

SPECA Workshop on Transport related Sustainable Development Goals (SDGs)

ITF Study on Urban Sustainable Transport

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Global Urban Passenger Travel Demand and CO2 Emission to 2050

- Study made by Guineng CHEN and Jari KAUPPILA
- IT was presented at the last meeting of the Transportation Research Board (TRB – Washington DC, January)
- <http://www.trb.org/Main/Home.aspx>
- Published in the “Transportation Research Record” (TRB journal), N° 2671, 2017, pp. 71-79
- <http://dx.doi.org/10.3141/2671-08>



ITF Transport Outlook 2017

<http://dx.doi.org/10.1787/9789282108000-en>

Strategic Tool

- Strategic tool to support policy-makers in shaping the future of transport policies
- Examines development of global transport volumes and related CO2 emissions, health impacts
- Allows us to analyse how world could change if we choose different policies and development paths

Approach

- Examine factors that can affect supply and demand for transport services
 - Focus on scenarios illustrating potential upper and lower pathways
 - Covers key policies and external factors shaping future transport demand
 - Focus will be the chapter 5 on “mobility in cities” (international freight and international passenger aviation are the other sector in the outlook)
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Introduction

- I. Rapid urbanisation, income growth and private vehicle ownership results in significant growth in mobility demand and CO2 emissions from transport in the cities
- II. Most urban passenger transport models apply to the local level with highly disaggregated individual data and methods
- III. Existing global scale analysis is less complex and data-intensive, but have a number of caveats related to the validity of such long-term projections
 - *Based on vehicle population statistics*
 - *Limited representation of travel behaviour*
 - *Constant “time-money budget” approach*
- IV. Lack of historical data for global passenger transport



Database

- ***Geographical coverage***
 - All the urban agglomerations (1692 cities) with population above 300 thousand (UN World Urbanization Prospects 2014).
- ***Urban boundary***
 - Global Built-up Reference Layer (BUREF2010) complimented by the space-based land remote sensing data LANDSAT of year 2010.
- ***Transport network***
 - Road and public transport supply, come from the intersection of this global urban boundary layer with the open-source *OpenStreetMap* layer.



Database

- ***City population projection***

- United Nation's World Urbanization Prospects 2014. Replicate the method for 2030 to 2050.

- ***City GDP projection***

- It's estimated by redistributing the national GDP volume (ECO,OECD) into the urban areas according to the GDP distribution map obtained from LANDSAT 2010 (cell grid with 1 square km resolution). The relation between urban concentration of population and GDP is modelled with an S-shaped logistic curve.

- ***Demand related indicators***

- Modal split , trip rates, travel distance by mode, transit fare, fuel cost, parking cost, average vehicle occupancy, and so on, are collected through the analysis of multiple data sources, including individual city's household surveys when available.
- Travel surveys are very expensive and time-consuming so 2010 data is not always available. For some cities, data will be from another year, as close as possible to year 2010.



Model Calibration

- **Modal split** – estimated by a discrete choice model. The model estimates the impacts of urban development policies related to socio-economic development, car ownership, urban structure, road supply, public transport provision and pricing indicators on the aggregated modal split of a city.
- **Urban transport supply** (road provision and public transport supply) – estimated by regression models and explained by the *population*, *GDP per capita* and *area size*;
- **Trip rate** and **Trip distance** - estimated by regression models, explained by GDP per capita and area size, respectively.
- **Transit price** and **Parking price** – indexed to GDP per capita.
- **Passenger Car Ownership** - estimated by a sigmoid curve (logistic function) based on the GDP per capita and urbanisation rate.
- **CO2 Intensities, Technological Pathways** by mode and by fuel type are taken from IEA's Mobility Model for converting vehicle activities into CO2 emission.



Policy Scenarios

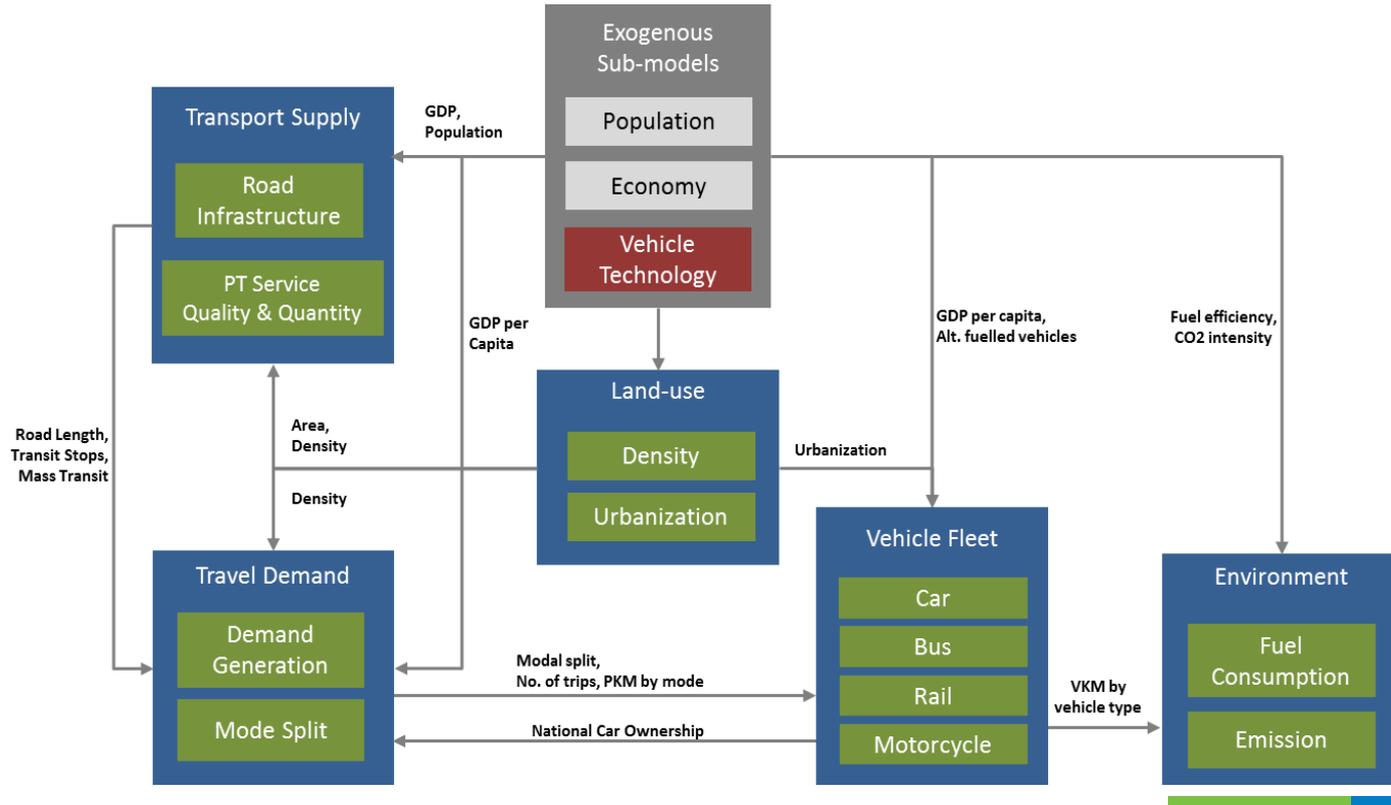
- **Baseline**
 - No additional measure aiming at influencing travel demand and reducing CO2 emissions is implemented during the 2015-2050 period.

- **Robust Governance (ROG)**
 - It assumes that local governments play an active role and adopt pricing and regulatory policies to slow down the ownership and use of personal vehicles from 2020 onwards.

- **Integrated Land Use and Transport Planning (LUTP)**
 - On top of the policies introduced in ROG scenario, the Integrated Land Use and Transport Planning (LUTP) scenario assumes stronger prioritisation for sustainable urban transport development and a joint land-use policy.



Model Framework



Policy Scenarios

Variables	Baseline	ROG	LUTP
GDP	BAU	BAU	BAU
Population	BAU	BAU	BAU
Urbanization	BAU	BAU	BAU
Car ownership	BAU	Low growth	Low growth
Road supply	BAU	Need-based expansion	Need-based expansion
PT stop supply	BAU	BAU	EU expansion pattern
Mass transit	BAU	BAU	Low thresholds of GDP per capita and population density
Fuel price	Current oil price + IEA-MoMo-4DS	Current oil price + High taxation	Current oil price + High taxation
Parking price	BAU	50% higher in all countries	50% higher in all countries
PT ticket price	BAU	Low price elasticity to GDP per capita	Low price elasticity to GDP per capita
Urban sprawl	BAU	BAU	Constant urban area
Load Factors	IEA-MoMo-4DS	IEA-MoMo-2DS	IEA-MoMo-2DS
Energy Intensity	IEA-MoMo-4DS	IEA-MoMo-2DS	IEA-MoMo-2DS
Carbon Intensity	IEA-MoMo-4DS	IEA-MoMo-2DS	IEA-MoMo-2DS

Results

Average Modal Split by World Regions

■ Baseline

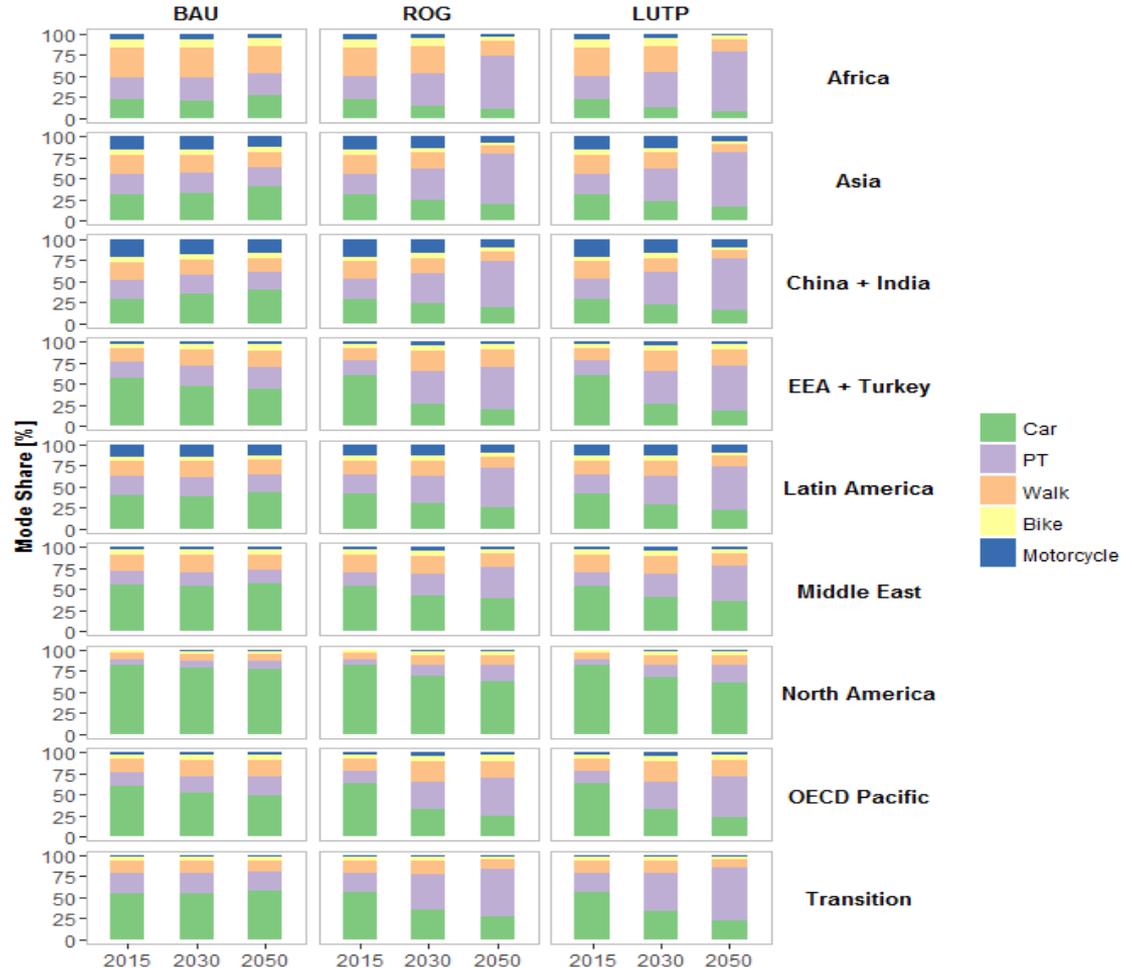
- Increasing car share in all developing regions; slightly decreasing in developed economies.

■ ROG Scenario

- Car share decreases in all regions, most notably in developed economies.
- Motorcycle share reduces in all developing regions, shifting to public transport.
- Non-motorised trips shift to public transport, especially in developing regions.

■ LUTP Scenario

- Additional policies reinforce the use of public transport and further reduce car use.



Total Mobility (PKM) by World Regions



■ Baseline

- Total mobility in cities will rise by 42% in 2030 and 96% in 2050 compared with 2015, reaching 25,680 billion and 35,280 billion PKMs, respectively.

■ ROG Scenario

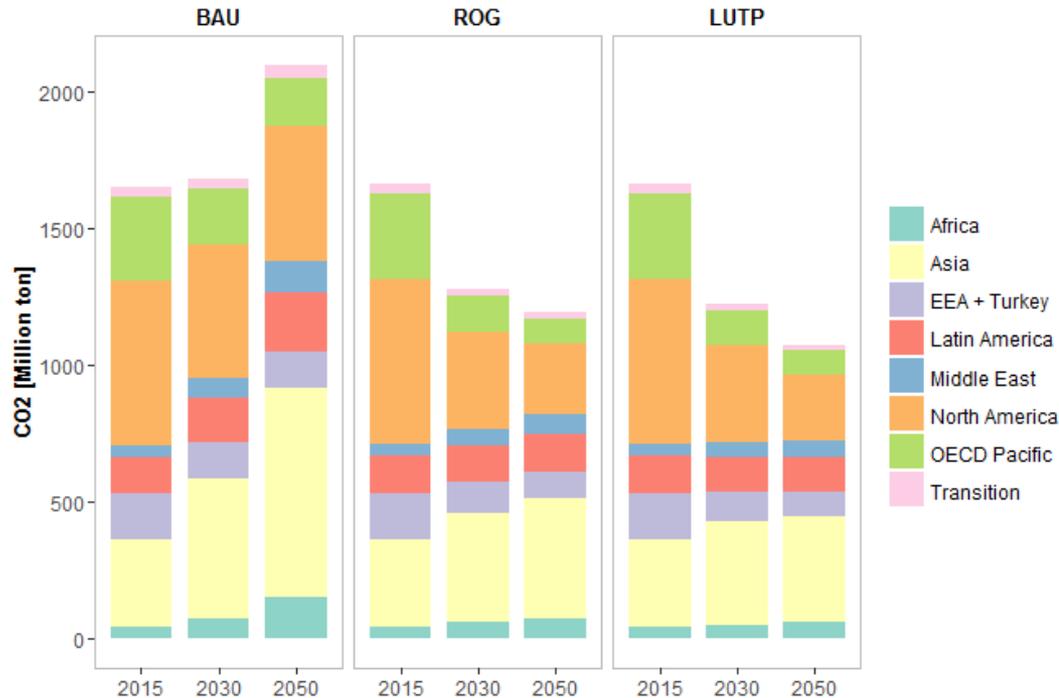
- It does not impact the total mobility levels (except North America, <2% reduction). Targeted pricing policies have different impacts on the mobility levels in developed and developing regions.

■ LUTP Scenario

- The overall passenger travelled figures are smaller under the LUTP scenario than in the ROG scenario because of the reduction in trip distances.
- Mobility demand is fulfilled through less carbon-intensive mobility options and reduced travelled distance.



CO2 Emissions by World Regions



■ Baseline

- 27% (448MT) higher in 2050 compared to 2015. Similar emission levels between 2015 and 2030, due to the expected large fuel efficiency gains and the low economic growth.
- This pace of technology improvement between 2030 and 2050 is not enough to offset the growing mobility demand.

ROG Scenario

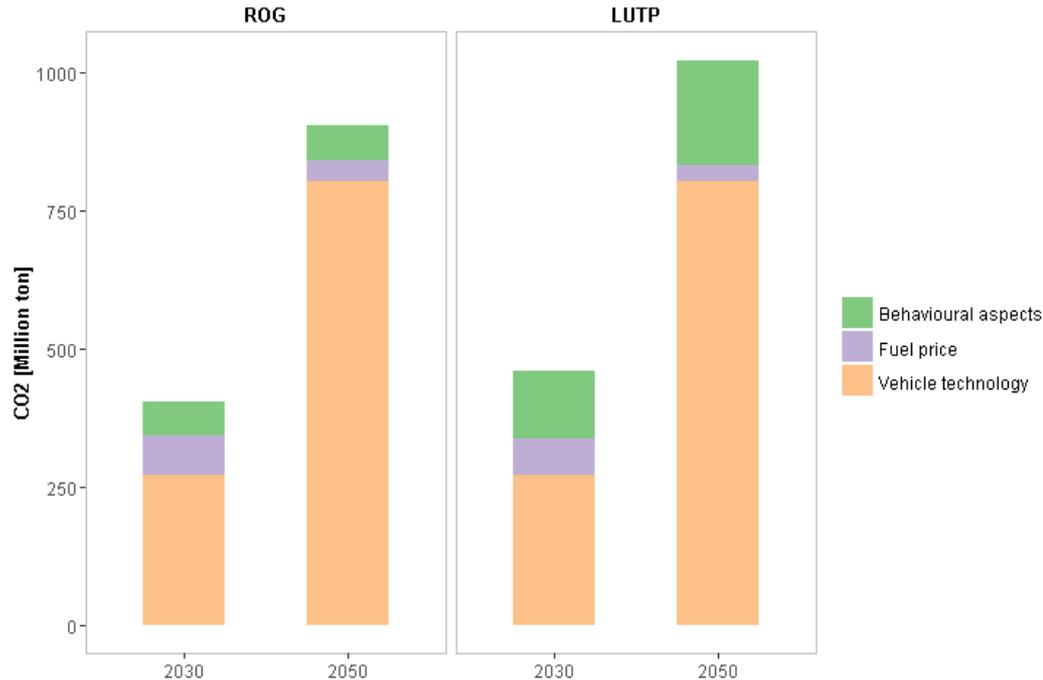
- With solely the ROG policy measures, the CO2 reduction potential is about 403 MT in 2030 and 905 MT in 2050.

LUTP Scenario

- Additional LUTP policies would further reduce the CO2 emissions by 55 MT in 2030 and 117 MT in 2050.
- Global CO2 emission level from the urban transport sector would be 26% lower in 2030 and 35% lower in 2050 compared with the level in 2015.



CO₂ Mitigation Potential by Policy Measures



- **Technology improvements** represent between 59% and 89% of all avoided CO₂ emissions compared to the baseline scenario.
- **Behavioural changes** can represent up to nearly 30% of avoided emissions.
- Although alternative-fueled vehicles have the most impact on CO₂ emissions, only behavioural measures can help reduce congestion.



Conclusions

- I. Without additional policy intervention, cities in developing economies will have an increasing trend on the car-dependent mobility and the opposite trend will be observed for the developed economies.
 - II. CO2 emissions from urban passenger transport in developed countries will stabilise by 2030 due to the higher fuel efficiency and market penetration rate of alternative-fuelled vehicles. More stringent measures should be introduced after 2030.
 - III. Vehicle technology is more efficient in CO2 mitigation than behavioural measures, proving the importance of the regulation of fuel efficiency standards and adoption of new vehicle technologies.
 - IV. The set of policies modelled in the ROG and LUTP scenarios help increase the mobility levels relative to baseline mobility. Developed countries benefit less in the mobility growth than the developing countries.
 - V. Implementing strategic development of public transport and road infrastructure, effective pricing policies targeting at transit use, car use and ownership and land-use planning policies can effectively influence the travel behaviour and demand, reducing the carbon intensity of urban mobility.
 - VI. The most drastic growth of mobility demand and CO2 emissions from urban passenger transport sector will occur in China + India and other developing Asian countries. A more in-depth examination at their travel behaviour and travel demand is crucial.
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Thank you for the attention!

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