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Transforming Transportation

: Automation, Decarbonization & Sharing

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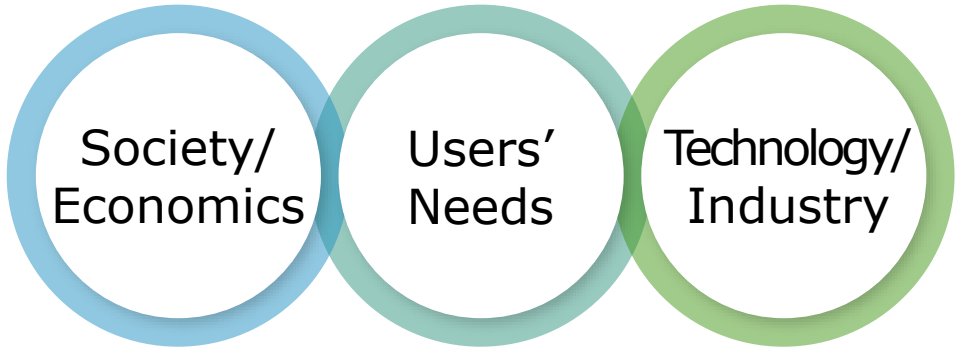
1. Evolution of Transport and Challenges of Future Mobility

Evolution of Transport System

Evolution of transport system

Century	Mode of high growth rate
17th - 18th	Canal
18th - 19th	Rail
19th - 20th	Road(auto)
20th – 21st	Air
After 21st	???

Challenges of future mobility



1. Minimizing congestion, accident and environmental costs
2. Satisfying individual demand and enhancing mobility service
3. Revitalizing the economy and transport industry
4. Strengthening global competitiveness in transportation sector

Externalities of Transport

Choice of each individual influences the entire society
* Internal cost : paid directly by the individual, reflected in market price
* External cost : affects third parties but not reflected in market price

Congestion Cost

- (Internal) Travel Time
- (External) Congestion cost passed on to other travelers

※ 59.62 Trillion KRW
(2017 in Korea, 3.4% of GDP)

Accident Cost

- (Internal) Insurance, repair costs, hospital costs
- (External) Mental and physical pain by others

※ 40.06 Trillion KRW
(20 of GDP)

Environmental Cost

- (Internal) Discomfort due to deterioration of environment
- (External) Damage to people and property due to noise and/or air pollution

※ 30.99 3 in Korea)

Challenges of Future Mobility

Traditional Transportation Policy Efforts

- Infrastructure Development


- Responding to Motorization

- Public Transport Promotion


Factors Accelerating Transport Transformation

- Responding to Climate Change
  : Decarbonization, Electrification
- Advancement of 4th Industrial Revolution
  : Hyper-intelligence/connectivity
- Demographic Changes
- Global Pandemic

Decisive Decade for Transport Transformation (2021-2030)

Future of Mobility: Major Challenges

- People-centered mobility
  : Green, Smart, Affordable
- Upgrading public transport
  : Access, Integration, Convenience
- Digitalization
  : C-ITS, 5G, IoT, ADAS
- Mass-Electrification
- Logistics: Automation, Digitalization, Decarbonization
- Point to Point Flying
  : Delivery Drone, Air Taxi
- Financing
  : R&D, innovation, infrastructure

2. Megatrends & Impacts to Future Transport

Climate Change Crisis

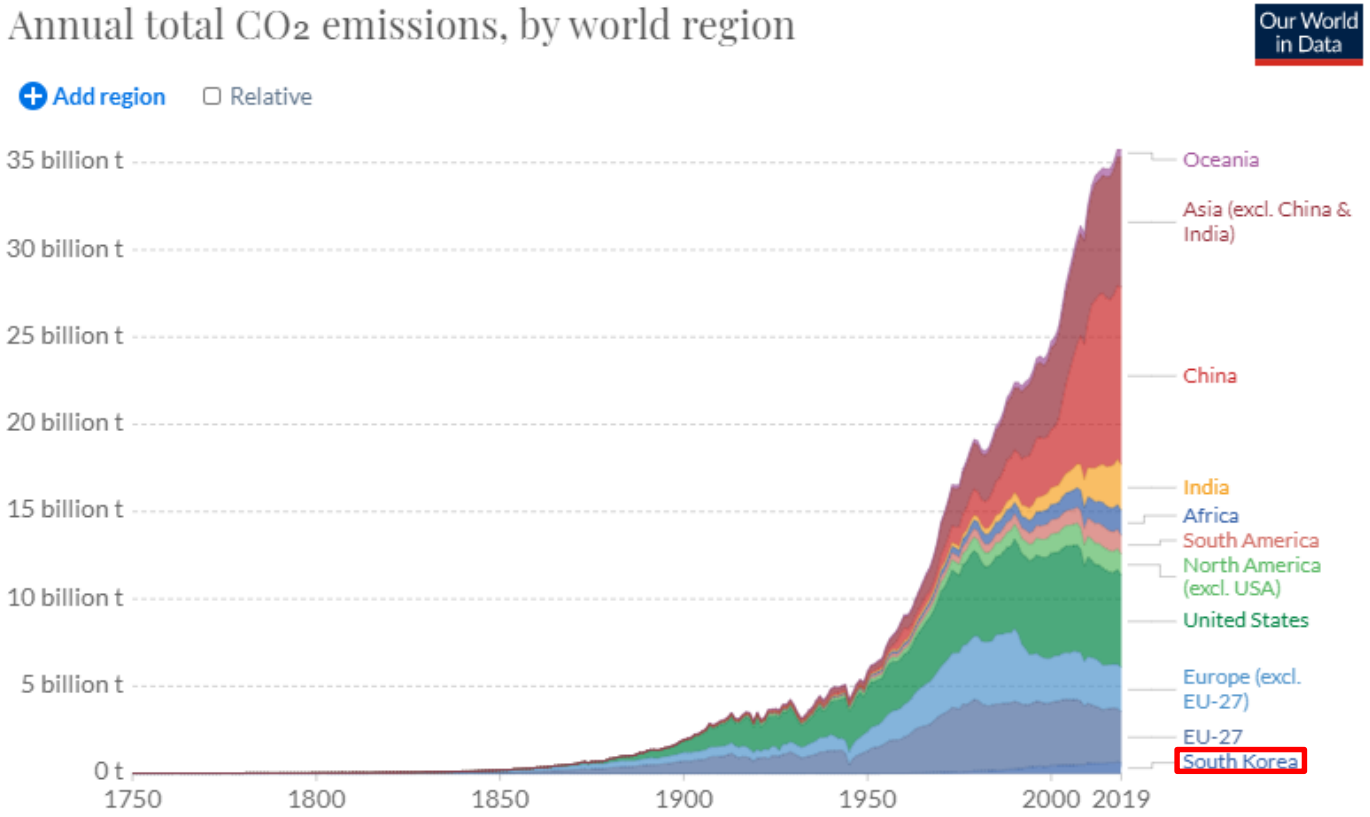
4th Industrial Revolution

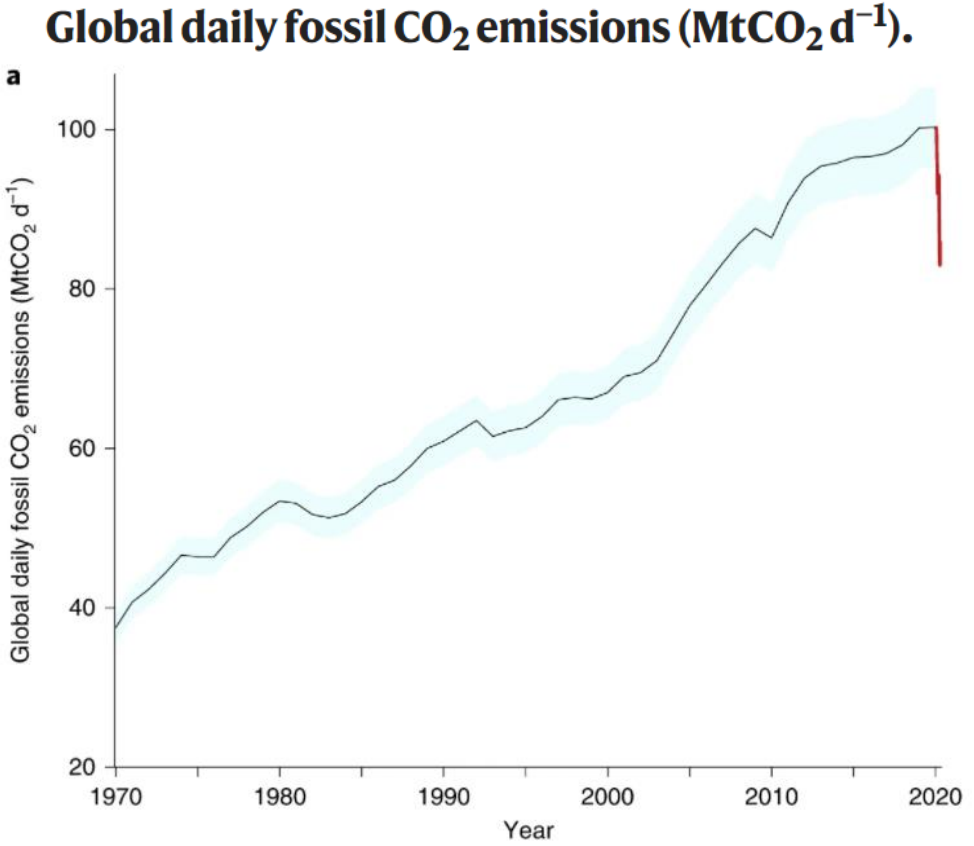
COVID-19 Pandemic

Demographic Structural Change

Climate Change Crisis and Transport Responding

- Global CO2 emissions reached approximately 35 billion tons (2019)
- UN IPCC Report (Aug 2021): a global consensus on "unequivocal" global warming and climate crisis
  - Global warming is likely to reach 1.5℃ within 20 years
  - Global warming will intensify extreme weather (heatwaves, heavy precipitation, droughts, melting of ice)

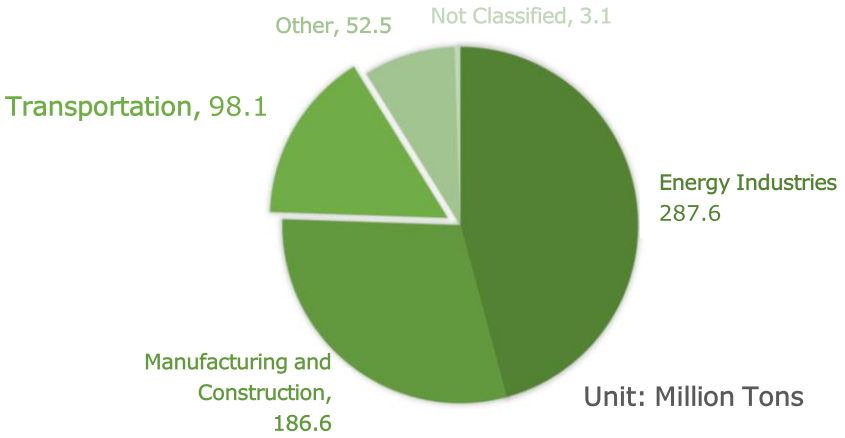


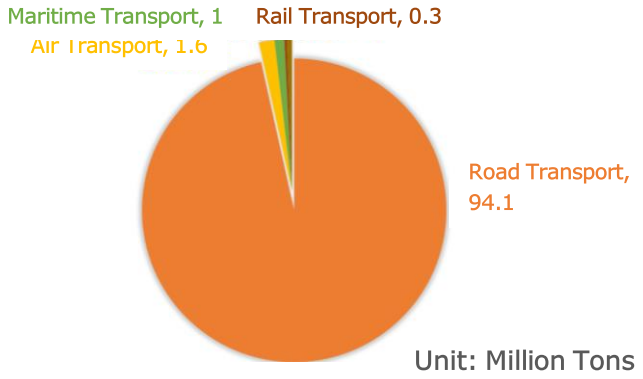


Source: (L) Our World in Data , (R) Nature Climate Change

2. Megatrends & Impacts to Future Transport

- In Korea, emissions from transportation sector accounts for 13%(98 mil. tons) of total emissions





- Dec. 7, 2020: "2050 Carbon Neutral Strategy" announced
- Aug. 2021: 2050 Carbon Neutral Scenarios(draft) announced

[Million tons of CO_2eq]

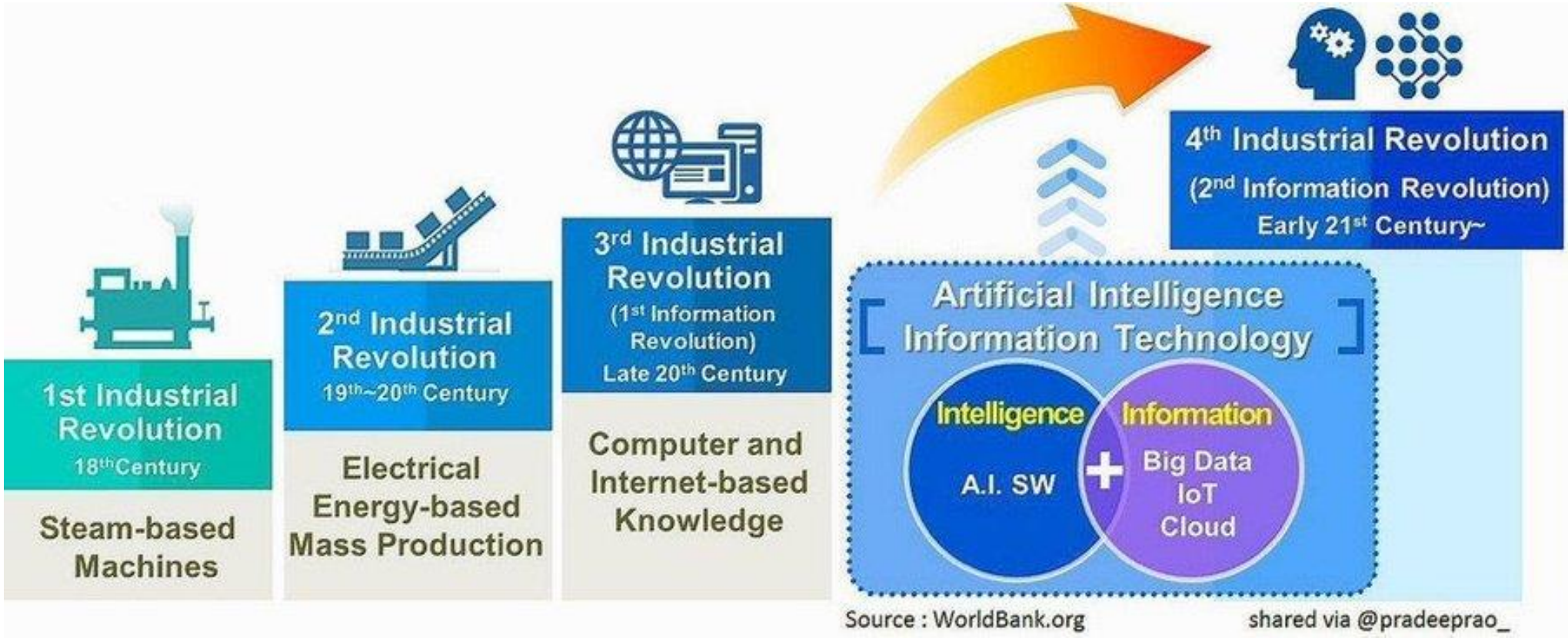
Scenario	Net Emission (2050)	Transport Net Emission (2050)
Scenario1	25.4	11.2
Scenario2	18.7	11.2
Scenario3	Net Zero	2.8

- Nov. 2021: Updated 2030 NDC* to be submitted at COP26

* NDC: Nationally Determined Contribution

Rapid advancement of 4th Industrial Revolution

- 4th Industrial Revolution : Economic and Social Innovation/Change based on convergence of ICT (AI, IoT, Big Data, Cloud)



2. Megatrends & Impacts to Future Transport

- Based on hyper-intelligence and hyper-connectivity, transport sector will go through rapid change in the coming decade(2021-2030)
- Traditional externalities caused by motorization are likely to be resolved

Smart Mobility

Automation

Autonomous

Drone

Electrification

Electric Vehicle

Sharing/Integration

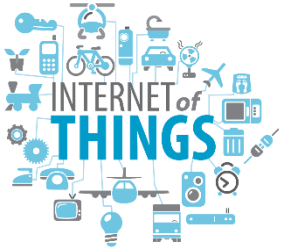
Shared Transport

Integration

Technology

AI

IoT



Big-data

Cloud

Solution

Safety

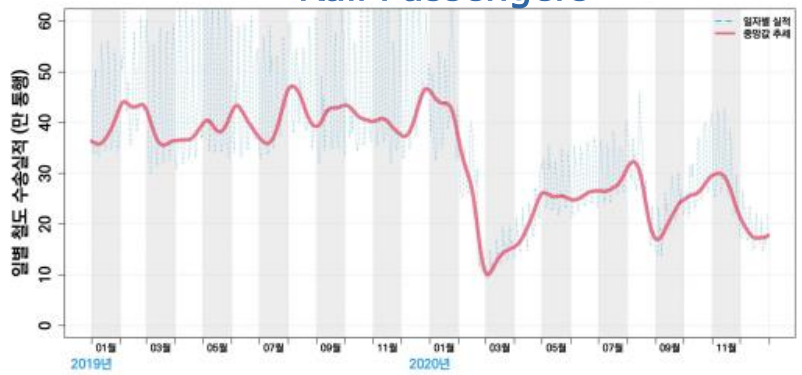
Traffic

Environment

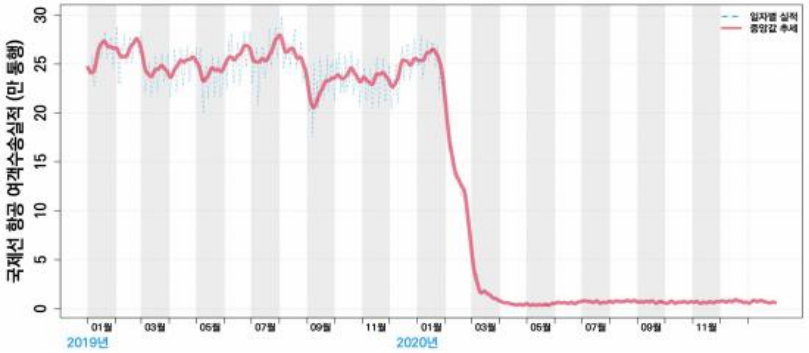
Impacts of COVID-19 Pandemic

- Decrease in traffic and ridership, public transport and aviation industry hard hit
- Increase in personal mobility, and more effective anti-infection measures for public transport required
- Great increase in deliveries and logistics, global supply chain affected
- COVID19 pandemic will put economy, urban structure and transport behavior in a more interrelated way

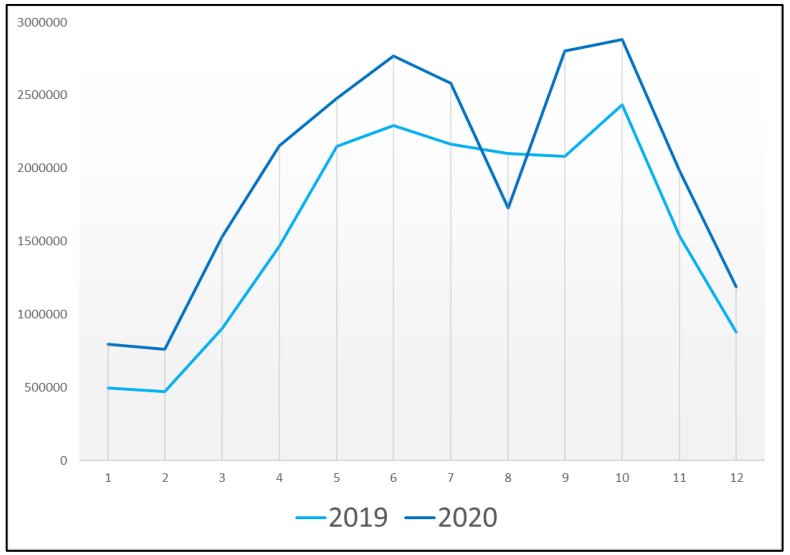
Rail Passengers



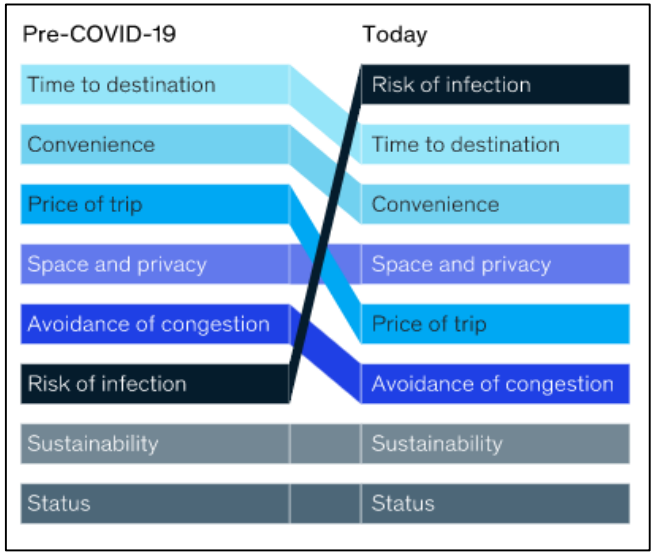
International Air Passengers



Bike-Sharing (Seoul)



Factors of Affecting Travel Behavior



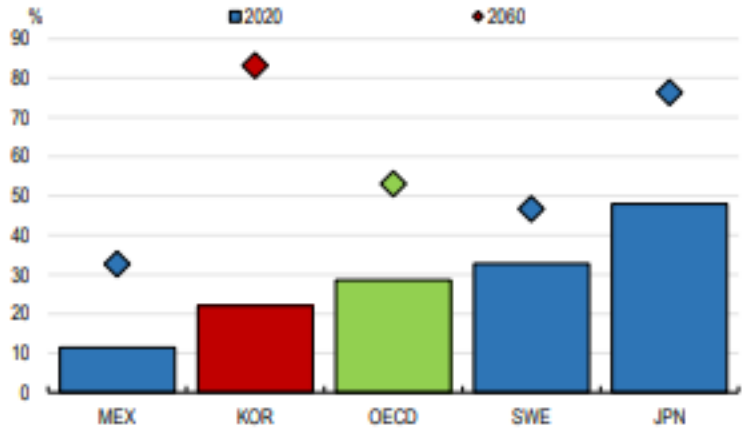
Source: 2021 Transportation Logistics Trends Issue Report, KOTI

McKinsey&Company, "Five COVID-19 effects shaping mobility's future", 2020.09.

Implications from Demographic Structural Change

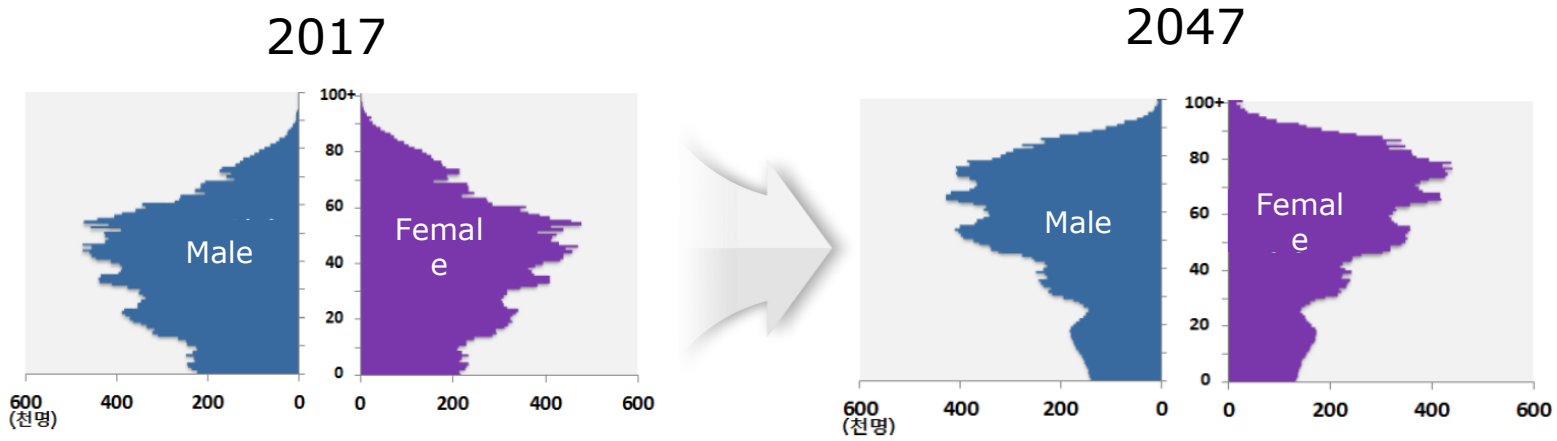
- Rapid aging population and low birth rate → demographic structural change
  - Population in rural and small/medium city collapsing
  - Productive capacity decreasing due to shrinking labor force
  - New mobility service for aged population required

Ratio of population aged 65 and over to population aged 15-64



20% (2020) → over 80% (2060)

Change in Demographic Structure in Korea (2017-2047)

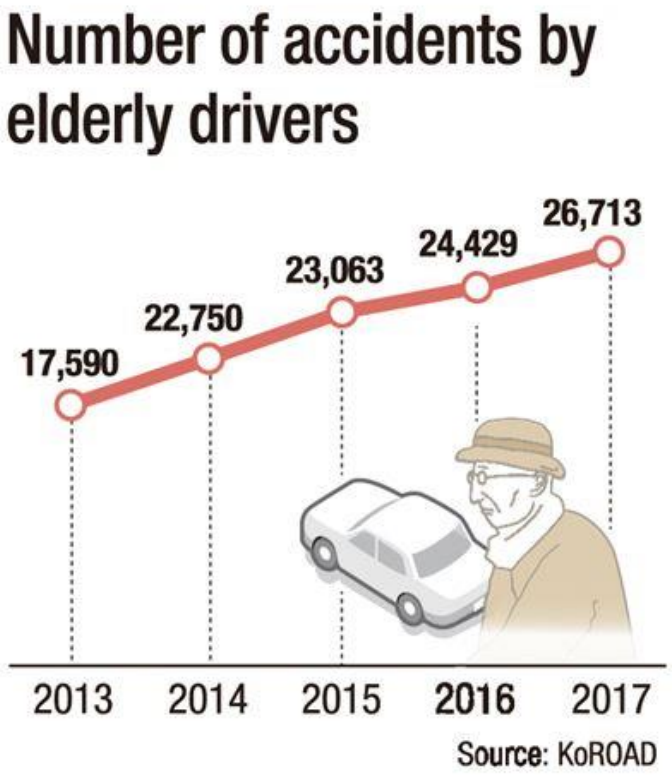


Source: (L) Economic Surveys: Korea(2020), OECD
(R) Statistics Korea

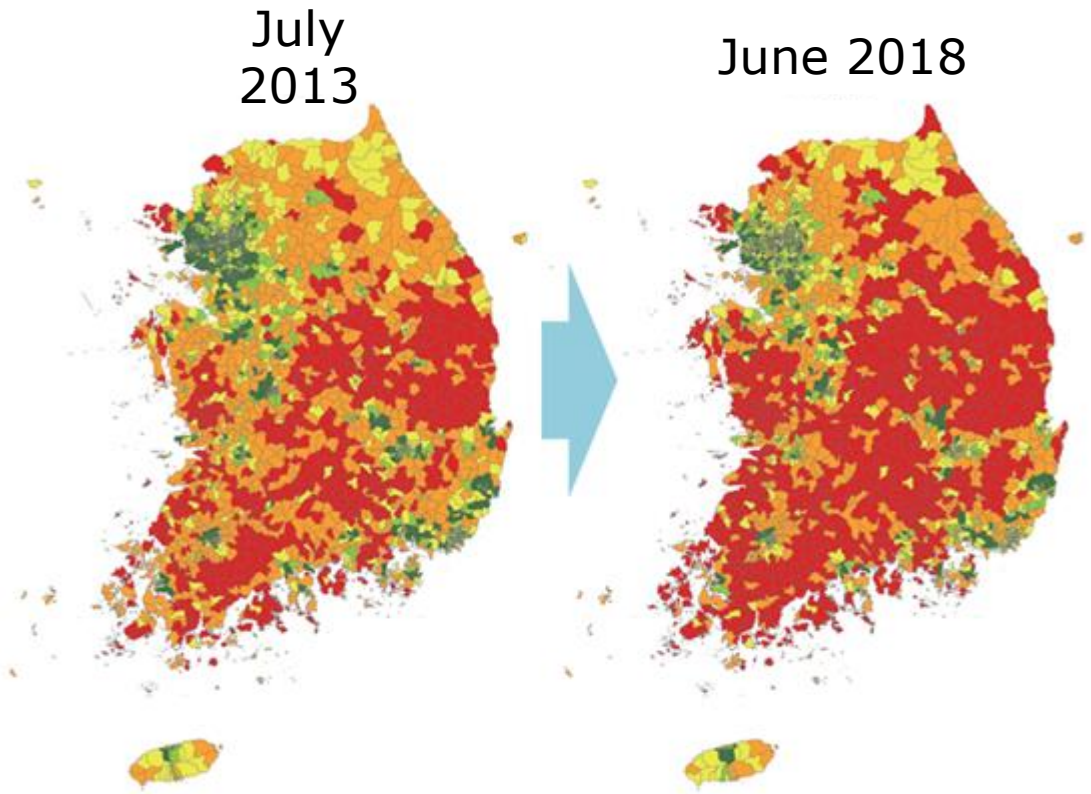
2. Megatrends & Impacts to Future Transport

- Mobility issues from demographic structural change
  - Increase in traffic accident rate for elderly people
  - Transport imbalance between regions

Accidents by elderly drivers



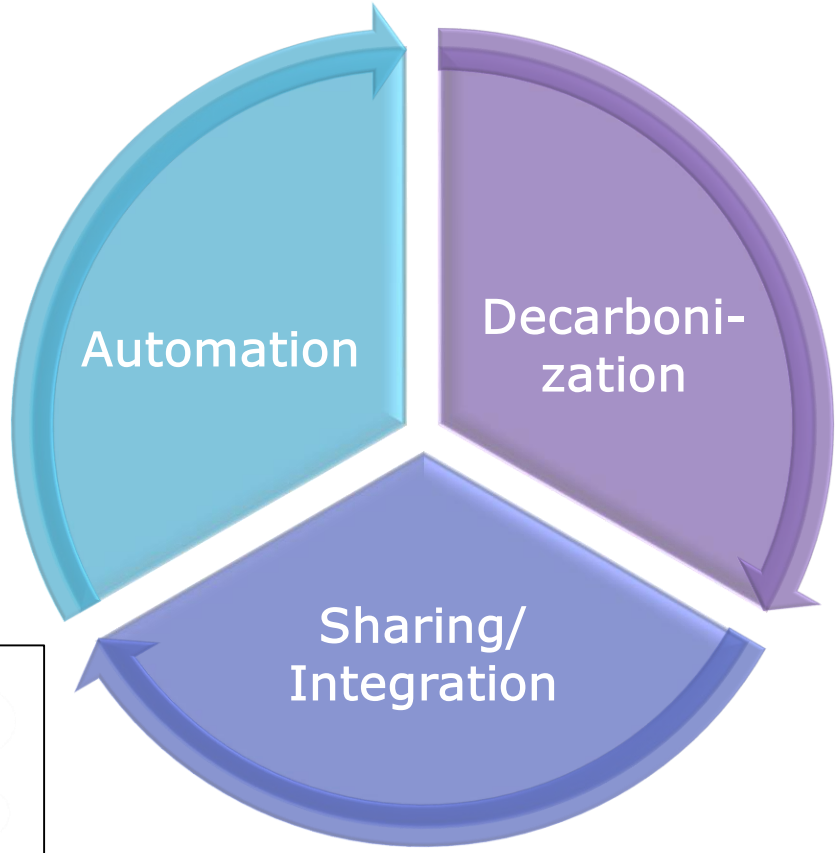
The Threat of Local Extinction



3. Direction of Transforming Transportation

Three directions of transportation transformation are likely to move forward

- Autonomous driving
- Unmanned aerial vehicles



- Reaching carbon neutral
- HEV, FCV, EV

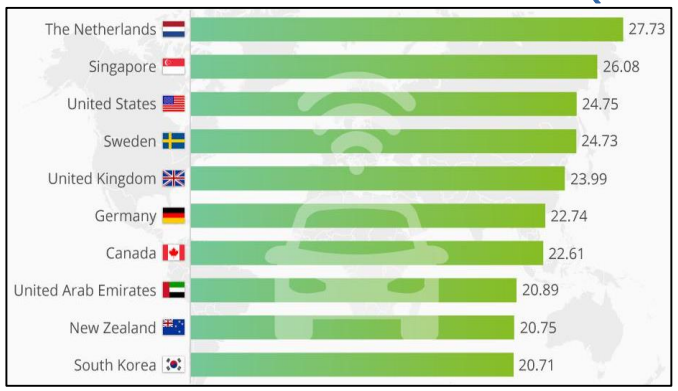
- Shared transport
- Integrated mobility (MaaS)

3. Direction of Transforming Transportation

Direction 1: Automation

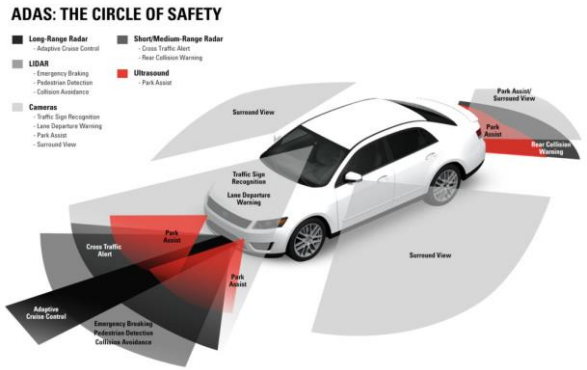
- Experimental projects on autonomous vehicles and UAVs in progress but commercialization uncertain
- Approaches for autonomous vehicles: Robotaxi(Top-down) vs. ADAS(Bottom-up)

Autonomous Vehicle Readiness(2018)



Robotaxi(Amazon)

ADAS



Socio-Economic Impact

- Increase in road capacity (1.5~3 times)
- Decrease in traffic accident (80~90% ↓)
- Decrease in commuting time and social costs (congestion)

Key Issues

- Decrease in employment : Social security net expansion required
- Security, Safety and Privacy
- Public Compliance and Social Conflict

Direction 2: Decarbonization

- Ambitious plans by the government for penetration of electric & hydrogen vehicles
- Present penetration rate is low, but future penetration is forecast to be high

Penetration rate of eco-friendly vehicles (2015, 2021)

Fuel Type	2015	%	May 2021	%
Gasoline	9,808,633	46.7	11,578,408	47.2
Diesel	8,622,179	41.1	9,936,438	40.5
LPG	2,257,447	10.8	1,965,331	8.0
Electric	5,712	0.0	159,851	0.7
Hydrogen	29	0.0	14,532	0.1
Hybrid	174,620	0.8	764,583	3.1
Other	121,265	0.6	131,752	0.5

2050 Carbon Neutrality Plan - Scenarios

Scenario	Penetration rate of Eco-friendly vehicles(2050)
Scenario1	76%
Scenario2	76%
Scenario3	97%

Socio-Economic Impact

- Industry of electric vehicles are challenged
- Individual behavior on automobile purchasing will be changed

Key Issues

- Role of electric and hydrogen-electric vehicles (electric-compact, hydrogen-large, public transport)
- Financing mass-electrification of vehicles
  : Building charging infrastructure
  : Battery price competitiveness

Direction 3: Sharing/Integration

Classification of Shared Mobility

- **Mass Transit**
  - Traditional Public Transit (Subway, Bus, etc.)
  - Demand-Responding Services
- **Individual Mobility**
  - Car Mobility
    - Car-sharing
      : Flexible version of rent-a-car (with/without a driver)
    - Ride-Hailing
      : commercial operation using non-commercial vehicles(with a driver)
  - Micro Mobility (Personal Mobility Devices. Bicycles)

Socio-Economic Effect

- More convenient service
  : User-oriented services
  : Lower user costs
- Changes in land-use
  : Smaller parking space required
  ⇒ land can generate higher value

Key Issues

- Decline in auto ownership
  : Auto industry less competitive
- Decline in public transit ridership
  : 12% decrease in ridership(San Francisco, 2019)
- Social conflict against existing transport industry
  : Passenger Transport Service Act amended(Korea, 2020)

3. Direction of Transforming Transportation

Transport Integration

- Making design of infrastructure and operation of transport modes into
  - a seamless transportation from origin to destination
  - to meet users' needs
  - in a sustainable way

Planning& Investment

- Land Use & Transportation
- Balanced Investment (Road-Rail, Link-Node)

Design& Construction

- Network Design(Hub&Spoke)
- Nodal Facilities (Transfer Facility)

Operation

- Scheduling / Fare & Payment / Information
- On-demand, user-oriented mobility service
- MaaS using Platform Technology

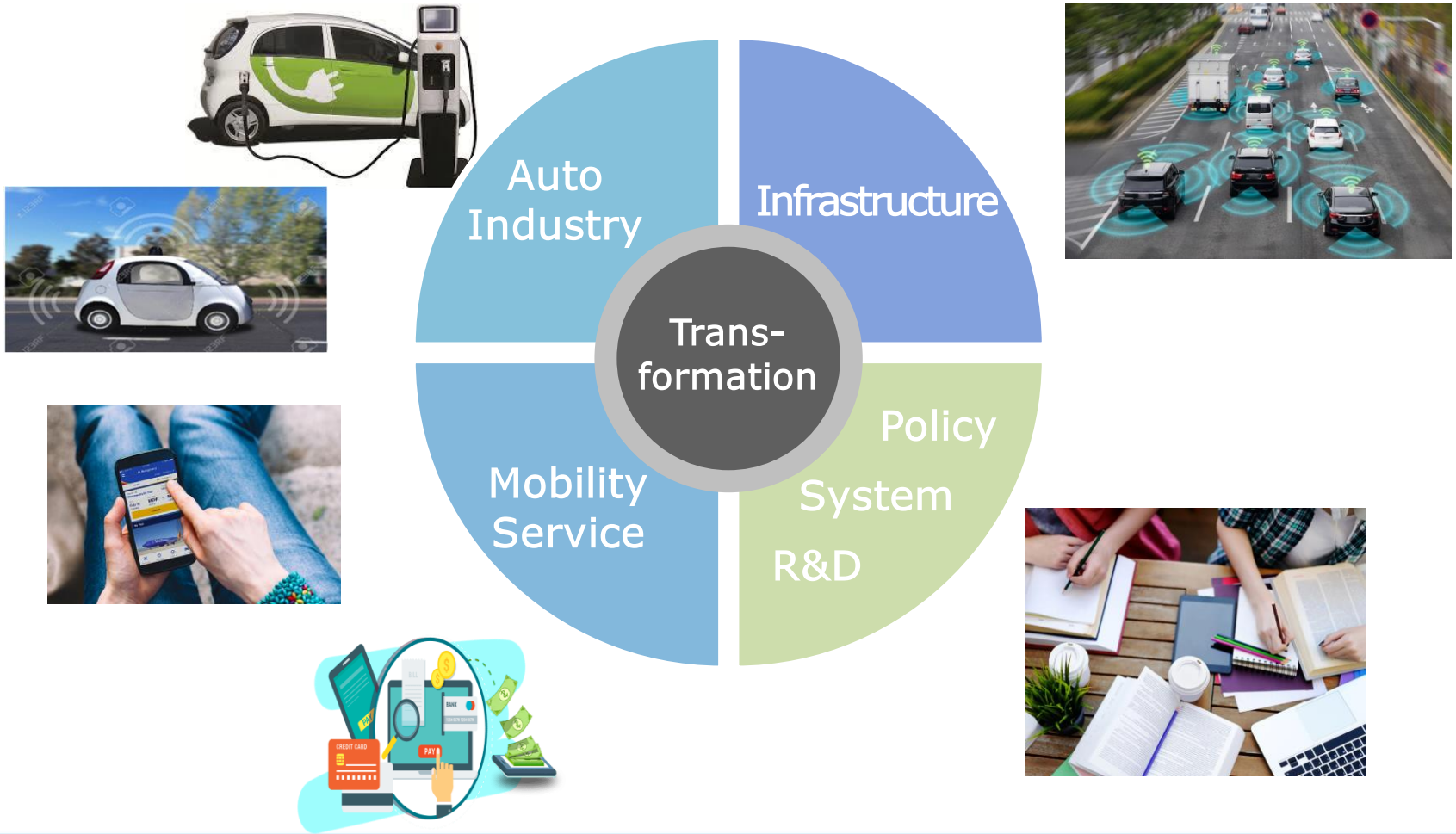
Institution

- Administrative coordination
- PPP (Public-private partnership)

4. Approach and Issues for Transportation Transformation

Comprehensive approach for transforming transportation

- Transportation transformation is a very complex process, integrated with automobile industry, infrastructure development, mobility service, innovation, regulation and financing

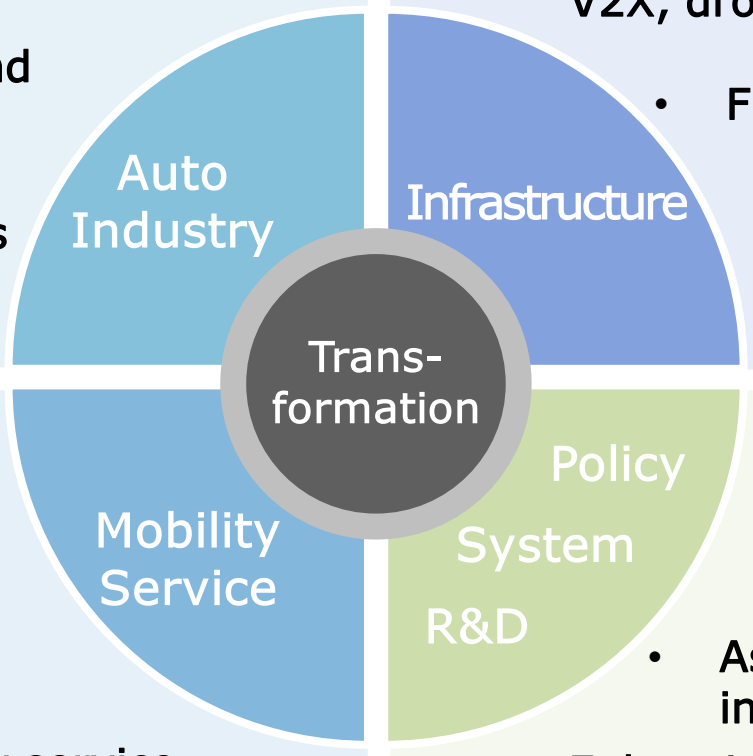


4. Approach and Issues for Transportation Transformation

Key issues relating to transportation transformation

- Collapse of ICE automobile industries
- Decrease in old labor force and demand in new workforce
- Technological competitiveness for autonomous and electric vehicles

- 3D digital map, C-ITS, control center, V2X, drone airspace control
- Financing infrastructure digitalization
- National plan for infrastructure digitalization



- Conflict with existing industries (taxi)
- Rise of platform-based enterprises
- Public compliance
- Improving the gap in mobility service between urban and rural areas

- Reforming regulations
- Enhancing the role of national R&D
- Assigning roles among government, industry, universities & institutes
- Enhancing social safety net and employment promotion

5. Conclusions

Directions for Successful Transportation Transformation

1) Automation, decarbonization, sharing/integration should be processed in a form of simultaneous transformation.

2) Successful & smooth transformation should be based on social agreement between various stakeholders.

3) Social security net and education & training of new workforce should be put into a top priority policy.