The present and future of Demand Responsive Transport in Korea

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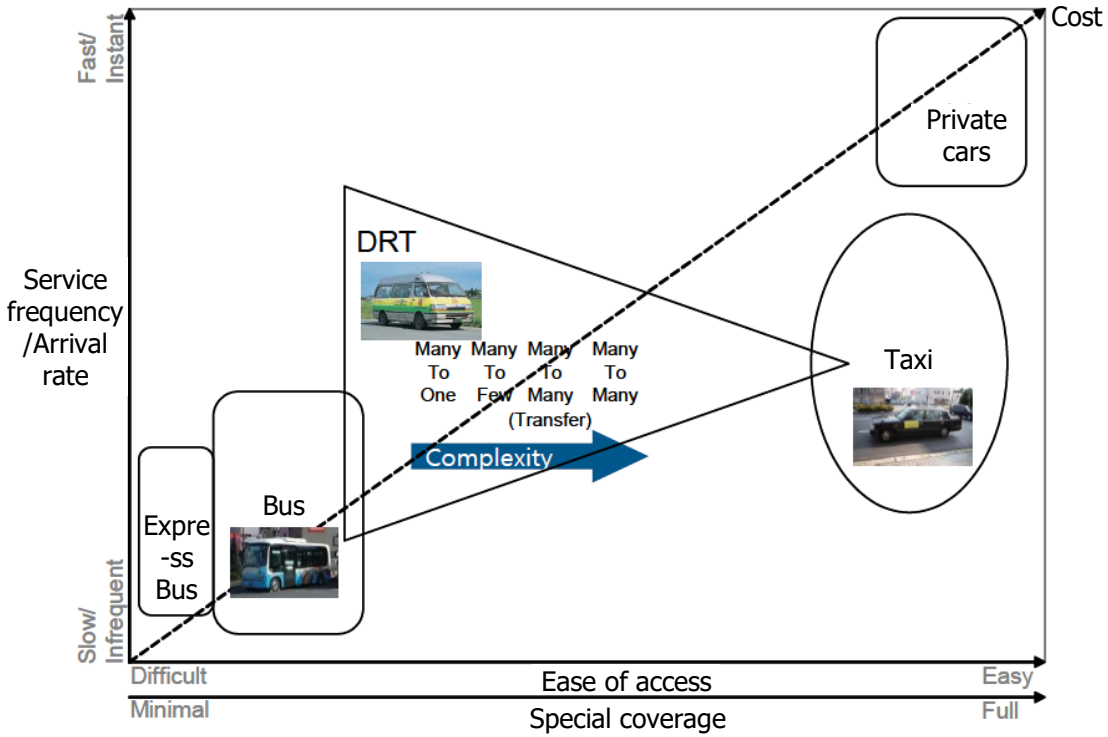
Why DRT?

Backgrounds

- Public transport is crucial for sustainable society
  - GHG emission
  - Congestion
  - Aging
  - Social inclusion for disadvantage groups
- Declination of Public transport demands
  - Depopulation
  - Increase in income
    → Growing preference for private cars
  - Inconvenience of using PT
- Increase in public transport deficit
  - Business difficulties of private transport companies
  - Manpower shortage

Features



Souce : Graham Currie, "Melbourne DRT Trial Program Development Operator Workshop", Monash University

History of DRT in Korea

Free shuttle bus for PWD* and welfare taxi introduction

Enactment of Act on Promotion of the transport convenience of mobility disadvantage persons

Special transportation introduction

Upward of Special transportation standard

Metropolitan DRT/ Tourism DRT pilot project launching

Living-lab trial of Autonomous DRT

Commerciali-zation of Autonomous DRT

2000 2006 2007 2008 2014 2018 2019 2020 2021 2022 2023 2026 2030

1st trial of rural DRT in Naju

Expansion of 'Rural DRT'

'Urban DRT' introduction

Expansion of Urban DRT

Enactment of Smart city act

Advanced DRT using ICT pilot project launching (Smart city projects)

Advanced DRT using ITC

Background of Advanced DRT

- High penetration rates of smartphones in Korea: 93.4% of the population
- ICT startups supported by public and private sides have been looking for new markets and business models to implement their technologies
- National project to promote smart city development such as National pilot project in Sejong-city, Smart Challenge Project, etc.
- Regulatory innovation initiatives (i.e. Regulatory Sandbox) lower the barrier for ICT startups to test their innovative technologies in real-world pilot projects

Case Studies

Citytour-DRT in Gangneung (operated by Ciel)

Shared-Taxi DRT in Pohang (operated by 42dot)

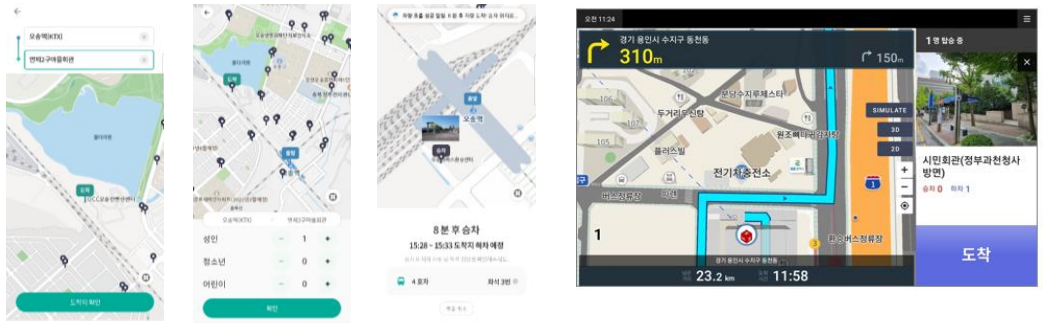
DRT in Sejong (operated by SCRT & Hyundai Motor)

Integrated Platform in Gyeonggi (operated by GT & Hyundai Motors)

Technologies of Advanced DRT

User Interface

- Mobile applications – Booking/Routes/ETA/Real-time tracking information
- In-vehicle display–GPS, QR, Information/Advertisement



Service management

- Service control for real-time reservations and fleet management
- Monitoring operation status in service areas

Optimization of dispatch and routes

- Dispatch algorithm to match real-time demand and supply under constraints
- Optimal routing considering boarding and alighting of users on the same vehicle

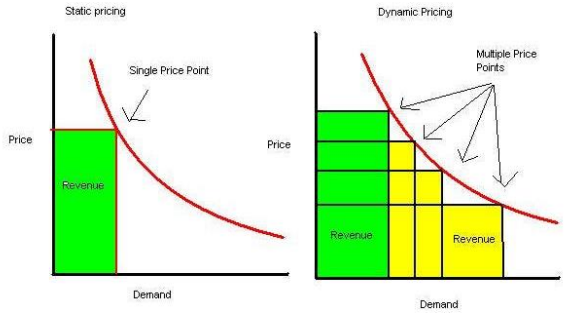
Service optimization

- Data collection of customers and fleets
- Security management
- Machine learning algorithm for optimizing expected time of arrivals and routing

Future DRT : Service Diversification

Dynamic Pricing

- Adjust fare in real-time based on factors such as the number of passengers, the distance of the journey, and the time of day
- Benefits
  - increased revenue
  - improved service quality
- Challenges
  - Complexity
  - customer acceptance



Mobility-as-a-Service

- Including taxi, bus, PM, etc in a single platform
- Integration with long-distance transport modes such as railway, express buses, etc
- Challenge to cope with the complexity as more transport modes are considered

Premium service

- Higher fare for the service with shorter waiting time and detour
- Special care service for the elderly and the young : safety and onboard assistance

Future DRT : Autonomous DRT(National R&D Project)

As-Is

Limits in Special Transport Modes for the PLM

- **Insufficient Provision: 83%** of Legal Standards
- **Long Waiting Time** Hinders Its Use (48.2 min. in avg))
- **Insufficient Service for Inter-regional Trips** Infringes PLM's Human Right



Limits in Public Initiative Transport Model

- **Service Reduction** as Population Decrease and Aging Causes Shortage of Transport Workers
- Transport Deprived Area Residents' **Reduced Accessibility towards Life SOCs** and Decline in Transport Service Quality
- **Deterioration in Passenger Transport Business**, including Worsened Profitability of the Public Transport Industry

To-Be

Autonomous DRT Service

- **Cost Reduction** with Saving Personnel Expenses
- **Alternative to Shortage of Transport Workers**
- Foundation to Provide **Sufficient Public Transport Service**
- Transport Deprived Area Residents' **Improved Accessibility Towards Life SOCs** such as Work, Healthcare, etc.




Period/ Budget	Apr. 21-'Dec. 26. (5y 9m) 1,741.5 billion KRW (1.3 million USD)

Project Partners

Managing Agency

- THE KOREA TRANSPORT INSTITUTE

User Behavior/ Use case

- THE KOREA TRANSPORT INSTITUTE
- 사단법인 한국지체장애인협회

Control System Technology

- LG U+
- KNUT
- CEST
- NZERO

Service Technology

- Ciel
- KST Mobility

AVs

- a2z AUTONOMOUS
- ETRI 한국전자통신연구원

Future DRT : Seoul Metropolitan DRT Pilot Project

Period/ Budget	Apr. 22-'Dec. 25. (3y 9m) 1,812.4 billion KRW (1.3 million USD)

Project Partners

Managing Agency

- THE KOREA TRANSPORT INSTITUTE
- 한국철도기술연구원 Korea Railroad Research Institute
- kakaomobility
- STUDIO G STUDIO GALILEI
- (주)미래교통
- 아주대학교 AJOU UNIVERSITY

Barriers and Challenges

Technical innovation

- Digital technology for public transport operation
  - mobile communication, GPS, data collection.
- AI-powered routing and dispatch algorithm to match demand and supply in real-time operation
  - Optimal waiting time and detours due to shared service
- Coping with the complexity Dynamic pricing for higher user's satisfaction

Economic efficiency

- Expected to reduce operation cost by 27% compared with buses → An affordable way as a low-cost solution
- However, DRT would not be commercially viable due to low level of demands or failure to optimally match demands and supply

  → Longer waiting time or unwanted detours
- Subsidy is essential to keep DRT services sustainable

Social agreement

- Conflict with other transport service such as taxies, buses, etc.
- Need to devise win-win solutions for all participants in the transport service market
  - A good practice: Paju Burumi("call-me") bus : a business model combining village bus operators and Shucle's DRT technologies
- Deregulation for new business models

Social inclusion

- Digital ability using cell phones and applications is essential for DRT powered by ICT
  - Digital divide as a barrier to widen user groups who truly need the new mobility services
- Personalization for the elderly and the people with disability
- Shortage of Transport Workers in rural areas

❖ Source : MOLIT(2019), Introduction of Demand Responsive Transport to enhance metropolitan transport system of Chungbuk Innovation City

Key Takeaways from the Korean DRT Practice

Digitalization of public transport services and **universal use of mobile phones** by all generations are important factors	Proactive investments for ICT infrastructure and digital ability are crucial to successfully implement DRT services
Proactive Investment and Diverse Pilot Projects Implementations for the **Development of Technology Converged DRT Solutions** (i.e., ICT, AI, Autonomous Driving, etc.)	Support and Corporation between the public and private sectors are essential for new transport technology development.
Private-Initiative Development in New Transport Technologies and Drastic Efforts in **Deregulation**	New technologies often conflict with regulations. Continuous innovations are required for institutional reform.

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KOREA TRANSPORT INSTITUTE

THANK YOU

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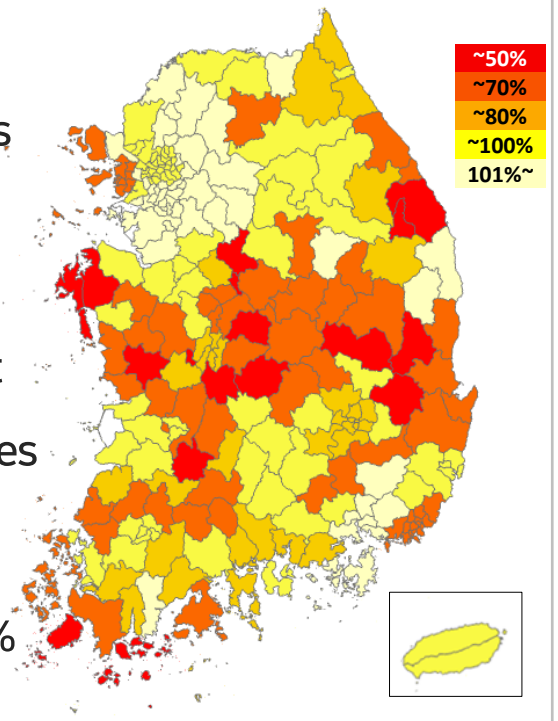
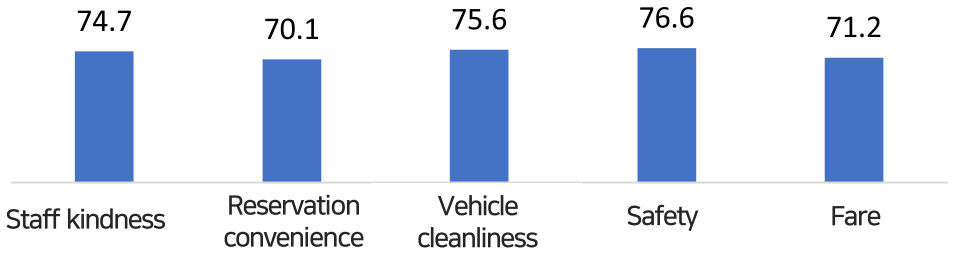
DRT for People with disability : Special Transportation

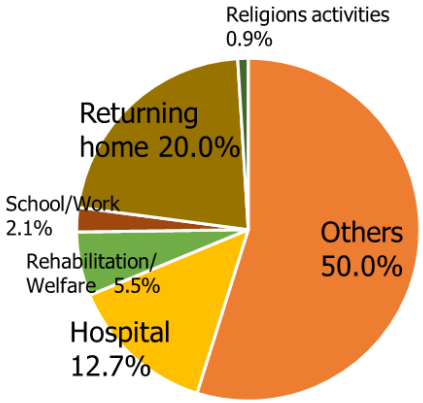
Current Status of ST

- Vehicles equipped with wheelchair boarding facilities for better mobility of the transportation vulnerable
- Demand responsive service prebooked on user's request
- Standard of supply : 1 vehicles per 150 people with mobility disability
- Average rate of supply : 86% (4,074 veh.)

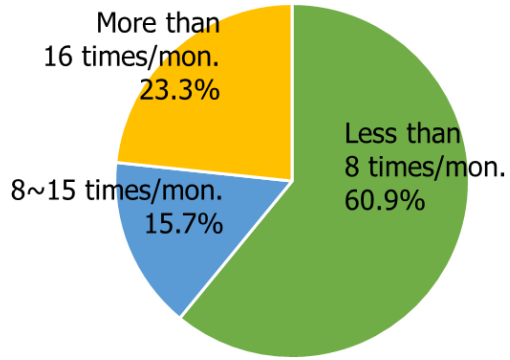




Usage characteristics



Purpose



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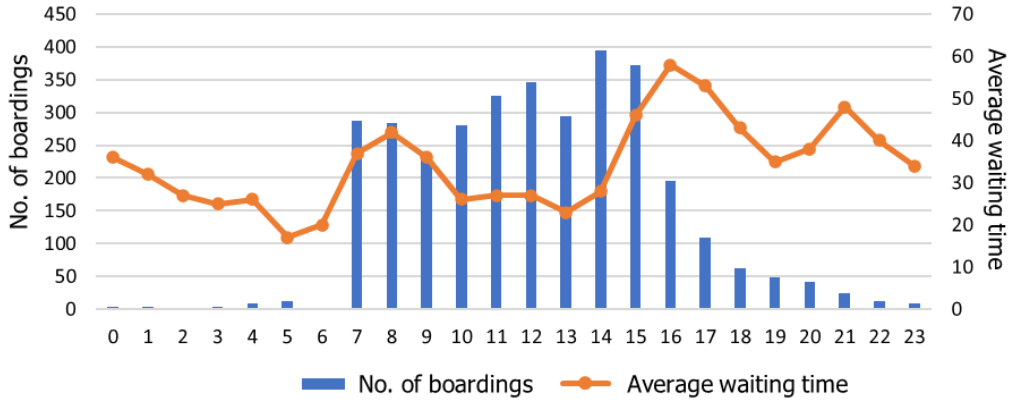
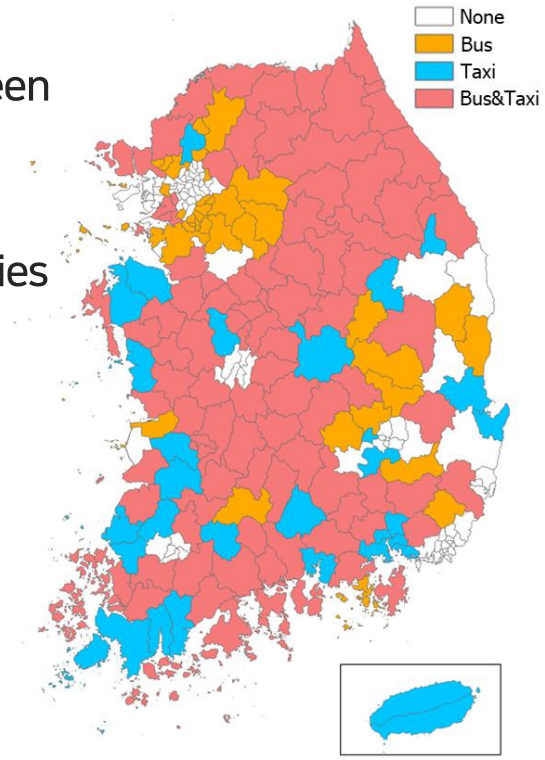


Time distribution

Rural and Urban DRT

Current Status of Rural & Urban DRT

- Started in rural areas at the beginning stage and expanded later to urban areas with lack of fixed PT services area
- Fares are lower than general taxi fare : so-called 10 cents taxi
- Operated by government subsidy to fill the gap between fare and operating costs : $154,000 per veh.
- Currently operated in 73 cities and 85 counties



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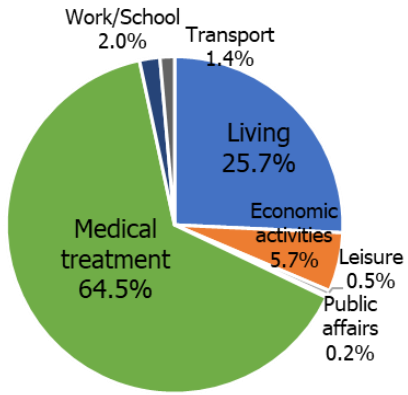

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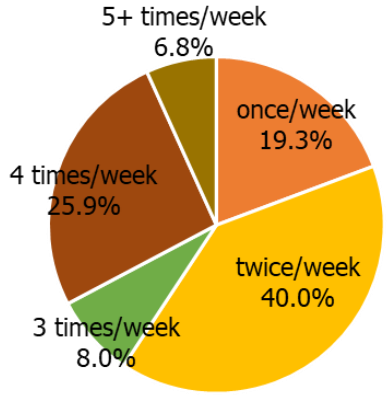

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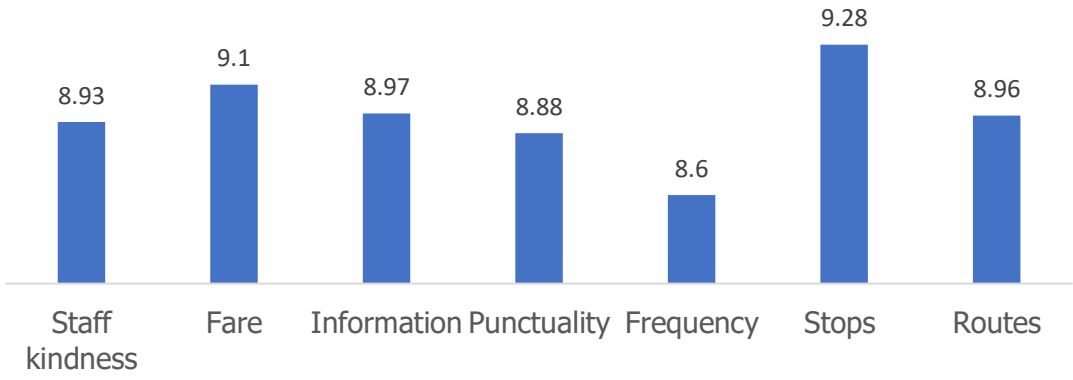


User satisfaction

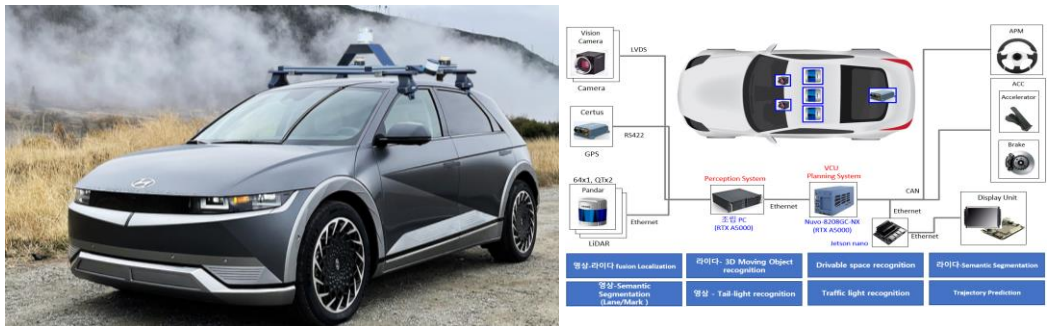
Technologies for Autonomous DRT

Level 4/4+ Autonomous Vehicles

AV for PWD (KIA Carnival)

- Wheelchairs can be loaded
- No. of passengers : Max 5 persons

AV for Rural DRT (Hyundai Ionic5)



- Small-sized vehicle considering road conditions in non-urbanized areas
- No. of passengers : Max 3 persons

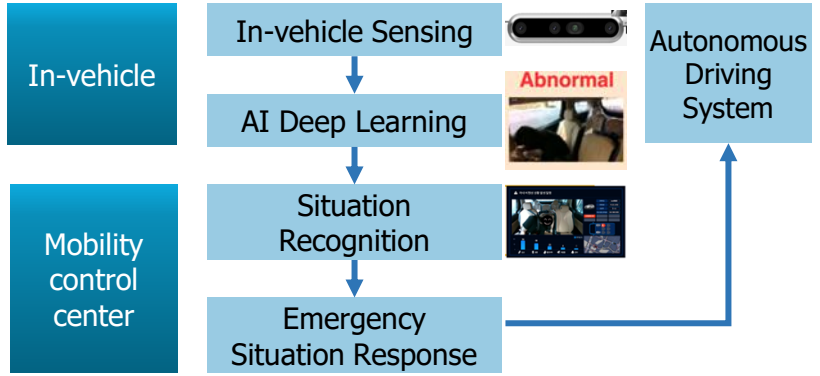
AI-powered in-vehicle passenger monitoring

Fully driverless operation on Lv4/4+ AVs

Concerns for unexpected situations in AVs

Real-time in-vehicle passenger monitoring

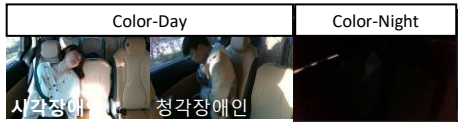
AI-powered monitoring algorithm process



Situation Scenario of vision-based passenger monitoring

AI Deep Learning Algorithm

Sample data collection



DL method

Supervised / Unsupervised BYOL Algorithm

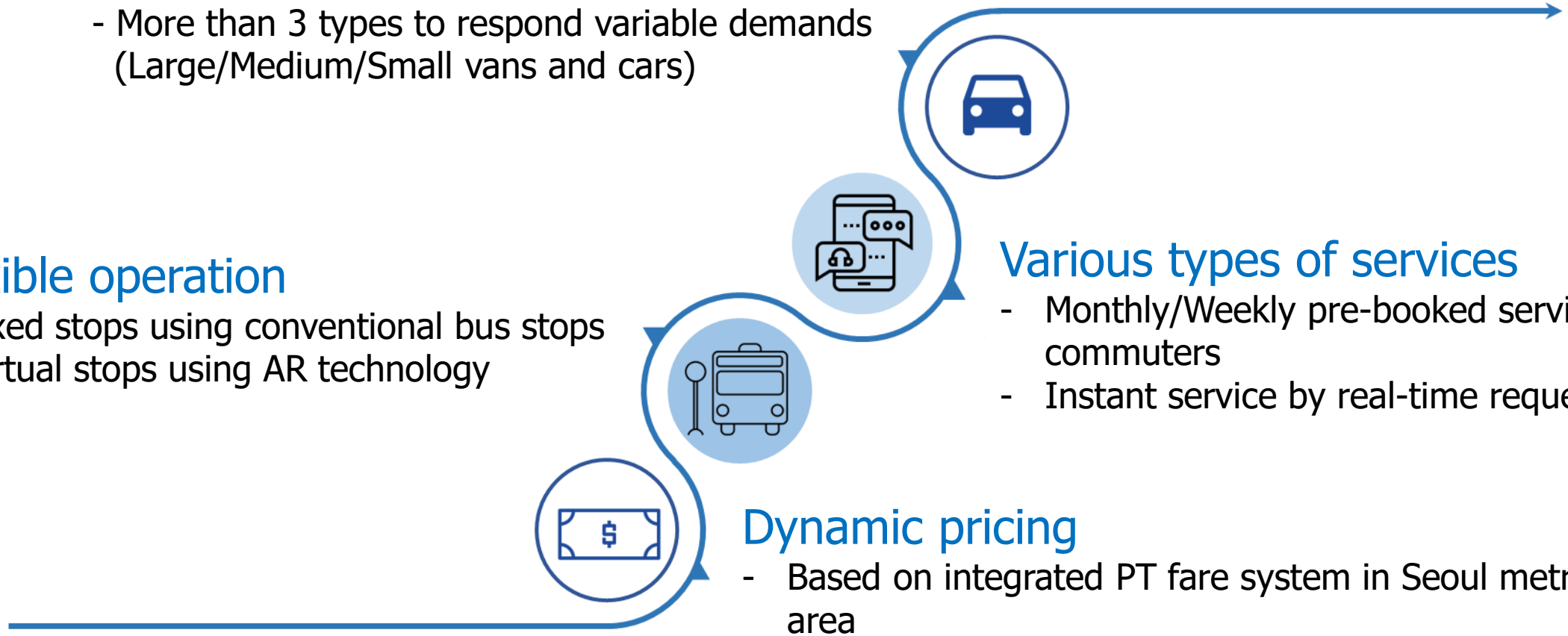
Learning Results

라벨링 정도	Color 이미지 분류 정확도	IR 이미지 분류 정확도	Depth 이미지 분류 정확도
1%	81.54%	78.72%	75.89%
10%	87.39%	88.75%	81.41%
100%	93.52%	97.04%	87.42%

Feature of Seoul Metropolitan DRT

Various fleet sizes

- More than 3 types to respond variable demands (Large/Medium/Small vans and cars)



Flexible operation

- Fixed stops using conventional bus stops
- Virtual stops using AR technology

Various types of services

- Monthly/Weekly pre-booked service for commuters
- Instant service by real-time requests

Dynamic pricing

- Based on integrated PT fare system in Seoul metropolitan area
- Flexible according to the size of demands and the types of purposes