스마트모빌러티서비스

Urban Planning and Smart Mobility Service Design

Using a case of Sejong 5-1 Smart City Pilot

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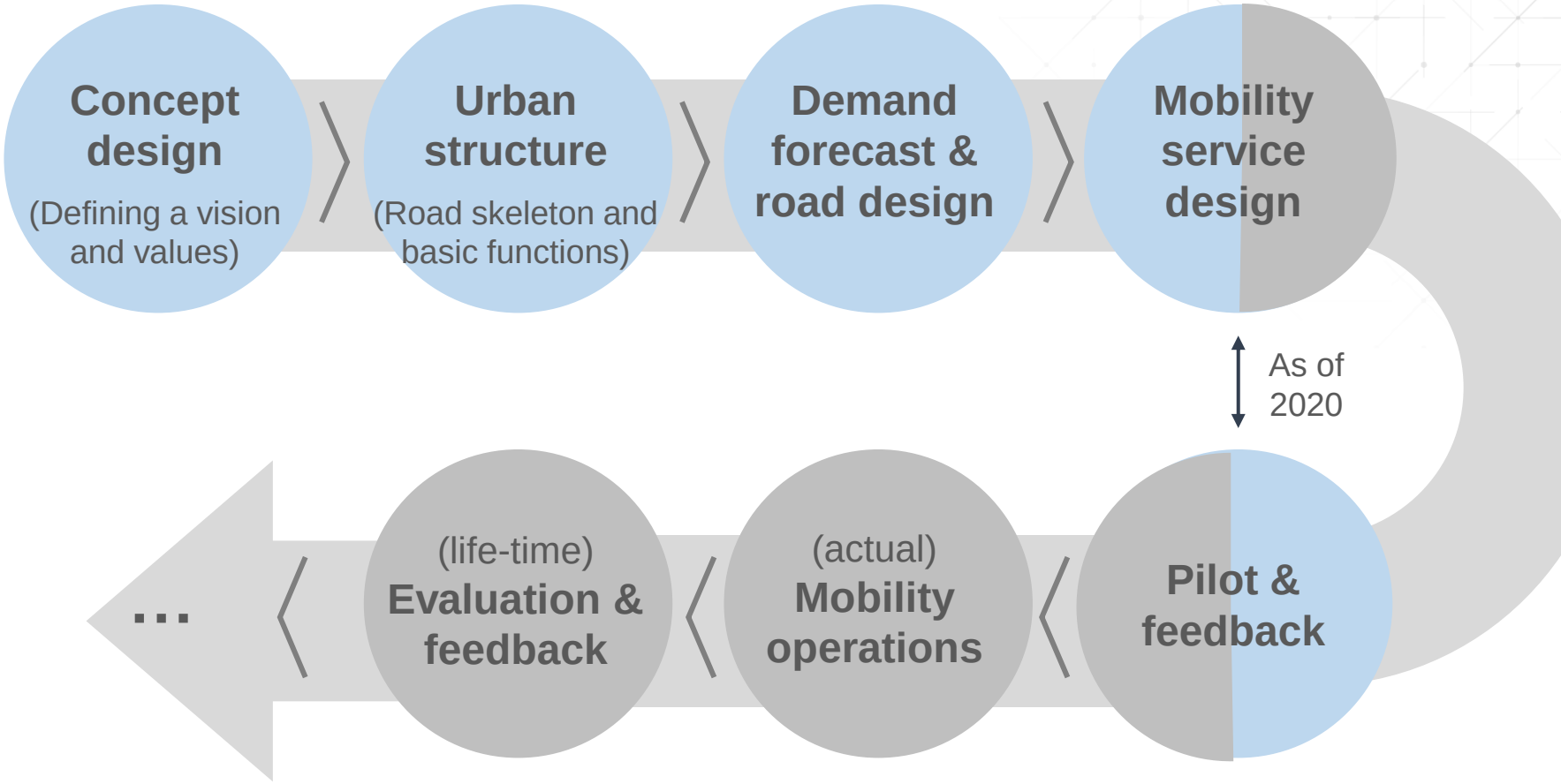
Planning Process in Smart City Pilot



National Pilot Smart City

- Demonstrating and integrating the Fourth Industrial Revolution technologies to sites without any pre-development plans
- Realizing the future smart city leading model by creating an innovative industrial ecosystem that can implement creative business models

2018 Project initiation
Regions are selected.

2019 Master planning for each area

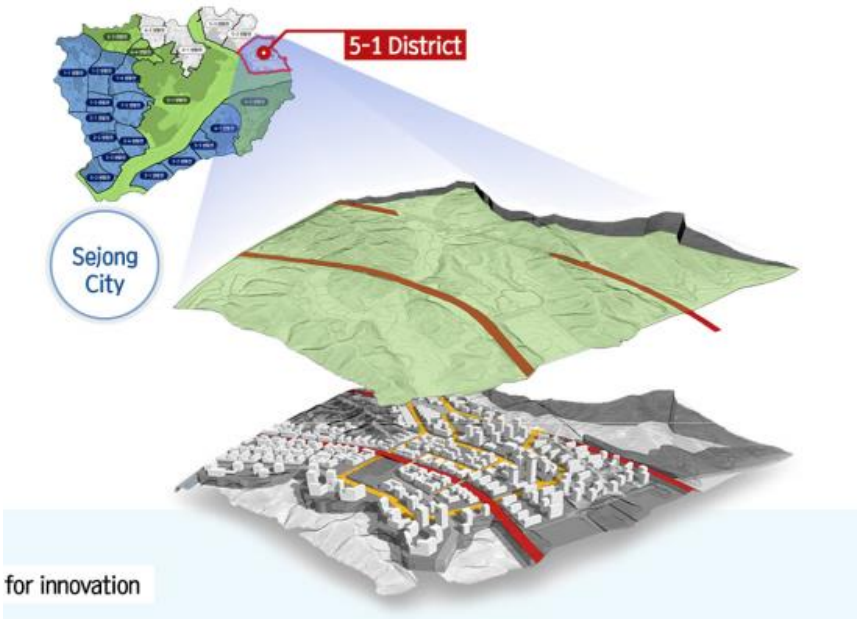
2020 Detailed designs of road, traffic, and mobility services
Mobility living lab initiation

2023 City opens!

Sejong 5-1 Smart City Pilot

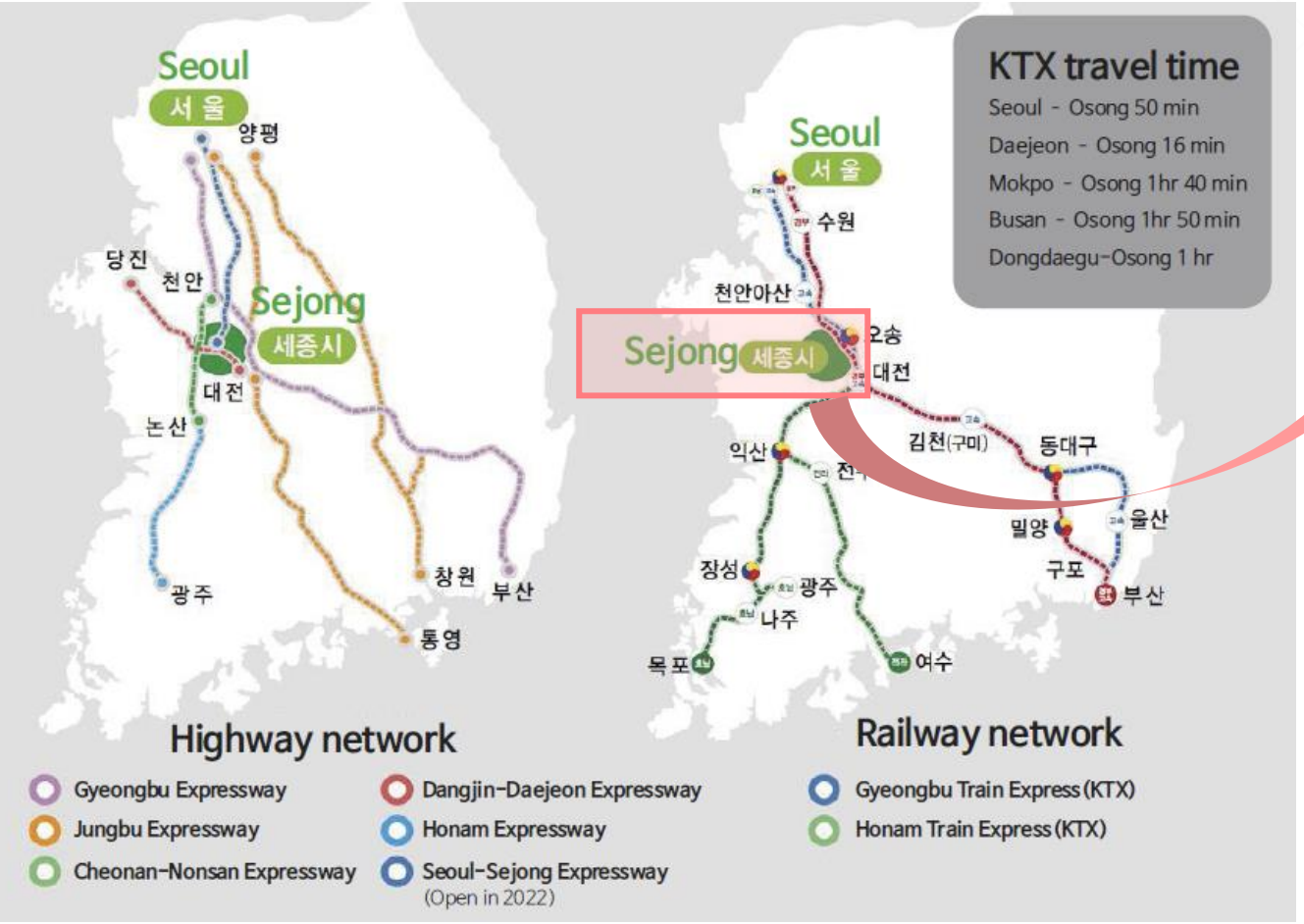
- The Sejong Pilot City with the concept of **AI-based city**, is creating a smart city that changes the daily lives of citizens through **7 innovative factors** including **mobility**, energy, and more.

  *e.g., smart transportation optimizes traffic by **sharing-based transportation** and **AI analysis of traffic flow data** to provide services that reduce commute time and costs, and **introduces various future transportation** such as shared cars and autonomous vehicles to be experienced in daily life.*



- 7 areas for innovation

Overview of Sejong 5-1 Life Zone



Location of Sejong 5-1 Life Zone

Sejong 5-1 Life Zone (as of 2019)

Sejong government complex

Location of Sejong 5-1 Life Zone

Sejong Smart City **overview**

- **Location**

  Hapgang-ri Sejong, Yongho-ri

- **Area**

  2,741million ㎡

- **Accessibility**

  · North-East of Multifunctional Administrative City, comparable to Yeouido size
  Optimal size to apply different new technologies

  · Entrance to the City from Osong and Cheongju direction and well-accessible to Osong Station (KTX) and Cheongju Airport

  · Close to universities and industry-university-institute cluster

  · Rich natural environment of Geum River and Miho Stream

- **Characteristics**

  A green field with complete compensation process of land and obstacles

Source : Jeong and Sejong MP Association (2019), Sejong Smart City National Pilot Project Master Plan

1st Step | Concept Design

Vision and Values of the City

A city with a sustainable platform,
which enhances citizen happiness and offers creative opportunities

Human-centric city for people	A decentralized city respecting sharing, equality and diversity	A city realizing convergence services with smart technologies
All of these enhances citizens' happiness		
Post-Materialism	Decentralization	Smart Technology
Lifestyle, work-and-life balance, human-centric, green	Sharing, development, distribution, diversity respect, citizen participation	Data-driven Artificial Intelligence, blockchain, creative innovation
Mobility	This city maintains the economic expenditure and comfort and decreases the total number of cars to 1/3 gradually	

A City-as-a-Platform, where customized predictions will be offered, hence contributing to citizen's enhanced happiness and quality of life

All phenomena and movements, as well as citizen's actions, will be used as data sources for analysis

Source : Jeong and Sejong MP Association (2019), Sejong Smart City National Pilot Project Master Plan

1st Step | Concept Design

Planning Principles

A Walkable Environment

- A park-type pedestrian walk in the middle of the road, creating a pedestrian-centered hierarchy, designating the pedestrian walk as the first
- Link roads with pocket parks that are located in between the roads
- Encourage in-road events via various culture/shopping experiences
- Create dynamic streets (e.g. seasonal/special-themed)

Creating New Value of Mixed-Use

- Realize job-house proximity
- Flexible commercial/office/residential spatial ratio as per demand
- Develop new business models
- Lead project development plans by zones
- A flexible space which is suitable for encouraging innnovation

Diversified Mobility

- A street system that accommodates active use of diverse mobility types
- New regulation that accommodates smart mobility and its active use
- New services such as mobile retail, mobile delivery, and mobile food

Respecting the Value of Original Site

- Area development that preserves original site
- A wildlife sanctuary in Life Zone
- Seek an architectural approach for preserved mountainous area development
- Conservation/transplant of existing planted trees to the fullest

Infrastructure for Innovative Services powered by Smart Technologies

- Collect all types of phenomena and movements of city-as-source-of-data, and analyze them
- Build a customized prediction platform
- Build an infrastructure driven by AI, blockchain, and data
- With a digital twin convergence platform, create new convergence opportunities

Source : Jeong and Sejong MP Association (2019), Sejong Smart City National Pilot Project Master Plan

1st Step | Concept Design

Mobility Concept Design

- Different definitions of Smart City & Mobility

2009 — Smart City in Europe

A city that brings improvement in people's quality of life and sustainable economic growth through investment in infrastructure based on human social capital, traditional transportation, modern ICT, effective use of natural resources, and active government participation

Caragliu, Bo, and Nijkamp, Smart Cities in Europe

2012 — Smart Cities Council

A city that increases the efficiency, improves the people's quality of life and the urban operation, and includes the growth of local economy through an integrated approach rather than a smart city that utilizes ICT well

Fast Company article, 'What Exactly is a Smart City?'

2013 — bsi.

A city that provides resources for changes and that is formed to realize roles as a city laboratory, a city innovation ecosystem, a living laboratory, and a transformative deputy

Anthony Townsend, Urban Future

FAST COMPANY

A smart city that improves habitability, usability, and sustainability through ICT(Information and Communications Technology)

Smart City Readiness Guide

2014 — SMART CITIES

A city that guarantees sustainable, prosperous, inclusive, and evolving future for citizens by effectively integrating physical, digital and human systems into the built environment

Smart City Framework

Source : Jeong and Sejong MP Association (2019), Sejong Smart City National Pilot Project Master Plan

- Keyword analysis via text-mining technique

A Study on the Concept of Smart City and Smart City Transport (So et al., 2018)

Rank	Categories	Keywords	Frequency	Percentage
1	Transpotation paradigm change	Paradigm shift, Advanced, Promising, Efficiency, Flexibility, Optimised, Innovation, Intelligent	51	28.7
2	Sharing, Automation, Electrification	Sharing, Automated, Electrification, MaaS	41	23.0
3	ICT technologies	ICT, Technology, Data, Digital, Communication	38	21.3
4	Sustainability and safety	Sustainability, Environmental, Green, Safety, Energy	37	20.8
5	Social	Life, Connected,	11	6.2

1st Step | Concept Design

Goal (vision) of Mobility Services

> Mobility ecosystem, enabling experience of having Seamless Mobility as if possessing an owned mobility

" You will experience the same level of mobility services as own car by shared-and integrated mobility services even if you do not own a car… "

Objectives

- Core 01 — No-owned-car City Based on (car/riding) Sharing Mobility
- Core 02 — Safe and Efficient Trips Based on Automated Mobility
- Core 03 — Door-to-door Seamless Trips Based on Integrated Mobility
- Core 04 — Safe and Pleasant Walk/Cycling Environment Based on Smart VRU Services

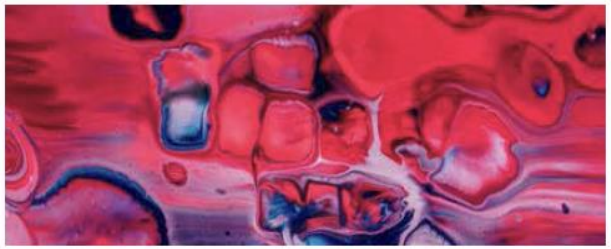
Mobility Services

Sharing Mobility	Automated Mobility	Integrated Mobility	Smart VRU Services
Free floating	**Automated shuttle (on-demand)**	**Integrated mobility**	Smart pedestrian crossing
Ride sharing	**Automated shuttle (ring)**	**Integrated payment**	Smart traffic signal control
P2P car sharing	**Auto. BRT bus**	**Smart parking**	Smart streetlight
Personal mobility			Smart surface lighting

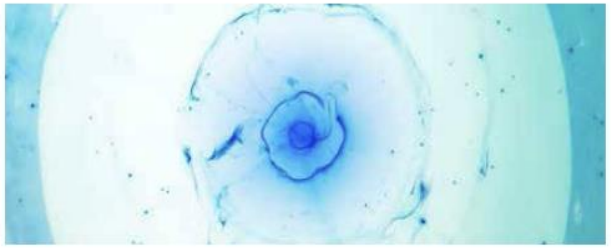
2nd Step | Basic Planning of Urban(Road) Structure

Urban Structure in Humanistic Discipline

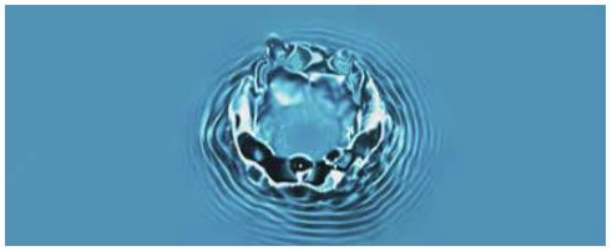
Cell of Organisms



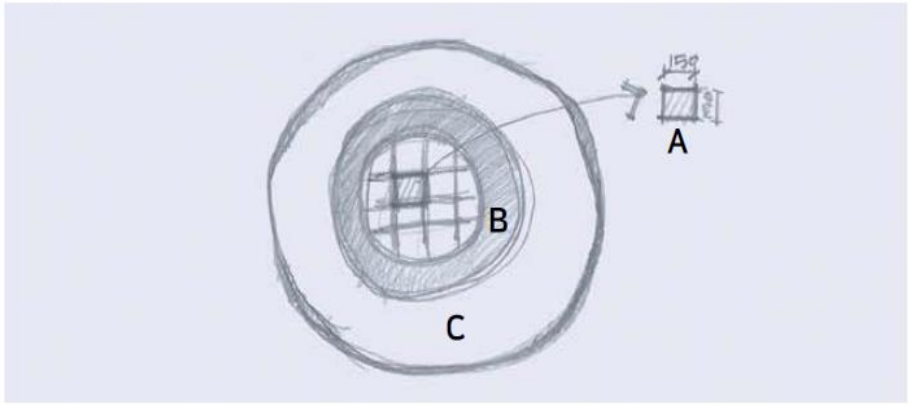
Atoms & Electrons
Basic Units of Matter



Wavelengths
of a Water Drop



※ Rhythm/Scale: A < B < C



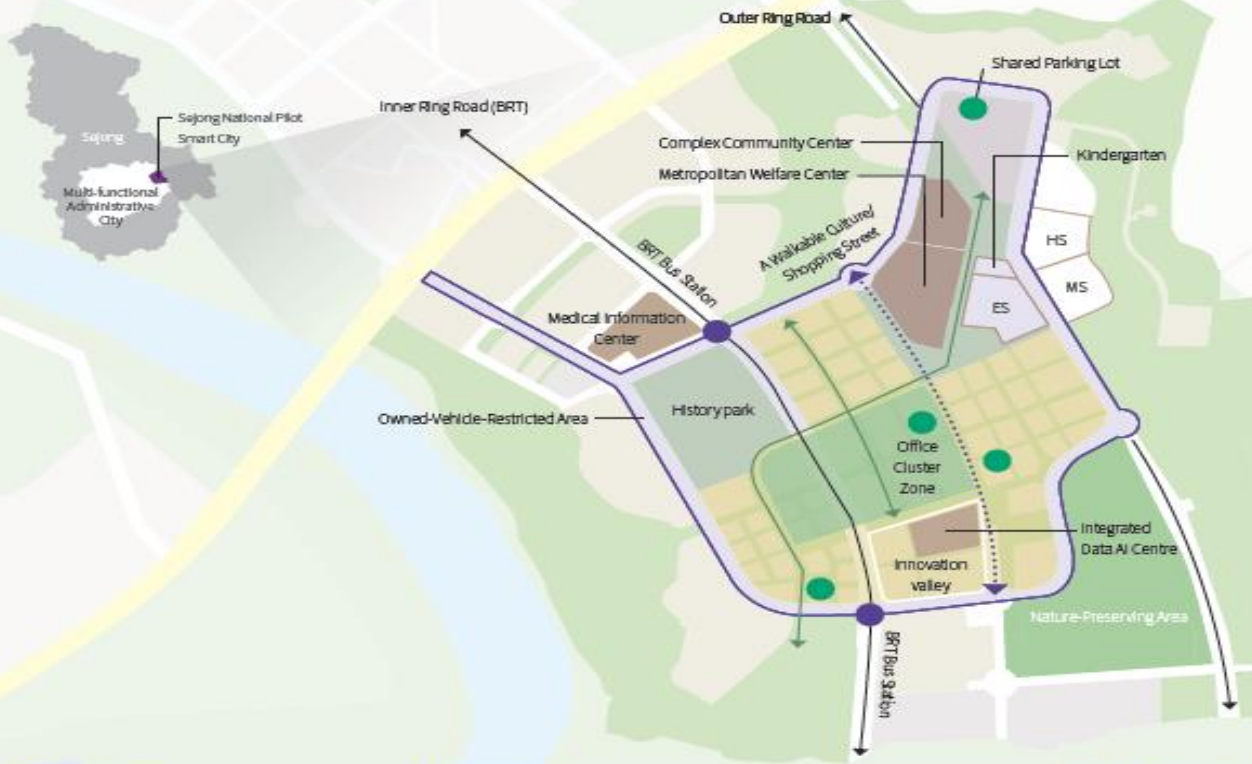
A	A walkable block, where a side of the block is 150 m long. Ideal for low-speed & small-scale walking, and various types of PM
B	Service area for A & C, where self-driving shuttles are around. This block serves a buffer for the different speed and scale of A & C
C	High-speed vehicles from another region can enter, where large-scale blocks are located

Source : Jeong and Sejong MP Association (2019), Sejong Smart City National Pilot Project Master Plan

2nd Step | Basic Planning of Urban(Road) Structure

Layer 1 – Urban Planning

Urban Planning



Project Overview

Location	Hapgang-ri, Sejong-si, Republic of Korea
Site area	2,741,000 m²
Planned population	approx. 20,000 (8,500 household units)

Conditions of Location

Character	Proximate to the entry of Osong, Multi-functional Administrative City, a region gifted with rich nature, where Miho stream and Geum River meets

Accessibility

Railway	Connected to Kyeongbu and Honam KTX lines from Osong Station (14 km)
Highway	Highway: Proximate to Kyeongbu, Joongbu, Cheonan-Nonsan highways
Airport	Cheongju Airport (37 km) Accessible within 2 hours from major Korean cities

A City of Sharing

- Self-Driving Lane (Ring)
- Owned-Vehicle-Restricted Area
- Short-cut Ring Road

A Walkable City

- Inner Ring Road (BRT)
- Within 400 m radius of walks
- A Walkable Culture/Shopping Street
- A Walkable Street filled with Colorful Experiences
- Culture & Shopping Street (Open-type, Arcade-type)

A City of Job-Housing Proximity

- Mixed-Use Area
- Major Businesses/Office Zone
- Office Cluster Zone
- Job-Housing Proximity

A City filled with Empirical Testings

- Complex Community Center
- Education and Research Environment
- Nature-Preserving Area
- Metropolitan Welfare Center
- Medical Information Center

Source : Jeong and Sejong MP Association (2019), Sejong Smart City National Pilot Project Master Plan

2nd Step | Basic Planning of Urban(Road) Structure

Layer 2 – Mobility Planning

Urban roads outside a ring

Outer ring road
(Vehicle-only)
(high-speed)

Pedestrian-exclusive roads

(PM and bicycles are permitted, but vehicles are restricted.)

Inner ring road
(Circular shuttle operation)
(Low-medium speed)

Sejong main arterial
(BRT operation)

2nd Step | Basic Planning of Urban(Road) Structure

Layer 2 – Mobility Planning

Self-Driving Lane (Ring)

- Lane for AV and shared vehicles
- Installation of transit area
- Owned-Vehicle-Restricted Area
- Operating route: 4.1 km / Operating time: 10 min

Owned-Vehicle-Restricted Area

- Shared Mobility/Micro-Mobility
- No traffic jam for both vehicles and pedestrians
- Optimized traffic via AI analysis of traffic data
- Smart signal system
- City data analysis center
- Smart crosswalk

Short-cut Ring Road

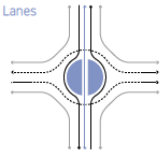
- Underpass that facilitates traffic flow of ring road
- Underground slip road with entry to shared vehicle parking lot (within owned-vehicle-restricted area)

Intersection of Inner Roads

- Self-driving lane
- Pedestrian walks
- lane for shared vehicle/service
- AV platform
- Owned/shared/service vehicle lane

Self-Driving Lane & Lanes (general)

- Self-driving Lane at the center
- Side lanes are for shared/service vehicles



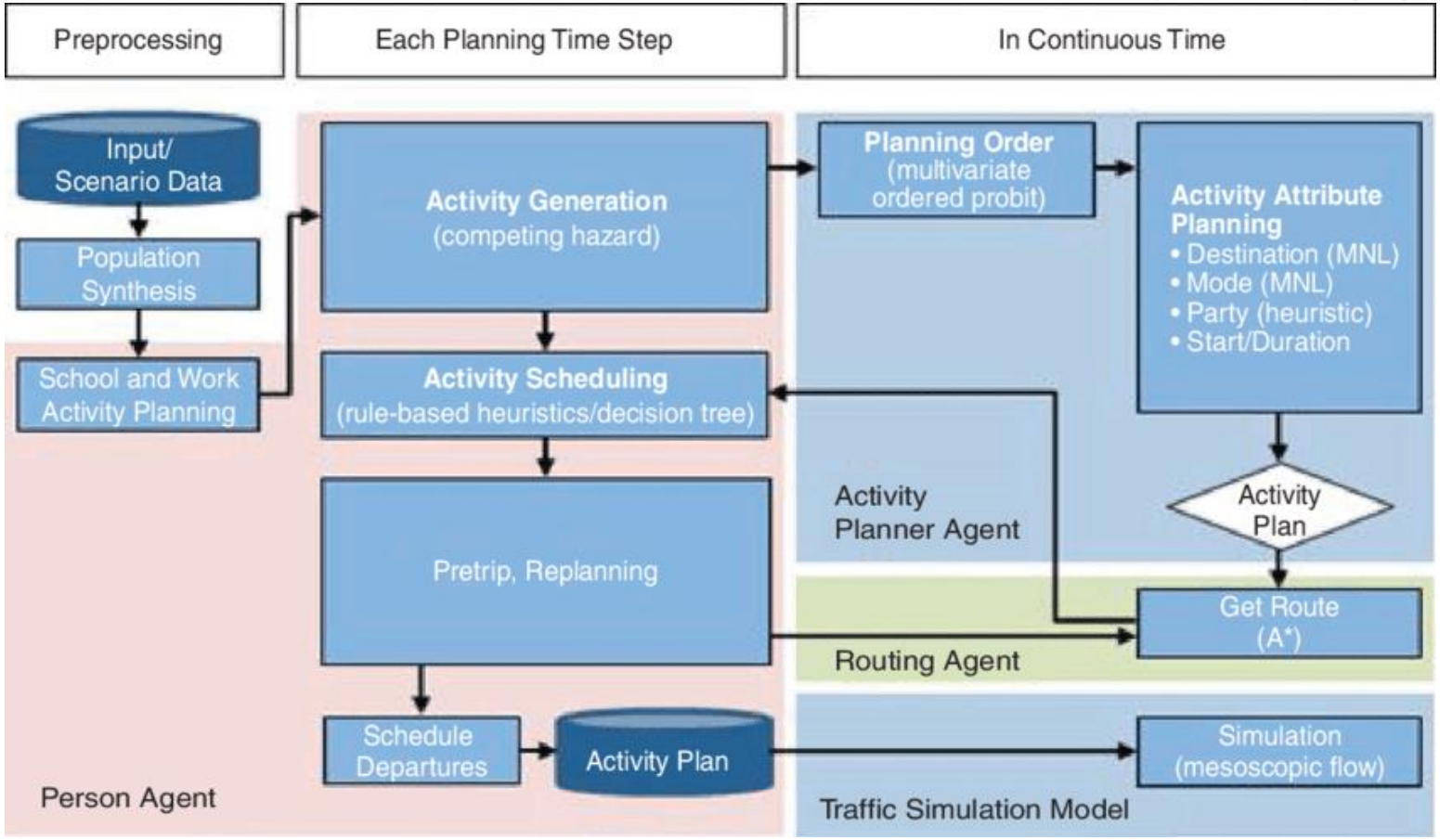
Street Planning for Self-Driving Lane

Source : Jeong and Sejong MP Association (2019), Sejong Smart City National Pilot Project Master Plan

3rd Step | Demand Forecast (& road design)

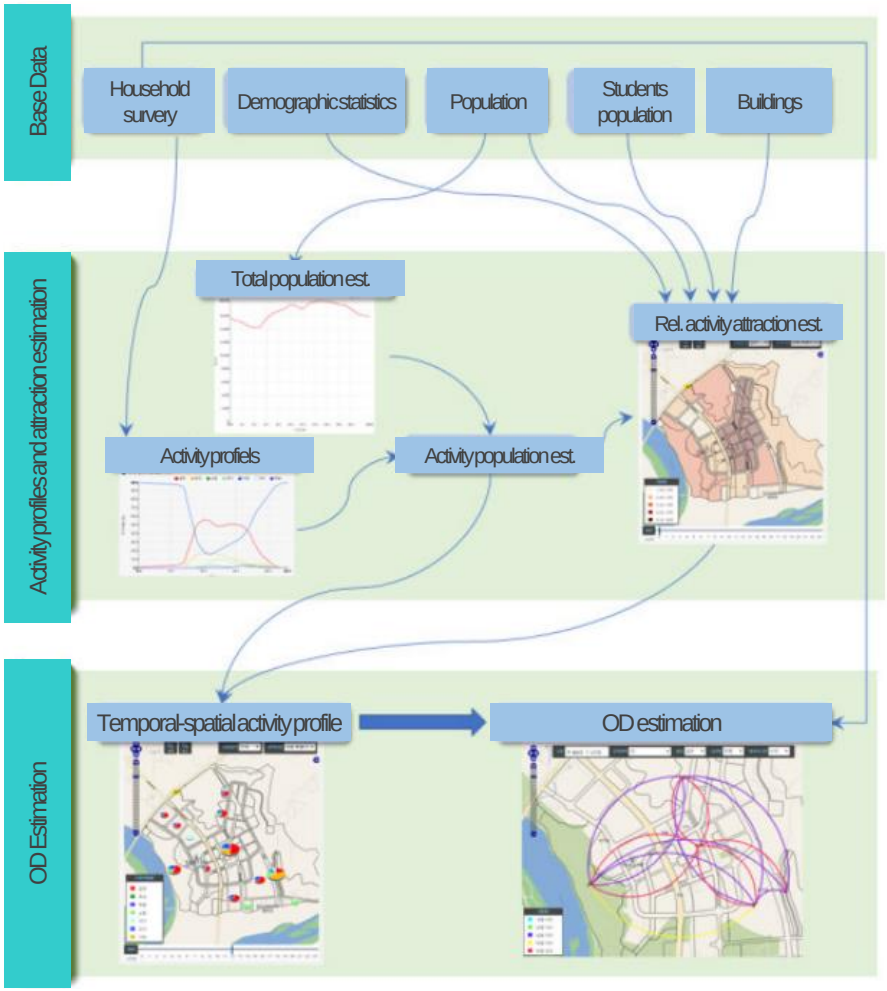
Activity-Based Travel Demand Modeling

Auld, J., Hope, M., Ley, H., Sokolov, V., Xu, B., & Zhang, K. (2016). POLARIS: Agent-based modeling framework development and implementation for integrated travel demand and network and operations simulations. *Transportation Research Part C: Emerging Technologies*, *64*, 101-116.

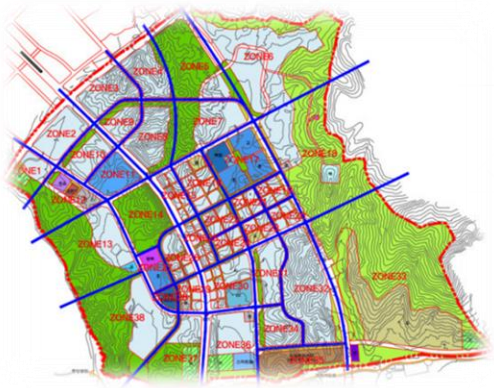


3rd Step | Demand Forecast (& road design)

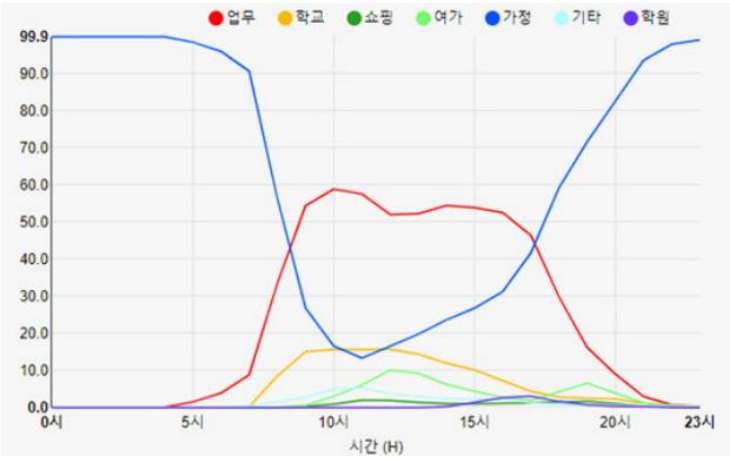
Activity-Based Travel Demand Modeling



- Traffic zones



- Hourly activity profiles



3rd Step | Demand Forecast (& road design)

Activity-Based Travel Demand Modeling

- Mode alternatives

In-In Trips	Passenger cars	Car sharing	Ride sharing	Auto. shuttle	Micro Mobility	...
In-Out Trips	Passenger cars	Car sharing	Ride sharing	Bus Rapid Transit	...	

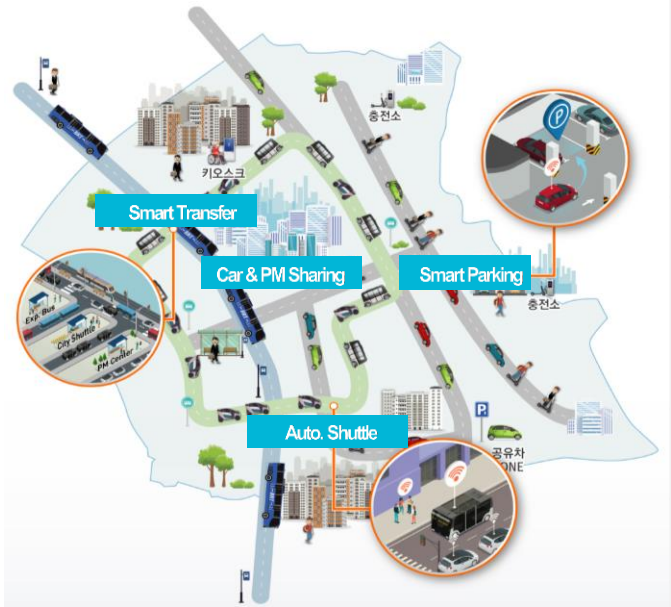
- Mode share estimation

Trips	Passenger car	Car sharing	Ride sharing	Auto. shuttle	Micro PM	Bicycle	Walk	BRT	Total
In-In	17	2	2	11	24	8	36	-	100
In-Out	44	16	8	-	-	-	-	32	100
Total	36	13	7	3	6	2	9	24	100

4th Step | Mobility Service Design

Mobility Service Architecture

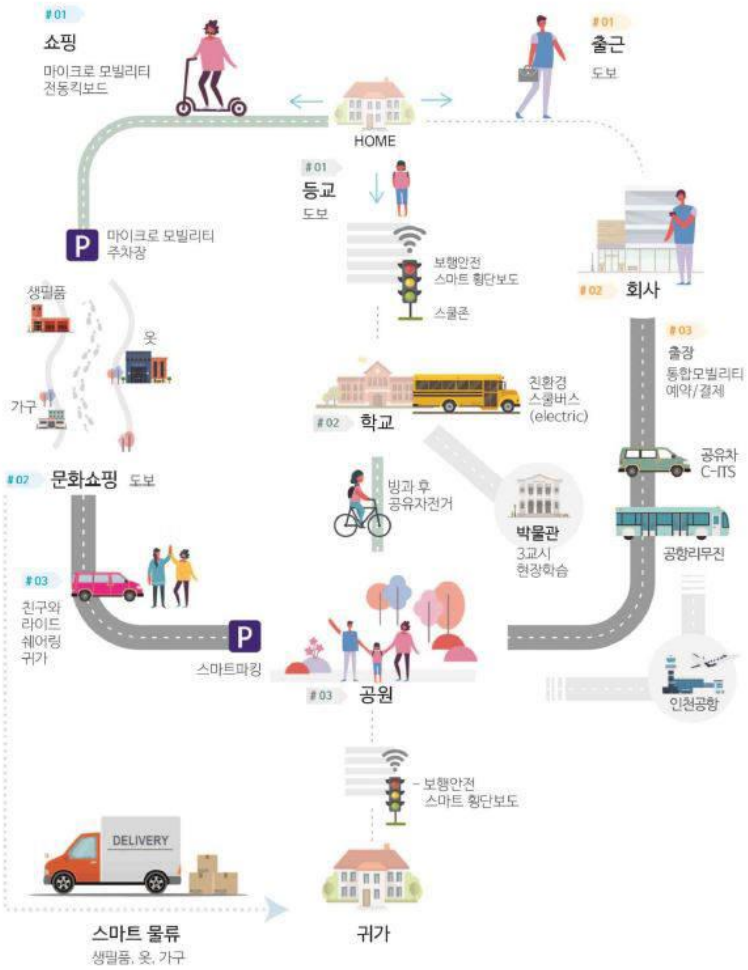
- **6** service areas / **9** mobility services / **19** service functions



Category		
Areas	Services	Functions
Personal Mobility	Micro PM sharing	Open-Micro PM sharing
		Shielded-Micro PM sharing
	Car/Ride-sharing	Free-floating car sharing
		P2P car sharing
		Ride sharing (open P2P sharing)
Group Mobility	Automated shuttle	Automated circular shuttle (inside ring)
		Automated circular shuttle (on ring)
		Automated BRT
	Demand-responsive transit	Demand-responsive bus
		Demand-responsive Auto. circular shuttle
Mobility integration	Integrated mobility	Integrated mobility + integrated payment
Parking	Parking sharing	Smart parking
		P2P parking space sharing
Safety	Smart road	Smart intersection
	Pedestrian safety	Smart pedestrian crossing
		Smart school zone safety
		Smart surface signing
Logistics	Smart logistics	Unmanned(robot) delivery
		Smart logistics system

4th Step | Mobility Service Design

Development of Service Scenarios



01

Rent a shared e-bike near home to get to a self-driving shuttle bus stop.
Return e-bike, wait for the smart streetlight, and get on the bus.

02

Self-driving shuttle strictly obeys traffic rules, and communicates with surrounding vehicles in real-time for a safe drive.

03

With colleagues, take a shared autonomous vehicle (AV) to get to the meeting venue in afternoon.

04

After work, take self-driving shuttle bus to pick up my kid at the kindergarten, and return home.

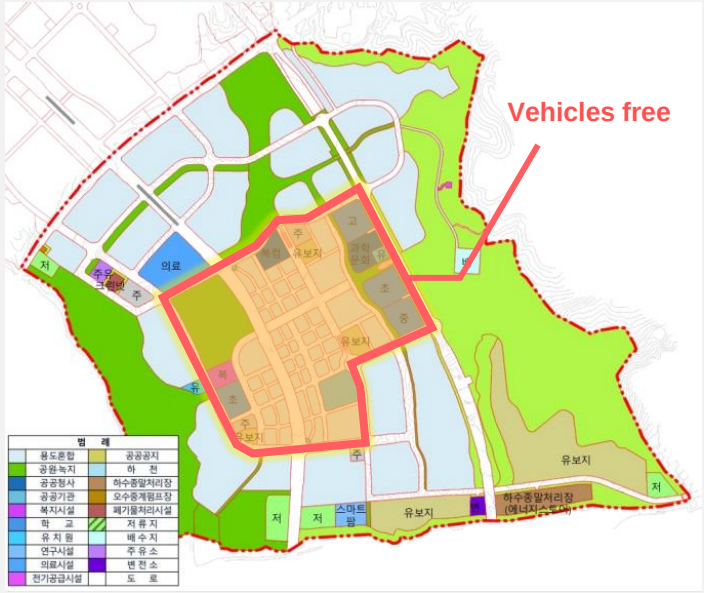
Source : Jeong and Sejong MP Association (2019), Sejong Smart City National Pilot Project Master Plan

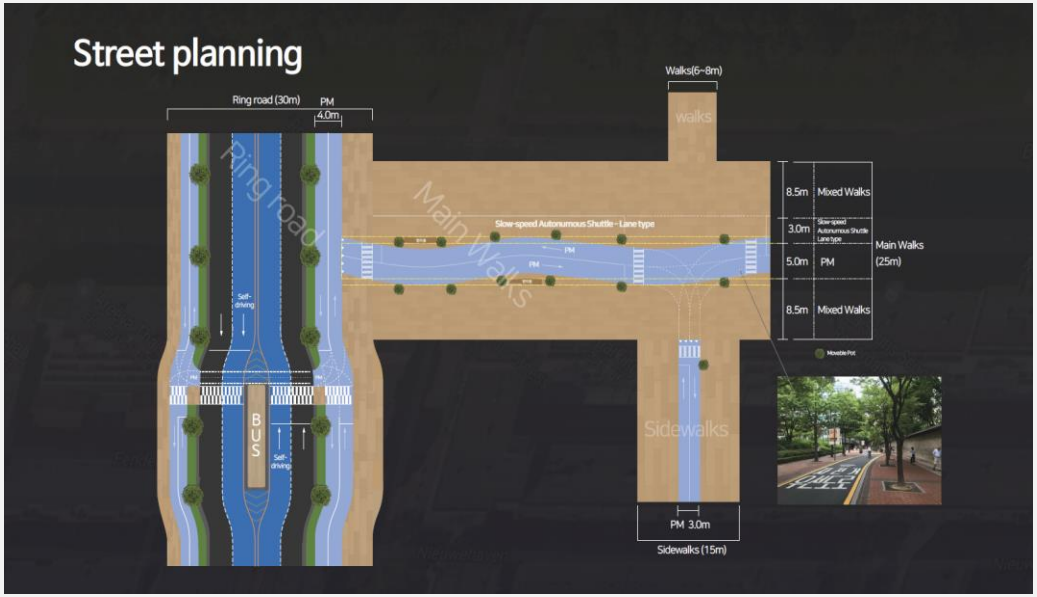
4th Step | Mobility Service Design

Mobility Service Features

Pedestrian-exclusive Area (Vehicles Free)

- Vehicles are limited to enter/drive to this area – only pedestrians and shared mobility are only permitted.
- Walking-friendly, promoting shared mobility, safety by vehicles-free
- However, still concerned about intersecting of PM roads, crash risk among pedestrians and PMs, and inoperability in inclement weather, low temperature, and VRUs – possibly happen in reality!, .





Source : Jeong and Sejong MP Association (2019), Sejong Smart City National Pilot Project Master Plan

4th Step | Mobility Service Design

Mobility Service Features

Shielded-Micro PM

- Vulnerable to inclement weathers, temperature, elderly, heavy baggage, etc.
  - Nearly impossible during rainy/snow, winter…

>> Mobility system should be sustained for all time!"

Typical micro PM

Shielded-Micro PM

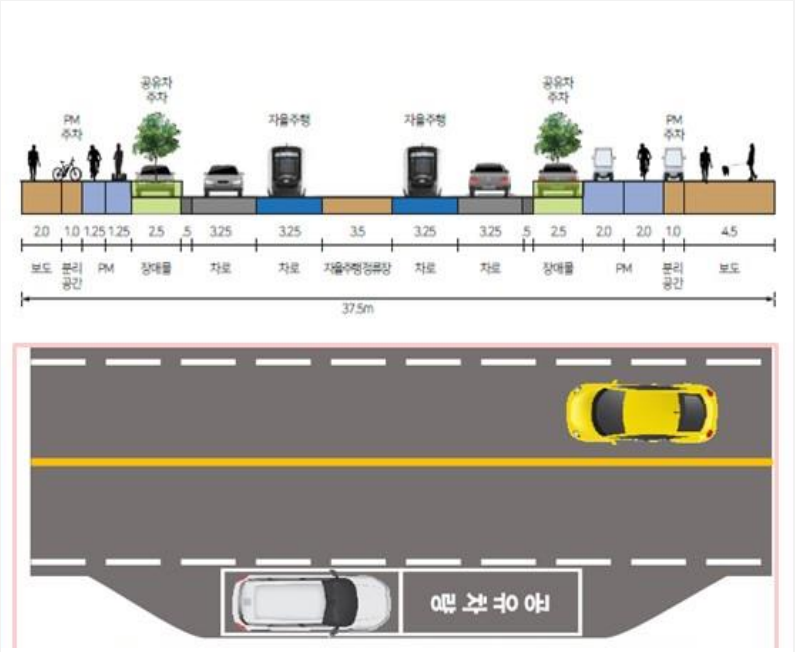
+

Source: https://electricmotorcycles.news/bio-hybrid-a-new-form-of-personal-mobility/

Source: https://www.toyota.com.bh/about/innovation/personal-mobility/

Free-floating Car Sharing

- Rent/return anytime & anywhere "free-floating"
- Synergy with street parking, but an issue in space-use (due to limited space)



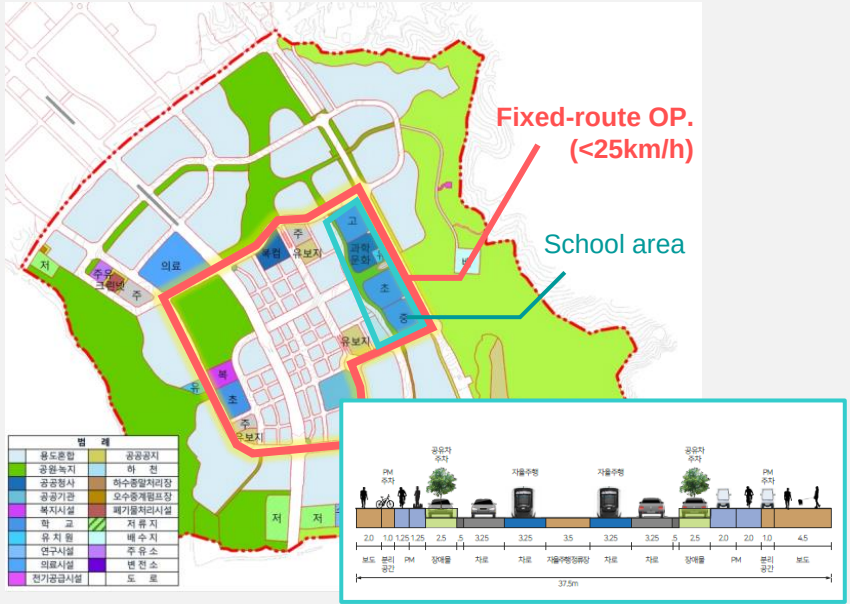
4th Step | Mobility Service Design

Mobility Service Features

Automated Shuttle

- Safety issue with the school area
- Road space issue in allocating an exclusive AV shuttle lane
- Technical issue with roundabouts

>> Incomparability in urban planning and mobility design



Smart Panels for Pedestrian Safety

- Moving traffic signs to surface for the current generation who walk while looking at a smartphone
- Deployment of traffic signs at right-front (existing) and bottom (additional signs)
- But, concern about promoting "*smombie (smartphone zombie)*"

5th Step | Pilot (Mobility Living Lab Project)

Mobility Living Lab Project

Poster for promoting participation and volunteers

- Operation of civic volunteers
- Technologies and services in validation with the volunteers
- Feedback to the Sejong 5-1 Smart City pilot

Period	Dec. 2019 – Dec. 2022
Period	9 M USD
Services implementation	Micro PM sharing Car sharing (free-floating) Automated shuttle Demand-responsive transit Integrated mobility Smart parking
Validation & feedback	Problem identification and improvement on service operations Verification of technology feasibility Social acceptance of new technologies and services

Issues to be Further Studied

From Planning to Operation

- Systematic planning process in consideration of both urban and mobility system
- Conformity of land use and mobility services
- Efficient road space use by adding future mobility means and services
- Smooth interaction between pedestrians and PMs & among PMs
- Are Avs safe enough? And what is the optimal operation strategy of AV shuttles?
- Where should PMs be located and driven?
- …

Toward Smart City & Mobility

Understanding in **Urban Planning (humanity)** + Understanding in **Data and Transport Tech. knowledge (technology)**

Mobility-friendly urban planning?

Data-driven mobility operations and feedback

Urban planning is an interdisciplinary field.

Now, I know why urban planning is called a comprehensive science.

Conformity of urban planning and mobility service design/operation is important.

Everybody says this, but there is no articulate methodology to plan urban mobility system in consideration of city visions, land-use, and mobility demand.

What does a mobility-friendly city look like?

Flexible and smooth entry of emerging mobility means/services

Safety first! - validation of technologies/means/services in terms of safety
Road space use by adding new modes

감사합니다.

Thank You.

Vielen Dank.

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