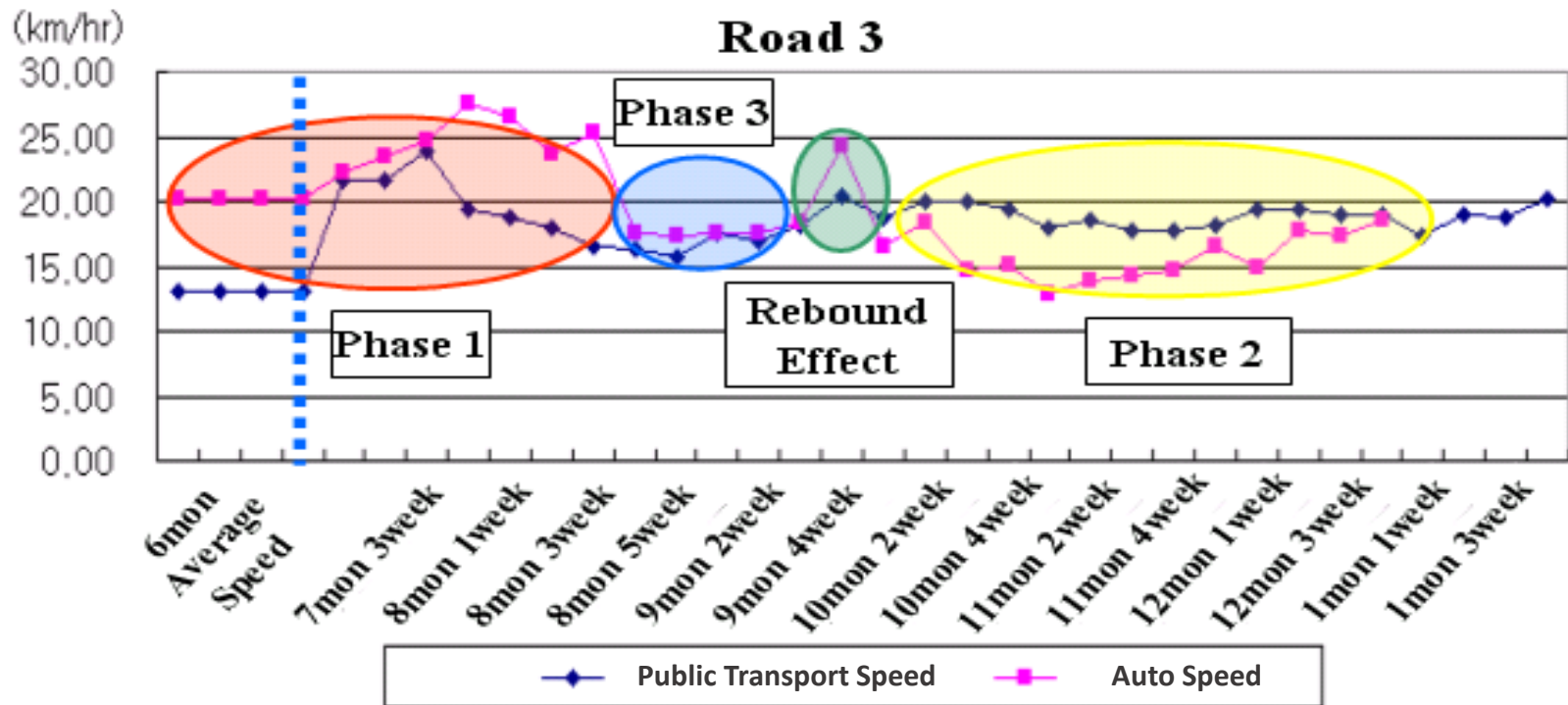


H_0 : The Bus speed is the same as the Auto speed					
Before(2017) (Phase1)			After(2018) (Phase 3)		
	Auto	Bus		Auto	Bus
Mean	19.80	13.66	Mean	17.23	16.27
Variance	1.01	0.17	Variance	0.25	0.20
t statistic	16.95		t statistic	4.34	
T reject	2.12				
DF	16.00				
Pr>t	<.0001		Pr>t	<.0001	

IV. Discussions

Rebound Effect occurred in 2004 in some BRT corridors

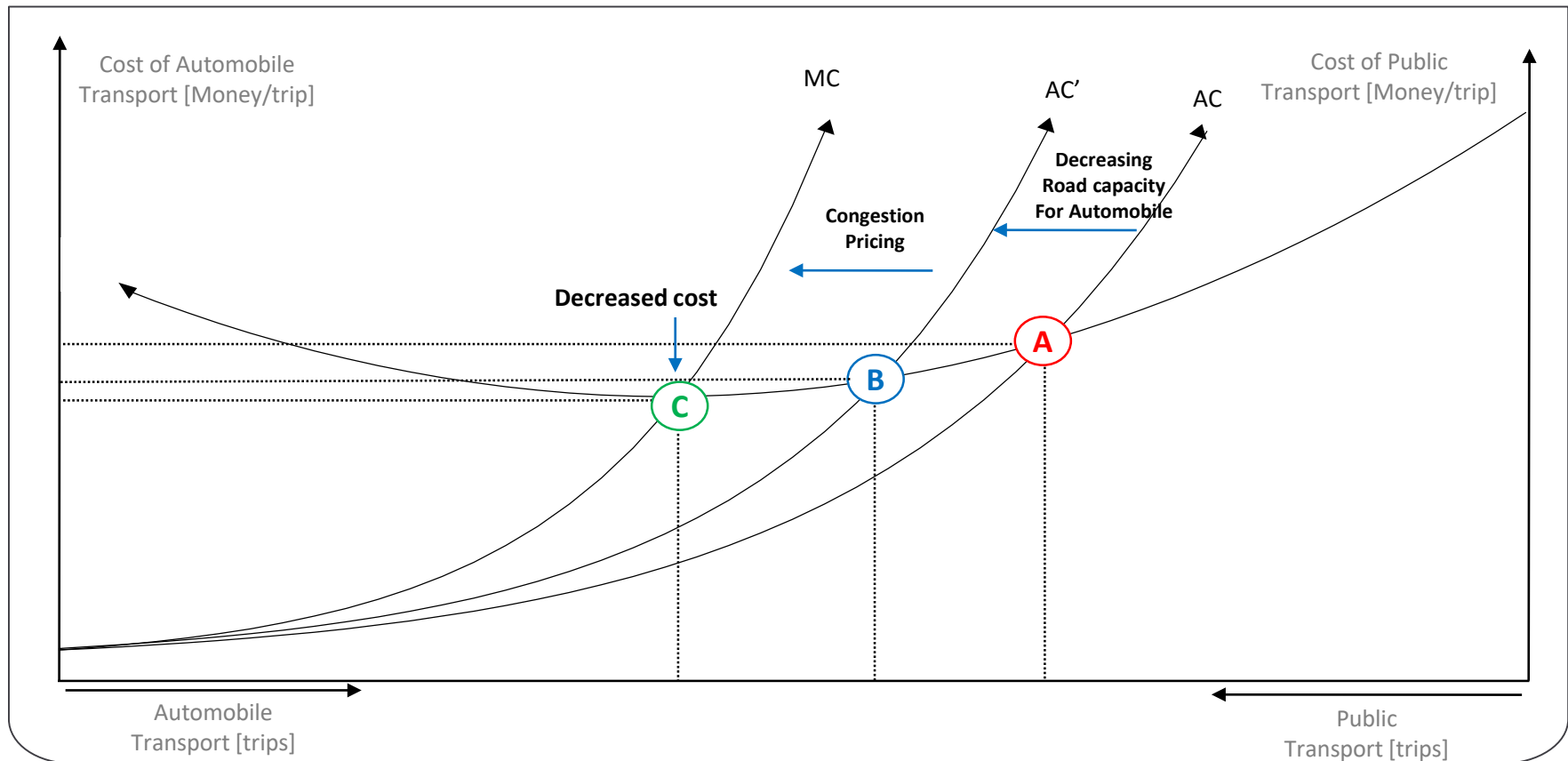
- Rebound Effects even after introducing BRT in some downtown areas



IV. Discussions

Combination of Downs-Thomson-Lee Paradox and Edgeworth Paradox

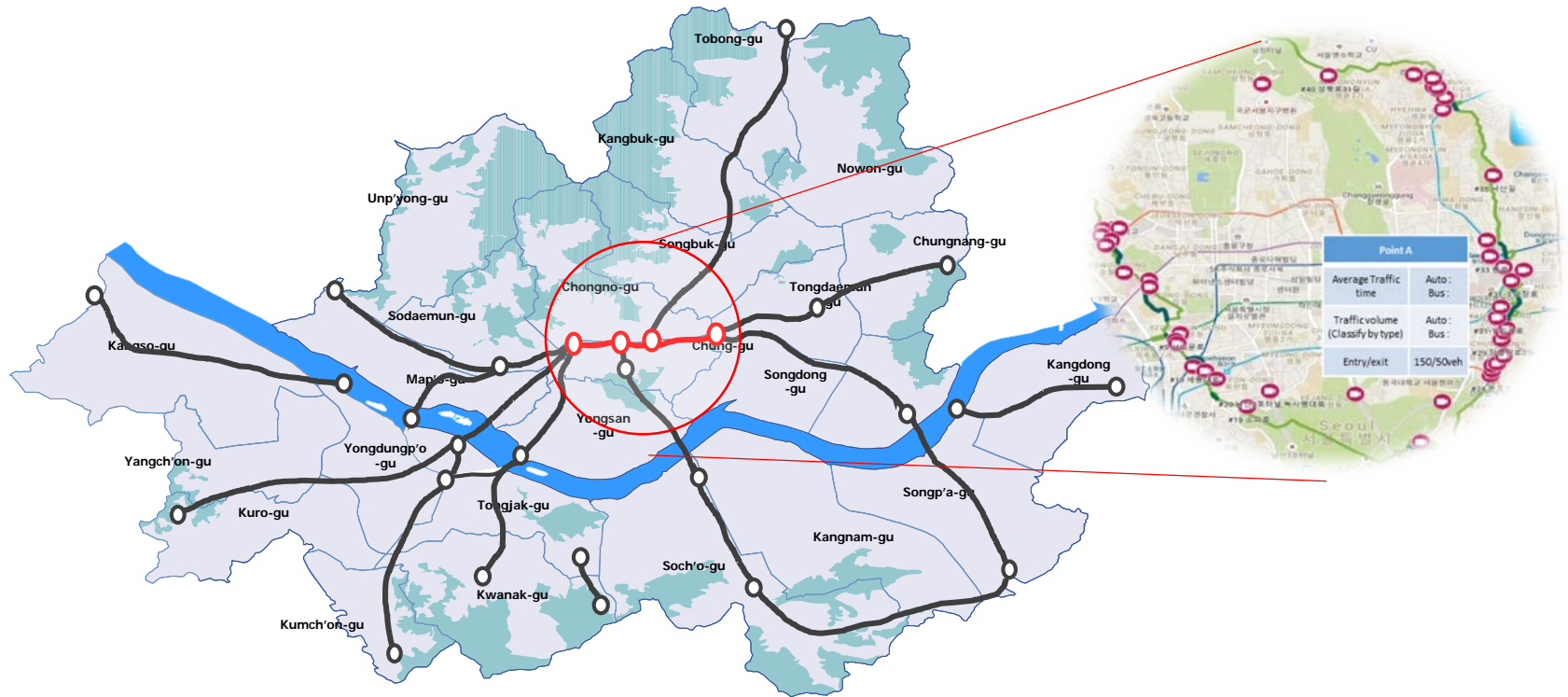
- Imposing Congestion Pricing in Downtown areas in order to enhance to maintain phase 2 or 3



LEE PARADOX (2005)

BRT and Congestion Pricing in the old town of Seoul

- Real time monitoring system to be introduce in the old town of Seoul

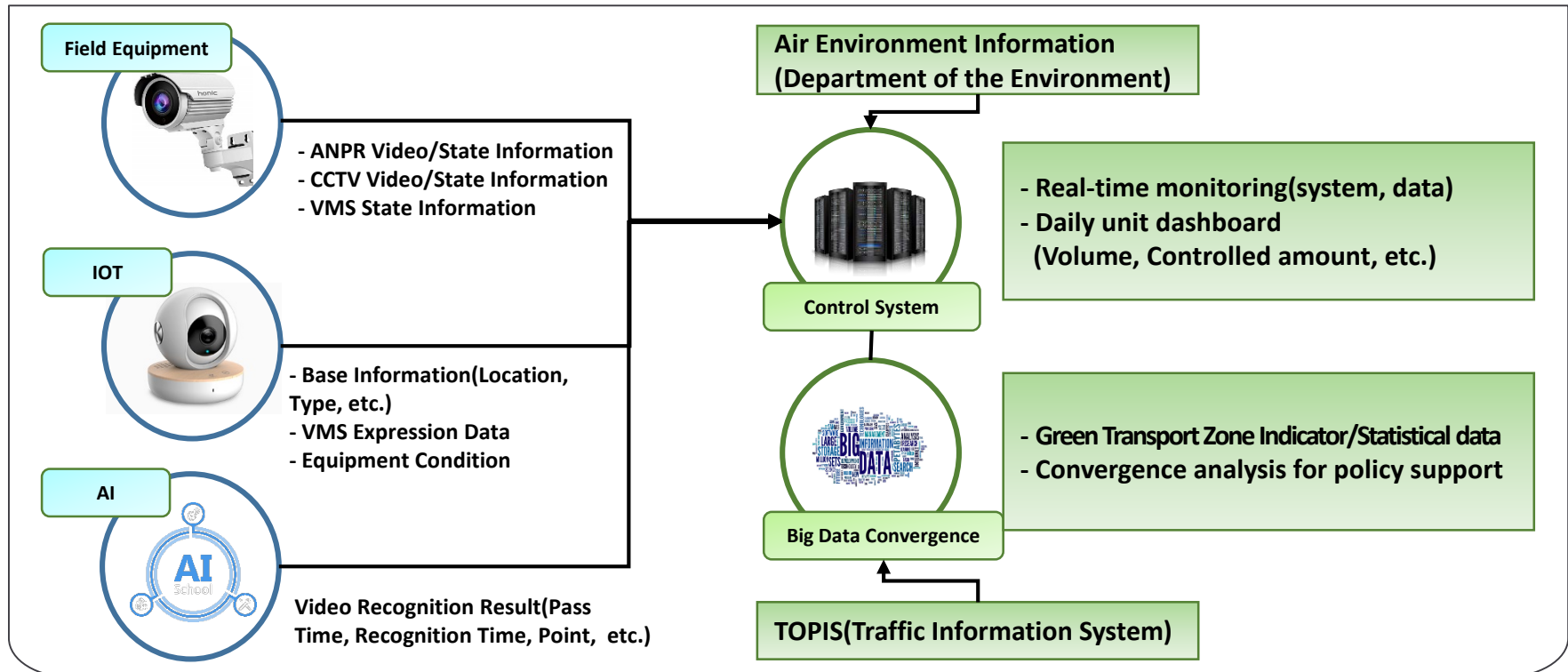


IV. Discussions

Data collection and real time control for congestion pricing

- Seoul Metropolitan Government collects traffic data from Smart Camera

Data processing system

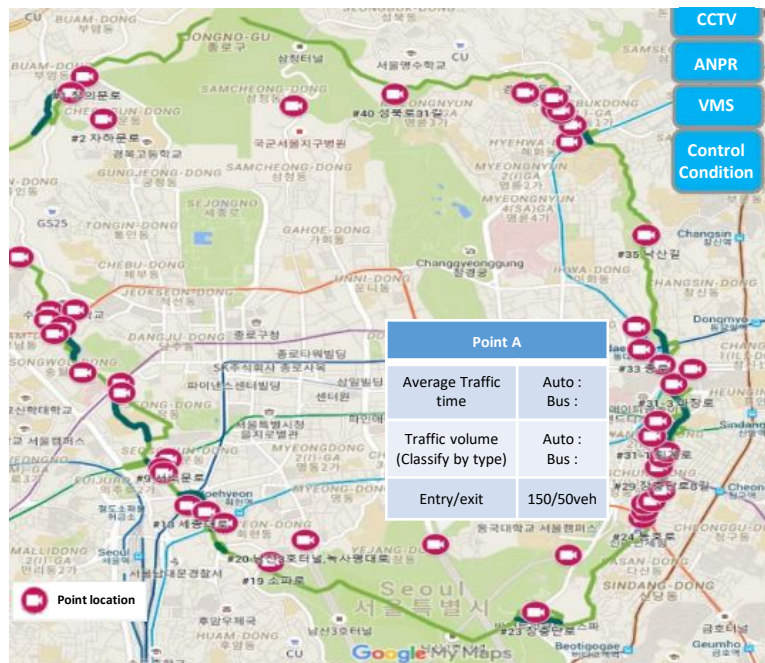


IV. Discussions

Locations of Congestion Pricing areas

- Using the Smart Camera of the ANPR(Automatic number plate recognition), Congestion Charge would be initiated in order to monitor speeds control

Present condition of monitoring facilities



Control map of Speeds

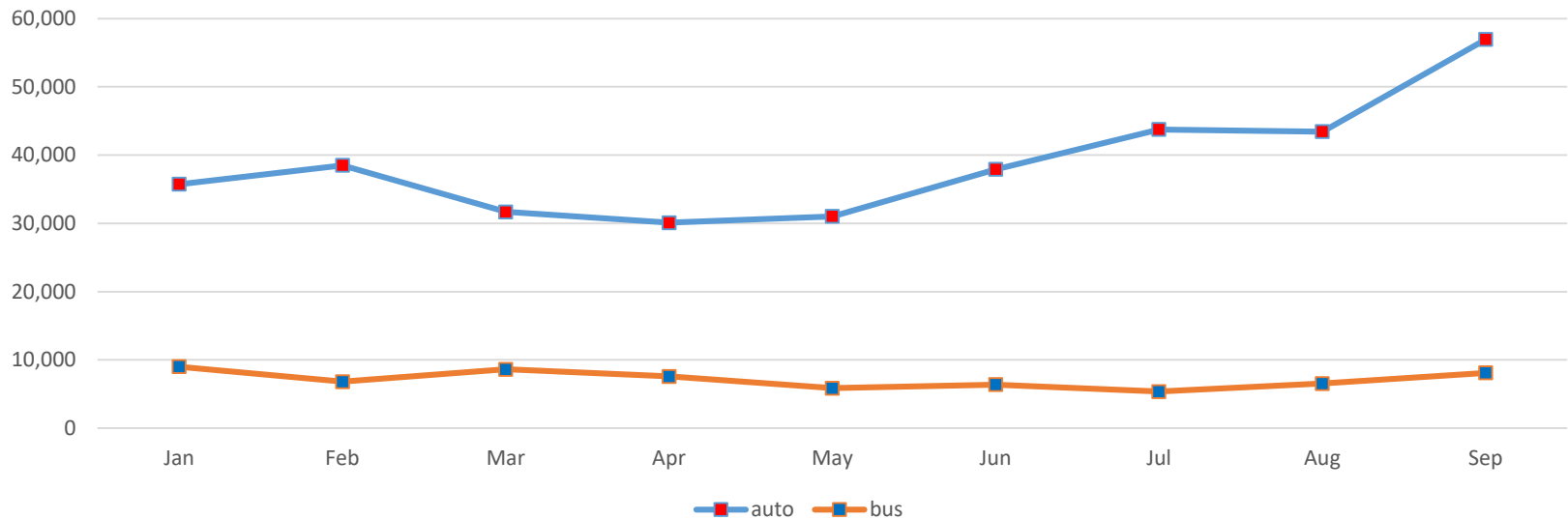


Health and Wider Benefits are required in the BRT Introduction

- Health benefit and wider benefits should be considered in conjunction with public transport use
- It is because travel time saving benefits in public transport use is not largely enough to justify the social benefits of introducing the BRT
- Gaining Travel Time Saving Benefits Marginally from Bus Speed Improvement Schemes.

Auto and buses travel time saving benefits

Benefit, 1000won/day



Thank You

Q & A



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