PERSPECTIVES ON FUTURE TRANSPORTATION RESEARCH IN INDONESIA

Prof. Dr. Ir. Agus Taufik Mulyono, ST., MT., IPU., ASEAN Eng.
Head of Center for Transportation and Logistic Studies (PUSTRAL) UGM
Head of Indonesia Transportastion Society (MTI)

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Presentation Outline:

- Understanding the Nature of Transportation
- The Node-Space-Node Problem
- Challenges of the Industrial Era 4.0: Sustainable Transportation
- Key Performance Indicators (KPI) for the Development of Sustainable Civilized Transportation (Industrial Era 4.0)
- Key Performance Indicators (KPI) for the Operation of Sustainable Civilized Transportation (Industrial Era 4.0)
- Sustainable-Civilized Transportation Research
MTI’s Perspective:
Understanding the Nature of Transportation
Transportation: Access-Main Trip-Egress

Origin of Trip

- Road Network
- Railroad Network
- Shipping lane
- Flight Line

Terminal, Toll Gate, Station
Ports, Airports

Main Trip

- Road Network
- Railroad Network
- Shipping lane
- Flight Line

Destination Node

- Terminal, Toll Gate, Station
- Ports, Airports

Final Destination of the Trip

Space Problem

Node Problem

Space Problem

Node Problem

Space Problem

Source: Agus Taufik Mulyono (2019)
The Nature of Transportation

- Transportation: the process of moving people/goods/services from the Origin of Trip to the Final Destination of Trip safely, securely, comfortably, on time (effective), orderly and smoothly as well as with affordable (efficient) operational costs, through 3 (three) important components:
  - **NODE** (terminal, port, airport, station, toll gate, bus stop, agent)
  - **SPACE** (road & rail network, shipping lanes, flight lines)
  - **SERVICE** (travel time, waiting time, safety, security, cost affordability, smooth and order, comfort, equity, health, legal certainty)

- The trip of **NODE-SPACE-NODE** through 3 segments:
  - **ACCESS** (Origin of Trip - Origin Node)
  - **MAIN-TRIP** (Origin Node - Destination Node)
  - **EGRESS** (Destination Node – Final Destination of the Trip)
MTI’s Perspective:
The Node-Space-Node Problem
There is no certainty of the mode share, 75% of passenger transport costs and 85% of freight transport costs are based on road modes, unfair intermodal/intermodal transport tariff competition, uncertain travel time, public vs private, commercial vs pioneering, competition vs intermodal integration.

The cost of access + egress can occur higher than the cost of the main trip due to poor transport infrastructure and non-compliance with service standards.

Terminal overcapacity during peak hours, uncertain waiting times, basic services are inadequate. Intermodal/multimodal transportation is not optimal.

Logistics handling costs at the node are expensive, uncertain handling time, and often mixed with passenger services.

The low basic services for people with physical disabilities, the elderly, children, the poor, pregnant women. Low efforts to reduce GHGs due to transportation.

Source: Agus Taufik Mulyono (2019)
Problem of “Transportation Spaces”

- **MODE SHARE**: there is no courage to set targets for mode share, especially in the solid lane of transportation of goods (logistics). Conditions of production of freight transportation in Java:
  - Road Mode: 93.5%
  - Railways Mode: 1.1%
  - Shipping Mode: 5.2%
  - Flight Mode: 0.2%

- **TRAVEL TIME**: still high, especially on national road and railroad transportation (> 2.0 hours/100 km).

- **FACILITIES-INFRASTRUCTURE CONDITIONS**: lack of attention on safety and security aspects, and inaccurate maintenance, as well as low services for people with disabilities, the elderly, children, the poor, and pregnant women.
There is no policy on Mode Share of passenger transportation, especially railroad mode, sea-lines mode. Has the effect of increasing potential deficiencies in safety, security, timeliness, and optimizing intermodal terminal capacity.
### Imbalance Number of Freight Trips in Each Mode

<table>
<thead>
<tr>
<th>Mode</th>
<th>Sumatera</th>
<th>Jawa</th>
<th>Kalimantan</th>
<th>Sulawesi</th>
<th>Bali NT</th>
<th>Maluku-Papua</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flight</td>
<td>0,0%</td>
<td>0,0%</td>
<td>0,0%</td>
<td>0,0%</td>
<td>0,0%</td>
<td>1,1%</td>
<td>0,2%</td>
</tr>
<tr>
<td>Ship</td>
<td>2,7%</td>
<td>0,2%</td>
<td>58,8%</td>
<td>3,6%</td>
<td>0,2%</td>
<td>79,7%</td>
<td>24,2%</td>
</tr>
<tr>
<td>Railway</td>
<td>2,1%</td>
<td>0,1%</td>
<td>0,1%</td>
<td>41,2%</td>
<td>96,4%</td>
<td>99,8%</td>
<td>1,1%</td>
</tr>
<tr>
<td>Roadway</td>
<td>95,2%</td>
<td>99,7%</td>
<td>41,2%</td>
<td>96,4%</td>
<td>99,8%</td>
<td>10,2%</td>
<td>75,3%</td>
</tr>
</tbody>
</table>

Source: Agus Taufik Mulyono (2018); IndII (2015)

The double track railroad and port development have not yet had a significant impact on operators due to the poor integration of the infrastructure network system and the intermodal freight terminal services.
### Imbalance of Transport Production for Each Passenger and Freight Transportation Modals in Java Island

<table>
<thead>
<tr>
<th>Transportation Modal</th>
<th>Freight Transportation Production (million ton.km/year)</th>
<th>Passenger Transportation Production (million seat.km/year)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Road:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• North Route (Pantura)</td>
<td>23,517.8</td>
<td>6,285.6</td>
</tr>
<tr>
<td></td>
<td>(74.7%)</td>
<td>(64.8%)</td>
</tr>
<tr>
<td>• Middle Route</td>
<td>4,439.1</td>
<td>2,066.1</td>
</tr>
<tr>
<td></td>
<td>(14.1%)</td>
<td>(21.3%)</td>
</tr>
<tr>
<td>• South Route</td>
<td>1,479.8</td>
<td>632.4</td>
</tr>
<tr>
<td></td>
<td>(4.7%)</td>
<td>(6.5%)</td>
</tr>
<tr>
<td>Railway</td>
<td>346.3</td>
<td>628.6</td>
</tr>
<tr>
<td></td>
<td>(1.1%)</td>
<td>(6.5%)</td>
</tr>
<tr>
<td>Sea</td>
<td>1,637.1</td>
<td>29.1</td>
</tr>
<tr>
<td></td>
<td>(5.2%)</td>
<td>(0.3%)</td>
</tr>
<tr>
<td>Air</td>
<td>62.9</td>
<td>67.9</td>
</tr>
<tr>
<td></td>
<td>(0.2%)</td>
<td>(0.7%)</td>
</tr>
</tbody>
</table>

Source: Mulyono and Kushari (2018)

Imbalance of freight load shall not be neglected since it will speed up the structural damage rate of the north java national road during the design period due to high loading time of freight heavy vehicle. If it is not handled seriously and properly, the road service quality for road user will decrease; particularly due to increase on vehicle operating cost and the need of (everlasting) road reconstruction project as what currently happened.
### Imbalance of Passenger Transport Production in Java Island

<table>
<thead>
<tr>
<th>Route</th>
<th>Rail</th>
<th>Sea</th>
<th>Air</th>
</tr>
</thead>
<tbody>
<tr>
<td>North Route</td>
<td>6.5%</td>
<td>0.3%</td>
<td>0.7%</td>
</tr>
<tr>
<td>Middle Route</td>
<td>64.8%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>South Route</td>
<td>21.3%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>92.6%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Agus Taufik Mulyono (2018)
### Imbalance of Freight Transport Production in Java Island

<table>
<thead>
<tr>
<th>Modal</th>
<th>North Route</th>
<th>Middle Route</th>
<th>South Route</th>
<th>Rail</th>
<th>Sea</th>
<th>Air</th>
</tr>
</thead>
<tbody>
<tr>
<td>Road</td>
<td>74.7%</td>
<td>14.1%</td>
<td>4.7%</td>
<td>1.1%</td>
<td>5.2%</td>
<td>0.2%</td>
</tr>
</tbody>
</table>

Source: Agus Taufik Mulyono (2018)
Problem of “Transportation Spaces”

- **COMPETITIVENESS**: The low competitiveness of infrastructure and transportation services is triggered by some conditions:
  - Commercial vs. Pioneer routes: difficult to control?
  - Mode competition vs. intermodal integration: lack of infrastructure and service networks integration?
  - Public vs private: congestion out of control?
  - Transport capacity: ODOL (Over Dimension Over Load) is difficult to solve?
  - Safety: high accident fatality?
  - Condition of facilities and infrastructure: improper function?
  - Social impact: seamless conflict of interest?
  - Environment: GHGs are increasing, lack of monitoring?
  - Health & psychological users: no complaints?
  - Affordability: the unfair subsidies?
  - ICT system: online motorcycle taxi (OJOL) behavior is difficult to control?
Problem of “Transportation Nodes”

- **WAITING TIME**: Delays often occur, resulting in large losses for users (public). OTP (on time performance) facts at node:
  - Bus Terminal: 67.0% (vehicles, roads, management)
  - Train Station: 90.0% (management, train facilities)
  - Seaport: 75.0% (weather, ships, management)
  - Airport Terminal: 80.0% (weather, airlines, management)
  - All Nodes: 72.0% (far enough from the target)

- **DWELLING TIME**: generally still quite high (> 3.0 days), the complexity of port services has not been resolved.

- **OVERCAPACITY**: some nodes experience greater density than the carrying capacity/planned capacity due to planning and field management errors.
Problem of “Transportation Nodes”

- INTEGRATION: especially in intermodal and multimodal transportation, do not yet have an indicator of standardization of integration, and there is no assessment of the effectiveness and efficiency of its implementation in the field:
  - Integration of networks: order of infrastructure, facilities and services
  - Integration of operations: order of operational facilities, infrastructure, and services
  - Integration of functions: order of function, infrastructure, facilities, and services.
  - Institutional Integration: synchronization of action programs between institutions.
  - Integrated Financing: one document-one time pay
Problem of “Transportation Nodes”

- **LOGISTICS COSTS**: poor service conditions resulting in high logistics costs, can be detrimental to public spending. Field facts, logistics costs are greatly influenced by:
  - 10,0% (administrative costs for sending documents)
  - 60,0% (handling and inventory costs at the node)
  - 30,0% (inter node travel costs)

- **MITIGATION-ADAPTATION** of environmental impact: related to health, safety and security services for people with disabilities, children, elderly people, pregnant women and poor people.
## Logistics Cost Components

<table>
<thead>
<tr>
<th>Logistics Cost Components</th>
<th>Cost Comparison</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Field Findings</td>
</tr>
<tr>
<td>1. Administration Cost of Delivery Documents:</td>
<td><img src="red.png" alt="Red Circle" /></td>
</tr>
<tr>
<td>- Customs</td>
<td>10.0%</td>
</tr>
<tr>
<td>- Tax</td>
<td></td>
</tr>
<tr>
<td>- Packing list</td>
<td></td>
</tr>
<tr>
<td>- Insurance</td>
<td></td>
</tr>
<tr>
<td>- Security</td>
<td></td>
</tr>
<tr>
<td>2. Handling and Inventory Cost:</td>
<td></td>
</tr>
<tr>
<td>- Vessel Cost in the Port (Docking, Berthing, Pilot and tugboat)</td>
<td><img src="red.png" alt="Red Circle" /></td>
</tr>
<tr>
<td>- Wharfage</td>
<td>60.0%</td>
</tr>
<tr>
<td>- Handling (container movement)</td>
<td></td>
</tr>
<tr>
<td>- Loading-unloading</td>
<td></td>
</tr>
<tr>
<td>- Cargo pile up</td>
<td></td>
</tr>
<tr>
<td>- Haulage</td>
<td></td>
</tr>
<tr>
<td>- Demurrage</td>
<td></td>
</tr>
<tr>
<td>- Container Rent</td>
<td></td>
</tr>
<tr>
<td>- Repair Container</td>
<td></td>
</tr>
<tr>
<td>- Equipment Rent (Fork lift, Container Crane, Rubber Tyred Gantry, etc.)</td>
<td><img src="red.png" alt="Red Circle" /></td>
</tr>
<tr>
<td>3. Transportation Cost:</td>
<td><img src="red.png" alt="Red Circle" /></td>
</tr>
<tr>
<td>- Fuel (Producer → port → shipping → port → consumer)</td>
<td>30.0%</td>
</tr>
<tr>
<td>- Ship Crew and truck driver/train</td>
<td></td>
</tr>
<tr>
<td>- Vessel and truck/train operation cost</td>
<td></td>
</tr>
<tr>
<td>- Entrance and exist cost in the port (land and sea)</td>
<td></td>
</tr>
</tbody>
</table>

Source: Agus Taufik Mulyono (2018)
The challenge of “Transportation Management”

- **SUSTAINABLE TRANSPORTATION KPIs** : currently do not have a quantitative (measurable) sustainable development and operation KPI, at the node and between nodes.

- **TRANSPORTATION LAW** : National Transportation System (SISTRANAS) to regulate the legal certainty of integration and synchronization:
  - Efficiency : Integrating the order of facilities, operational, and functional to the infrastructure and services network.
  - Effectiveness : Integration of institutions and financing.
  - Action solutions : ODOL, OJOL, traffic jams, travel time, accident fatalities, Central-Regional connectivity, logistic lane.
  - Collaboration between government interests, research institutions, universities, industry, professional associations, and the community.

- **STANDARDIZATION OF INFRASTRUCTURE AND SERVICES NETWORKS** : not yet available comprehensively and integratively in the implementation of intermodal / multimodal transportation.
There no courage to standardize road class among road status to increase national connectivity of logistics transport.

Consequence of Single Class:
- Conflict Between the Central and Local
- Unclear funding allocation
- More aligned to goods transporter with cheaper transport cost
- Short Travel time
- Expensive infrastructure cost that the government should bear
- Shall amend Law regarding Road and Law regarding Authority Distribution Between Central Government and Local Government

Single Class is suitable for continuous road network serving export goods transport from producer to port/outlet.

Field findings: terminal & handling cost shall be performed?

Source: Agus Taufik Mulyono (2018)
"Unimoda" Transportation Sector

UU No. 38/2004: Jalan
"...jalan sebagai bagian sistem transportasi nasional mempunyai peranan penting...."

UU No. 22/2009: LLAJ
"...LLAJ sebagai bagian dari sistem transportasi nasional ...."

UU No. 23/2007: Perkeretaapian
"...sebagai salah satu moda transportasi dalam sistem transportasi nasional ...."

UU No. 17/2008: Pelayaran
"...merupakan bagian dari sistem transportasi nasional yang harus dikembangkan...."

UU No. 1/2009: Penerbangan
"...merupakan bagian dari sistem transportasi nasional yang...."

NOT YET Intermodal / Multimodal Transport Integration

Road Network Master Plan
National/Province/Regency/City

National General Safety Plan

National Railroad Master Plan

National Port Master Plan

National Airport Master Plan

Spatial planning (UU 26/2007)

National Urban System:
• National City : (PKN/PKSN/ The Capital of Prov)
• Regional City : (PKW/PKSP/ The Capital of Regency)
• Local City : (PKL)

National Transportation Network System :
• Land Transportation (Highways & Terminals, Railway & Railway, SDP & Wharf)
• Sea Transportation (Seaports & Shipping Lines)
• Air Transportation (Airport & Airspace/Aviation Lines)

Source : Agus Taufik Mulyono (2018)
MTI’s Perspective:
Challenges of the Industrial Era 4.0
Sustainable Civilized Transportation
Challenges of Industrial Era 4.0 → Civilization of Transportation

Source: Agus Taufik Mulyono (2019)
Industrial Era 4.0: Intermodal & Inter-space Harmonization

INTEGRATION OF OPERATIONS (operational orders of infrastructure, services)

INTEGRATION OF NETWORKS (facilities orders of infrastructure, services)

INTEGRATION OF FUNCTIONS (functional orders of infrastructure, services)

INSTITUTIONAL INTEGRATION (the suitability of action programs between institutions)

INTEGRATED FINANCING (one document & one time pay)

SYNCHRONIZATION OF INTER-MODE INTER-SPACE TRANSPORTATION POLICY

Source: Agus Taufik Mulyono (2019)
Industrial Era 4.0: Answering Acceleration Connectivity

What is the indicator of connectivity?
- Number of network
- Scope of network
- Travel time
- Interconnections

Source: Agus Taufik Mulyono (2019)
Challenges of IT Systems Development in Industrial Era 4.0:

- Monitoring and Evaluation of KPI achievement for each Node-Link-Node between Countries.
- Accuracy of connectivity Scores between countries, as input and technological solutions and national economy improvement.

Source: Agus Taufik Mulyono (2018); Berlian Kushari (2015)
Challenges of IT Systems Development in Industrial Era 4.0:

- Monitoring and Evaluation of KPI achievements for each Node-Link-Node in the country's border areas.
- Accuracy of Regional Connectivity Scores in national border regions, as input and technological solutions and security improvement of national borders.

Source: Agus Taufik Mulyono (2018); Berlian Kushari (2015)
Challenges of IT Systems Development in Industrial Era 4.0:

- Monitoring and Evaluation of key performance indicators (KPI) for each Node-Link-Node, within Islands and between Islands.
- Quick and precise connectivity score so that it can be given technological solutions and improvements to civilization in an effective and efficient transportation.

Source: Agus Taufik Mulyono (2018); Berlian Kushari (2015)
Inter-connectedness Node Connectivity in Island

Region 1: Sumatera and surrounding areas
- 14 nodes
- 78 links

Region 2: Java and surrounding areas
- 11 nodes
- 55 links

Region 3: Kalimantan and surrounding areas
- 17 nodes
- 36 links

Source: Agus Taufik Mulyono (2018); Berlian Kushari (2015)
Inter-connectedness Node Connectivity in Island

Region 4: Sulawesi and surrounding areas
6 nodes 15 links

Region 5: Bali-NTB-NTT
7 nodes 3 links

Region 6: Kep. Maluku - Papua
10 nodes 28 links

Source: Agus Taufik Mulyono (2018); Berlian Kushari (2015)
MTI’s Perspective:
Key Performance Indicators (KPI)
Sustainable Civilized Transportation in the Industrial Era 4.0
Development of Sustainable Civilized Transportation KPIs in the Industrial Era 4.0

- **Transportation Node**
  - Passenger Capacity \(10^3 \text{ people/year}\)
  - Freight Capacity \(10^3 \text{ ton/year}\)
  - Hierarchy/Type of Infrastructure
  - Mode Integration Needs

- **Transportation Space**
  - Operational Class
  - Capacity (number of transports/day)
  - Utilization Rate (%)
  - Speed (km/hour)
  - Service Frequency (trips/year)
  - Freight Transportation (ton.km/yr)
  - Passenger Transport (seat.km/year)
  - Service Time at the Node (hours)
  - Travel time (hours)

- **Transportation Service**

Source: Agus Taufik Mulyono (2018)
Operation of Sustainable Civilized Transportation KPIs in the Industrial Era 4.0

- **Economic Dimension**
  - Transportation production
  - Mode Share
  - Transportation costs and rates

- **Social Dimension**
  - Accessibility and mobility
  - Transportation safety
  - Affordability

- **Environmental Dimension**
  - Transportation emissions
  - Energy efficiency
  - Renewable energy
  - Air pollution

- **Operational Dimension**
  - Occupancy rate
  - Technology status
  - Reliability of service
  - Mode integration

Source: Agus Taufik Mulyono (2018)
### OPERATION OF SUSTAINABLE CIVILIZED TRANSPORTATION KPIs

**“ECONOMIC dimension”**

<table>
<thead>
<tr>
<th>ECONOMIC DIMENSION</th>
<th>Transportation Production</th>
<th>Mode Share</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passenger transport production</td>
<td>Passenger transport share mode (%)</td>
<td></td>
</tr>
<tr>
<td>Freight transport production</td>
<td>Freight transport share mode (%)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ECONOMIC DIMENSION</th>
<th>Transportation Costs and Rates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Government subsidies on transportation rates (%)</td>
<td></td>
</tr>
<tr>
<td>Direct costs borne by passenger transport users (1,000 Rp/passenger)</td>
<td></td>
</tr>
<tr>
<td>Direct costs borne by freight transportation users (1,000 Rp/ton)</td>
<td></td>
</tr>
<tr>
<td>Congestion costs against direct passenger transportation costs (%)</td>
<td></td>
</tr>
<tr>
<td>Congestion costs against direct freight transportation costs (%)</td>
<td></td>
</tr>
<tr>
<td>Emission costs (CO2) to direct passenger transportation costs (%)</td>
<td></td>
</tr>
<tr>
<td>Emission costs (CO2) to direct freight transportation costs (%)</td>
<td></td>
</tr>
<tr>
<td>External costs that can be internalized to passenger transportation rates (%)</td>
<td></td>
</tr>
<tr>
<td>External costs that can be internalized to freight transportation rates (%)</td>
<td></td>
</tr>
</tbody>
</table>

Source: Agus Taufik Mulyono (2018)
### OPERATION OF SUSTAINABLE CIVILIZED TRANSPORTATION KPIs

#### “SOCIAL dimension”

<table>
<thead>
<tr>
<th>SOCIAL DIMENSION</th>
<th>Accessibility and Mobility</th>
<th>Transportation Safety</th>
<th>Affordability</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Average passenger travel distance (km)</td>
<td>The rate of reduction in the number of transportation accidents against the base line (%)</td>
<td>Mid-income level family income spent on transportation costs (%)</td>
</tr>
<tr>
<td></td>
<td>Average freight travel distance (km)</td>
<td>Rate of railway transport accident (%)</td>
<td>Source: Agus Taufik Mulyono (2018)</td>
</tr>
<tr>
<td></td>
<td>Average travel time of road transport of passengers (hour/100km)</td>
<td>Average travel time of railway transport accident of passengers (hour)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Average travel time of road transport of freight (hours/100km)</td>
<td>Average travel time of railway transport of freight (hour)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Average travel time of water transport vehicles (hours)</td>
<td>Average travel time of flight transport of passengers (hour)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Average travel time of flight transport of freight (hour)</td>
<td>Average travel time of sea transport of passengers (hour)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Average travel time of sea transport of freight (hour)</td>
<td>Average travel time of sea transport of freight (hour)</td>
<td></td>
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<tr>
<td></td>
<td>The rate of reduction in the number of transportation accidents against the base line (%)</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>Rate of railway transport accident (%)</td>
<td>Rate of railway transport accident (%)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>AOC 121 and AOC 135 air transportation accident ratio (incidence/million flight cycle)</td>
<td>AOC 121 and AOC 135 air transportation accident ratio (incidence/million flight cycle)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Number of marine transportation accident (events/year)</td>
<td>Number of marine transportation accident (events/year)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Number of ferry transportation accident (events/year)</td>
<td>Number of ferry transportation accident (events/year)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Number of river and lake transportation accidents (events/year)</td>
<td>Number of river and lake transportation accidents (events/year)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Number of victims fatalities in transportation accident (fatalities/yr)</td>
<td>Number of victims fatalities in transportation accident (fatalities/yr)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mid-income level family income spent on transportation costs (%)</td>
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</tr>
</tbody>
</table>
## OPERATION OF SUSTAINABLE CIVILIZED TRANSPORTATION KPIs

**“ENVIRONMENTAL dimension”**

<table>
<thead>
<tr>
<th>ENVIRONMENTAL DIMENSIONS</th>
<th>Transportation Emissions</th>
<th>Sound Pollution</th>
<th>Energy Efficiency</th>
<th>Renewable energy</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Max tolerance of NOx emission level to environmental quality standard (150 μg/Nm³), (%)</td>
<td>Noise level (dBA)</td>
<td>Fuel consumption of transportation facilities (liters/km vehicles)</td>
<td>Use of renewable energy sources (percent alternative fuel fleet)</td>
</tr>
<tr>
<td></td>
<td>Max tolerance of CO₂ emission levels to environmental quality standards (400 million.ton/year), (%)</td>
<td></td>
<td>Fuel consumption of passenger transportation (liters/km vehicles)</td>
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<tr>
<td></td>
<td>Max tolerance of CO emission levels to environmental quality standards (10,000 μg/Nm³), (%)</td>
<td></td>
<td>Fuel consumption of freight transportation (liters/km vehicles)</td>
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<td></td>
<td>Max tolerance of HC emission level to environmental quality standard (160 μg/Nm³), (%)</td>
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<td></td>
<td>Max tolerance of SOx emission levels to environmental quality standards (365 μg/Nm³), (%)</td>
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<tr>
<td></td>
<td>Max tolerance of PM₁₀ emission levels to environmental quality standards (150 μg/Nm³), (%)</td>
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</tbody>
</table>

Source: Agus Taufik Mulyono (2018)
<table>
<thead>
<tr>
<th>OPERATIONAL DIMENSIONS</th>
<th>Occupancy Rate</th>
<th>Technology Status</th>
<th>Reliability of Road Infrastructure</th>
<th>Reliability of Port Services</th>
<th>Mode Integration</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Passenger transport occupancy rate (%)</td>
<td>Average transportation age (year)</td>
<td>The maximum tolerance stability of national roads (IRI &lt;8), (%)</td>
<td>On-time performance level of transportation service (%)</td>
<td>Intermodal</td>
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<td></td>
<td>Passenger transport Load Factor (%)</td>
<td>Proportion of fleets that meet emissions standards (%)</td>
<td></td>
<td>Dwelling time on the terminal (hour)</td>
<td>Passenger transfer time between flight and train mode terminals (minutes)</td>
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<td>Ships Waiting Time (hour)</td>
<td>Passenger transfer time between sea and train mode terminals (minutes)</td>
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<td></td>
<td>Boat Guide Service Time (Approach time) (hours)</td>
<td>Time of transfer of freight between flight and train modes terminals (minutes)</td>
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<td></td>
<td>Effectiveness level of Ship Services (%)</td>
<td>Time of freight transfer between sea and train mode terminals (minutes)</td>
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<td>Fulfillment of frequency of transportation services (%)</td>
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<td>Tolerance of service delay due to operational errors (hours)</td>
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<td>The transfer time on the modal transfer facility (min)</td>
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<td>Fulfillment of need for modal integration (%)</td>
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<td>Number of Multimodal Transportation Business Entity services</td>
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</tr>
</tbody>
</table>

Source: Agus Taufik Mulyono (2018)
MTI’s Perspective :
Sustainable Civilized Transportation Research
Transportation Research: Collaboration

Source: Agus Taufik Mulyono (2019)
Transportation Research: Macro-Meso-Micro

**Macro Order Research**
- Academic research on the Transportation Bill
- Academic research on establishment of Ministry of Transportation
- Academic research on amendmentment of the Unimoda Law related to technological and civilization developments

**Meso Order Research**
- Transport Research Master Plan (RMP) for each relevant institution
- Big Data System of National and Local Transportation
- Grand Design of Human Reseource in Transportation (number, competency)
- Mapping of Impact of Transportation Infrastructure Development on Gross Domestic Product
- Grand Design of Energy Needs for Transportation Sector
- Business Model for Transportation Management Partnership
- KPI (Key Performance Indicator) for Developing Sustainable Civilized Transport Nodes-Space-Services
- KPI for the Operation of Sustainable Civilized Transportation (Economic, Socio-Culture, Environment, Operations)
- Standardization of Integrating Facility-Infrastructure-Service Network on Intermodal/ Multimodal Transportation.
- Mapping of function and role of related institution to anticipate development and application of autonomous vehicle

Source: Agus Taufik Mulyono (2019)
Transportation Research: Macro-Meso-Micro

Micro Order Research

- Production of Freight and Passenger Transportation for Each Link (Inner Island and Inter Island)
- Proportion of Mode Sharing of Transport Production: priority Java and Sumatera Island
- Standards and Operational Guidelines for Intermodal/Multimodal Transportation
- Big Data of travel time of Each Link in Transportation Space. Big Data of waiting time and dwelling time of Each Transportation Node
- Big Data of Origin-Destination (O-D) Based on Mobile GPS
- Punishment Scheme for ODOL Operator and ODOL Violation Negligence
- Model to Determine Optimum Quota of Online Taxi (Motorcycle and Car); Evaluation of Driving Behaviour of Online Taxi.
- Battery Technology for Electric Car: safe, affordable, environmentally friendly, and recyclable
- Development of green transport infrastructure design and utilization of recycled material to support green transportation infrastructure
- Mapping of alternative energy availability for transportation energy needs

Source: Agus Taufik Mulyono (2019)
Thank you

Future Transportation Research must be carried out in collaboration between relevant stakeholders: Central Government, Regional Governments, Independent Research Institutions, Universities, Business Entities, Professional Associations, NGOs, and Political Institutions, so a National Transportation Research Forum Institute must be formed.

(Agus Taufik Mulyono, 2019)