The present and future of Demand Responsive Transport in Korea

Kyounga Park

Chief Director of Metropolitan & Urban Transport Research
The Korea Transport Institute
Why DRT?

- 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
History of DRT in Korea

- 2000: Free shuttle bus for PWD* and welfare taxi introduction
- 2006: Enactment of Act on Promotion of the transport convenience of mobility disadvantage persons
- 2007: Special transportation introduction
- 2008: Upward of Special transportation standard
- 2010: Metropolitan DRT/Tourism DRT pilot project launching
- 2012: Living-lab trial of Autonomous DRT
- 2014: Commercialization of Autonomous DRT
- 2018: 1st trial of rural DRT in Naju
- 2019: Expansion of 'Rural DRT'
- 2020: ‘Urban DRT’ introduction
- 2021: Enactment of Smart city act
- 2022: Expansion of Urban DRT
- 2023: 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
Technologies of Advanced DRT

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

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

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
LG U+
KNU T
CEST
NZERO
IST Mobility
AVs

User Behavior/Use case

Control System Technology
Service Technology

ICT
A2Z
ETRI
Future DRT: Seoul Metropolitan DRT Pilot Project

- **Flexible Stops**
  - Stop to visit: Next inbound DRT will arrive in 10 minutes.
  - Stop to pass: No DRT is scheduled to arrive.

- **App for users**
  - Real-time DRT routes tracking such as detour at request or nonstop passing.
  - Assignment reflecting user preference (min. stops, min. travel time, etc.)
  - Real-time fare calculation
  - Reservation and transaction

- **Traffic Control Center**
  - Real-time route change at request of user call

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

- **Project Partners**
  - Managing Agency: KRI (한국철도기술연구원)
  - kakao mobility
  - STUDIO G
  - (주)미래교통
  - 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

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*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.
THANK YOU

kapark@koti.re.kr
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 vehicle per 150 people with mobility disability
- Average rate of supply : 86% (4,074 veh.)

Purpose

Usage characteristics

- 50%
- ~70%
- ~80%
- ~100%
- 101%

8~15 times/mon. 15.7%
More than 16 times/mon. 23.3%
Less than 8 times/mon. 60.9%
Others 50.0%
Religious activities 0.9%
Hospital 12.7%
School/Work 2.1%
Rehabilitation/Welfare 5.5%

Purpose

No. of usage

Time distribution

Average waiting time

Staff kindness 74.7
Reservation convenience 70.1
Vehicle cleanliness 75.6
Safety 76.6
Fare 71.2

No. of boardings
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
0 50 100 150 200 250 300 350 400 450

Average waiting time
0 10 20 30 40 50 60 70
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

Usage characteristics

Purpose

- Work/School: 2.0%
- Transport: 14.4%
- Economic activities: 25.7%
- Medical treatment: 64.5%
- Leisure: 5.7%
- Public affairs: 0.5%
- None: 0.2%

No. of usage

- 5+ times/week: 6.8%
- 4 times/week: 19.3%
- 3 times/week: 40.0%
- Twice/week: 25.9%
- Once/week: 19.3%

User satisfaction

- Staff kindness: 8.93
- Fare: 9.1
- Information Punctuality: 8.97
- Frequency: 8.88
- Stops: 8.6
- Routes: 8.96
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 Deep Learning Algorithm

- Sample data collection
- DL method: Supervised / Unsupervised
- BYOL Algorithm
- Learning Results:
  - Color-Day: 87.54%, 87.31%, 83.49%
  - Color-Night: 97.20%, 97.03%, 87.42%
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