Enhancing Social Inclusion and Innovations in Urban Transport Systems in Asia–Pacific Cities Virtual Expert Group Meeting (EGM)

Inclusive Transport Services & the Best Practices

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Inclusive Transport and Mobility

- Universally convenient and safety for different user groups including those in low-income households, women, disabled persons, the elderly and transport users in rural areas. *(UNESCAP report)*
- Accessible and safe anytime & anywhere to everybody
- Providing a seamless mobility for the ones who do not have their own mobility.

**Who**
Equal access to transport for all

- Disabled, aged, children, rural area, etc.)
- Ones who do not have their own mobility

**What**
Accessible and safe anytime/anywhere

- Accessible to the vehicles, affordable to everybody, and available when/where people want
- Reducing traffic crashes that devastate families as well as the victims.

**Achievement of Inclusive Transport** = **Equal Mobility for All**
Objectives of Inclusive Transport

**Better mobility for general**
- Mitigating traffic congestion via relevant traffic information and effective traffic control
  - Real-time traffic information
  - Minimizing vehicle stops
  - Providing public transit arrival Info.

**Better mobility for disabled, VRU, and Rural area**
- Providing equal mobility to the ones who can’t afford their own mobility (including rural areas)
  - On-demand service
  - Wheelchair-accessible
  - App design for the elderly

**Sustainable cities**
- Achieving an Environmentally-quality-life by reducing vehicle emissions
  - Emission monitoring
  - Access control for emissions vehicles

**Increased safety through intelligent technologies**
- Avoiding dangerous situations by advanced technologies
  - Advanced Driver Assistant System
  - Pedestrian recognition by big data and artificial intelligence
  - Warning to vehicles

**Improved safety for Disabled and VRUs**
- Securing traffic safety of disabled, VRUs
  - Faster mobility for emergency vehicles
  - Reducing traffic crashes where VRUs are frequent

**Special treatment for high-risk sections**
- Safe and effective operation of vulnerable road sections and vehicles
  - Monitoring incidents at tunnels and bridges
  - Tracking hazmat transportation vehicles
## Applications

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<th>Smart Transport Services and Systems</th>
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<td>Real-time traffic information service</td>
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<td>Real-time adaptive traffic signal control</td>
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<tr>
<td></td>
<td>Bus Information System (BIS)</td>
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<td></td>
<td>Transit signal priority system</td>
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<td>Tag-less fare payment</td>
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<td>Smart lane control system</td>
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<td>Smart Parking</td>
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<td>Smart toll system</td>
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<td>Dynamic pricing</td>
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<tr>
<td><strong>Better Mobility for Disabled, VRUs, and Rural areas</strong></td>
<td>On-demand bus service</td>
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<td>Wheelchair-accessible shared mobility service</td>
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<tr>
<td><strong>Increased Safety Through Intelligent Technologies</strong></td>
<td>Advanced Driver Assistance System (ADAS)</td>
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<td>In-roadway digital signs</td>
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<td>Smart intersection system</td>
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<td>Public bike–sharing service</td>
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<td>Special mobility App. design for the elderly</td>
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<td><strong>Improved Safety for Disabled and VRUs</strong></td>
<td>Intersection collision warning system</td>
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<td>Smart crosswalk safety system</td>
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<td>Emergency vehicle priority system</td>
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<td>VRUs indoor navigation</td>
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<td><strong>Sustainable Cities</strong></td>
<td>School zone safety solution</td>
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<td>Smart bus shelter</td>
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<td><strong>Special Treatment for High-risk Sections</strong></td>
<td>Low emission zone (LEZ) access control and enforcement</td>
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<td>Old–diesel vehicle access control and enforcement</td>
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<td></td>
<td>IoT air quality monitoring</td>
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<td>Smart tunnel monitoring system</td>
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<td>Smart bridge monitoring system</td>
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<td>CVO fleet GPS tracking</td>
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## Better Mobility for General

<table>
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<tr>
<th>Smart Transport Services and Systems</th>
<th>Descriptions</th>
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<tr>
<td>Real-time traffic information service</td>
<td>Adjusting traffic signal timing by direction in accordance with traffic demand information detected by traffic detectors installed in each direction at a signalized intersection.</td>
</tr>
<tr>
<td>Real-time adaptive traffic signal control</td>
<td>Providing real-time traffic conditions and congestion information to drivers via in-vehicle navigation and variable message signs by the collected traffic volume and speed data from forward road sections.</td>
</tr>
<tr>
<td>Bus Information System (BIS)</td>
<td>Provide passengers with real-time information about the bus’s current location, next stop, arrival time, and other details via bus stop signage, internet homepage, and mobile app.</td>
</tr>
<tr>
<td>Transit signal priority system</td>
<td>Detect vehicles at signal intersections and give them priority where they have the right of way.</td>
</tr>
<tr>
<td>Tag-less fare payment</td>
<td>Contactless fare payment through communication between a Bluetooth beacon on the mobility vehicle and the user's mobile phone’s Bluetooth.</td>
</tr>
<tr>
<td>Smart lane control system</td>
<td>Design effective traffic flow by detecting traffic volume and congestion and allowing (X) lane usage through lane control signals as needed.</td>
</tr>
<tr>
<td>Smart Parking</td>
<td>Sensors and cameras in parking lots provide real-time visibility into the location and status of parking spaces and guide drivers to parking spots, saving time and reducing greenhouse gas emissions.</td>
</tr>
<tr>
<td>Smart toll system</td>
<td>Tolling and relieving traffic congestion in non-stop high-speed driving environments by applying Wireless Area Networking for Vehicles (WAVE) on multi-lane roads.</td>
</tr>
<tr>
<td>Dynamic pricing</td>
<td>Fluidly measure the price of a good/infrastructure/service using supply and demand, competitor prices, and other historical or current external factors in the marketplace.</td>
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## Applications for Better Mobility

### Better Mobility for Disabled, VRUs, and Rural areas

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<th>Smart Transport Services and Systems</th>
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<td><strong>On-demand bus service</strong></td>
<td>Provide efficient transportation to destinations by scheduling vehicles based on passenger demand rather than a set route</td>
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<td><strong>Wheelchair-accessible shared mobility service</strong></td>
<td>A shared transportation service that is also accessible to people who use wheelchairs, giving them freedom of movement and the opportunity to participate in society</td>
</tr>
<tr>
<td><strong>Public bike-sharing service</strong></td>
<td>Provide efficient transportation to destinations by scheduling vehicles based on passenger demand rather than a set route</td>
</tr>
<tr>
<td><strong>Special mobility App. design for the elderly</strong></td>
<td>Providing a special smartphone app. GUI (bigger texts and icons, call to the operators, and emergency calls) for the elderly</td>
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## Applications for Sustainability

### Sustainable Cities

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<tr>
<td>Low emission zone (LEZ) access control and enforcement</td>
<td>Reduce urban pollution and improve air quality by restricting the operation of older, polluting vehicles in certain areas.</td>
</tr>
<tr>
<td>Old-diesel vehicle access control and enforcement</td>
<td>Restrict the entry of older diesel vehicles in certain areas to reduce urban pollution and air quality</td>
</tr>
<tr>
<td>IoT air quality monitoring</td>
<td>Analyze real-time data collected by air quality monitoring sensors to identify pollution sources and provide air quality information to users</td>
</tr>
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Source: [https://www.asiatime.co.kr/article/20220103500027#_enliple#_mobwcvr](https://www.asiatime.co.kr/article/20220103500027#_enliple#_mobwcvr)
# Applications for Improved Safety

## Increased Safety Through Intelligent Technologies

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<th>Smart Transport Services and Systems</th>
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<tr>
<td><strong>Advanced Driver Assistance System (ADAS)</strong></td>
<td>Help drivers operate their vehicles safely by using automated technologies such as sensors and cameras to detect nearby obstacles or driver behavior and respond accordingly</td>
</tr>
<tr>
<td><strong>In–roadway digital signs</strong></td>
<td>Provide drivers with the real-time information they need, including nearby traffic, weather, and unexpected events</td>
</tr>
<tr>
<td><strong>Smart intersection system</strong></td>
<td>Detect vehicles entering intersections in each direction and measure service levels to optimize signal cycles and green times and create optimal traffic conditions</td>
</tr>
<tr>
<td><strong>Intersection collision warning system</strong></td>
<td>Provide warnings about vehicles entering intersection to improve driver awareness and help prevent collisions</td>
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# Applications for Improved Safety

## Improved Safety for Disabled and VRUs

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<th>Smart Transport Services and Systems</th>
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<tr>
<td><strong>Emergency vehicle priority system</strong></td>
<td>Prioritize the shortest route to help emergency vehicles get there faster when they respond to an emergency call</td>
</tr>
<tr>
<td><strong>School zone safety solution</strong></td>
<td>Improve child safety around schools by encouraging vehicles to drive slower in childproofed zones with radar speed displays, audible alerts, and guidance beacons.</td>
</tr>
<tr>
<td><strong>Smart crosswalk safety system</strong></td>
<td>Assist vehicles detection of pedestrian and allow pedestrians to cross safely by Floor signals, voice prompts and spotlights</td>
</tr>
<tr>
<td><strong>VRUs indoor navigation</strong></td>
<td>Provide information to help pedestrians, cyclists, scootetists, and others know their indoor spaces and get to destination safely.</td>
</tr>
<tr>
<td><strong>Smart bus shelter</strong></td>
<td>Equip ‘Smart Shelter’, a future-proof integrated system at bus stops that provides various services such as city weather, real-time public transportation information, air quality information, advanced ICT facilities such as Wi-Fi and charging stations, and connectivity to emergency services.</td>
</tr>
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### Special treatment for High-risk Sections

<table>
<thead>
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<th>Smart Transport Services and Systems</th>
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<tr>
<td>Smart tunnel monitoring system</td>
<td>Support tunnel safety, security, and maintenance with sensors that monitor and measure physical parameters of the tunnel.</td>
</tr>
<tr>
<td>Smart bridge monitoring system</td>
<td>Continuously monitor bridge movements, vibrations, and structural changes to check bridge health and optimize maintenance cycles to improve safety.</td>
</tr>
<tr>
<td>CVO fleet tracking and monitoring</td>
<td>Optimize operations for vehicle routing and dispatching and improve transportation efficiency by tracking vehicle locations in real time and monitoring transportation status.</td>
</tr>
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![Tunnel/Bridge lane control system (LCS)](source: www.joongang.co.kr/article/25149743#home)

![CVO fleet tracking](source: www.damoov.com/telematics-based-vehicle-tracking-for-fleet-management)
Best Practices (1) – Urban Solutions

**Smart crosswalk, Republic of Korea**
- [Image of smart crosswalk]
- Extend green time by 3 to 13 seconds for elderly and Persons With Disabilities (PWD) at pedestrian crossings
- To activate it, tapping a CEPAS-compliant senior citizen card or PWD concession cards on the reader

**Green Man+, Singapore**
- Extend green time by 3 to 13 seconds for elderly and Persons With Disabilities (PWD) at pedestrian crossings
- To activate it, tapping a CEPAS-compliant senior citizen card or PWD concession cards on the reader

**Tagless payment, Republic of Korea**
- Developed by T-money Co., Ltd.
- Pilot services in Seoul
- Sensing a smartphone Bluetooth signal and communicating with the fare system server, then pay
- Source: [https://www.chosun.com/national/national_general/2023/07/21/ZEH7BEC6Q5CBNG4FUTA5DJ5Z64/](https://www.chosun.com/national/national_general/2023/07/21/ZEH7BEC6Q5CBNG4FUTA5DJ5Z64/)

**Contactless fare payment, Singapore**
- “SimplyGo”
- Launched in April 2019
- Automatically deducted from the linked mobile wallet or bank account by scanning a smartphone
Best Practices (2) – Barrier-free VRU Services

**Barrier-Free Service**, Busan, Republic of Korea

**Barrier-free navigation**
- Installed 4500 beacons spaced 20 meters apart on the 114 metro stations (lines 1–4)
- Communication between barrier-free navigation apps on smartphones and indoor positioning devices in the field
- Augmented reality and voice guidance

**Barrier-free station**
- Installed near Busan KTX station and around Sujeong-dong, Dong-gu, Busan, Korea
- Provide transportation waiting areas for all citizens including VRUs
- CCTV for security, air conditioning, emergency bell, KIOSK, heated chairs, Wi-Fi, etc.

**Barrier-free DRT**
- Operating DRT service for VRUs in Dong-gu
- Governance among Busan City Hall, DRT service provider, and VRU-related organizations in the region
- Hailing a DRT vehicle via phone or smartphone app

Selected for 2022 Smart Challenge Project
Ministry of Land, Infra., and Transport, Republic of Korea

Source: news.heraldcorp.com/view.php?ud=201810311000206
Source: news.mt.co.kr/mtview.php?no=2020080316068281643
Source: www.mk.co.kr/economy/view.php?sc=50000001&year=2022&no=29619
Source: Busan Smart City Challenge, http://bsc.itrocks.kr/
Best Practices (3) – Demand Responsive Transit

Bus with flexible route and schedule based on real-time demand

- Applying fares similar to existing public transportation
- Utilizing high-capacity vehicles
- Operating on flexible routes with certain limitations
- Focusing on operation in small and medium-sized cities – for welfare purposes

<table>
<thead>
<tr>
<th>Area (USA)</th>
<th>Sacramento</th>
<th>Des Moines</th>
<th>North County</th>
<th>Central Florida</th>
<th>State of Utah</th>
<th>San Joaquin</th>
<th>Denver</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fare rate</td>
<td>Flat rate</td>
<td>Flat rate</td>
<td>Differential rate</td>
<td>Flat rate</td>
<td>Flat rate</td>
<td>Flat rate</td>
<td>Flat rate</td>
</tr>
<tr>
<td>DRT Fare</td>
<td>$2.5</td>
<td>$1.75</td>
<td>$5 (<del>30km) $10 (30km</del>)</td>
<td>$2</td>
<td>$3.75</td>
<td>$3</td>
<td>$3</td>
</tr>
<tr>
<td>Regular bus fare</td>
<td>$2.5</td>
<td>$1.75</td>
<td>$2.5</td>
<td>$2</td>
<td>$2.5</td>
<td>$1.5</td>
<td>$2.8</td>
</tr>
</tbody>
</table>

Combining Strengths

Wheelchair-accessible on-demand transit
City of Edmonton, Alberta, Canada
Source: https://www.jan.kr/article/20180128631291

DRT for rural area
Jeonlabuk-do, South Korea
Source: https://www.jjan.kr/article/20180128631291

Source: https://www.ciel.co.kr/
Lessons Learned

Social issues (aging, regional decline) and global issues (climate change) have come to the fore of transportation sector.

- Demand-responsive transit (DRT), barrier-free transport services, IoT emission sensors, electric vehicles, etc.

Paradigm of smart transport services is changing to fill the gaps.

- From congestion mitigation to traffic safety improvement in past decades.
- Traffic safety continues to be an area of focus, it sheds a light on disabled, VRUs, and rural areas.

Software technologies to the smart transport service solutions

- Based on the software technologies (Big Data, A.I., platform tech., smart phone app.)
- Smart transportation services are no longer the preserve of developed countries, rather developing countries are taking a big step to leapfrog the general stage of technology development.
- Nevertheless, physical infrastructure and devices are still important and are evolving to high speculation.

  e.g., A.I. pedestrian recognition, high-resolution camera, LiDar traffic detectors, etc.
Lessons Learned

- Shared mobility services is becoming an alternative to many social issues and problems.
  - For the one who needs mobility in a short-term.
  - For the one who can’t drive or move by its own capacity.
  - For the region where traffic demand is sporadic over a large area.
  - For the region/time that public transit does not operate.

- Previous
  Only focused on the substitution effect of sharing cars for regular cars

- VRU solutions are becoming more sophisticated and caring.
  - Smart crosswalk, smart shelter, VRU app GUI, and indoor navigation

- Not many feasible solutions, despite the importance of sustainability and a clean environment
  - Still limited to emission monitoring and old diesel vehicles enforcement. It needs creative and proactive services
Locations of pilot projects and demonstrations with automated shuttle buses on public roads and private premises in Europe since 2008

- Frankfurt am Main, DE
- Hamburg, DE
- Aachen, DE
- Weeze Airport, DE
- Lahr, DE
- Neustadt/Weinstrasse, DE
- Sylt, DE
- BodBIrnbach, DE
- Winterhavens/Dossie, DE
- Berlin, DE
- Leuca, DE
- Tranjura, GD
- Dublin, IR
- Christchurch, NZ
- Turin, IT
- Luxembourg, LU
- Coventry, UK
- Salford, NO
- Gjovik, NO
- stavanger, NO
- Faroe Islands, NO
- Oslo, NO
- Kongsberg, NO
- Trondheim, NO
- Gdansk, PL
- Canterbury, SE
- Donostia/San Sebastian, SP
- Vanzuik, SE
- Stockholm, SE
- Gothenburg, SE
- Lausanne, CH
- Neuhauzen, CH
- Geneva, CH
- Zug, CH
- Zren, CH
- Bern, CH
- Fribourg, CH
- Cossonay, CH
- Appelscha, NL
- Drimmelen, NL
- Noordwijk, NL
- The Hague, NL
- Rotterdam, NL
- Scheemda, NL
- Amsterdam Schiphol-Haarlem Airport, NL
- Wageningen, NL
- Heathrow PRT, UK
- Devorsey, UK
- Milton Keynes, UK
- Edinburgh, UK
- London, UK
- Manchester, UK

- Demonstration project
- Planned for 2020
- Multiple pilot projects

Source: the authors, based on Alessandrini (2016), Ainsalu et al. (2018) and Hagenzieker et al. (2020)

Locations of pilot projects and demonstrations with automated shuttle buses on public roads and private premises in Europe since 2008

**Just one more thing**

**Game changer for inclusive transportation or just wishful thinking?**

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Thank You

Inclusive Transport Services & the Best Practices

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