A FRAMEWORK FOR BUILDING MECHANISMS TO MEASURE EMISSIONS FOR RIDE-HAILING

Summary of Methods and Data Used for Transportation Emission Calculation

BACKGROUND:

- With the urgency and implementation of better waste and pollution efficiency and the potential to improve air quality in cities like Jakarta, there is now a strong need to properly measure transportation (including ride-hailing) emissions to comprehend its impact in combatting our climate crisis.
- Emissions Calculator performs this task by using various emission-related factors to output data on carbon emissions related to mobility, mode used, carbon sequestration, etc.

Factors for calculations and what they mean:	
Fuel economy	Type of vehicle, person size of vehicle, type of fuel used
Distance travelled	How much distance the trip covered
CO2 emission factor	How much CO2 is emitted per unit fuel burned by the vehicle
Number of passengers	How many occupants were in the vehicle (excluding driver)
Tree sequestration rate	How much CO2 is absorbed by a tree over a given period, usually per year

ASSUMPTIONS:

Within the calculator, estimates gathered from various studies and analyses were used for:

- Fuel economy of vehicles
- CO2 emissions per unit fuel consumed (alias CO2 emission factor)
- Number of passengers per public transport type
- All cars have large petrol engine (>2.1 liters)
- All buses are fueled by diesel and used for long distance trips

PRELIMINARY LIMITATIONS:

Within the calculator, variable factors listed below should affect emission figures but considered to remain unchanged to simplify analyses:

- Extra distance drivers take between app pick-up & meeting points
- Congestion affecting driving behavior and fuel use
- Engine maintenance affecting energy efficiency
- Extra weight from ride-hailers in different vehicle

Further details are encouraged, to improve measurement qualities while maintaining simplicity of the method.

DATA FOR EMISSION CALCULATION:

Fuel Emission Factor [1]	kg CO_2/liter
Diesel	2.68
Petrol/Gasoline	2.34

Size of Fuel Engine	kg CO2 per passenger km
Small (<1.4 L)	0.12 – 0.17
Medium (1.4 – 2.1 L)	0.22
Large (>2.1 L)	0.14 – 0.27

Fuel Efficiency Values [3]	Kilometer per liter (kpl)
New small gas/petrol/electric hybrid	23.8
Small gas/petrol, highway	13.6
Small gas/petrol, city	11.1
Medium gas/petrol, highway	12.7
Medium gas/petrol, city	9.3
Large gas/petrol, highway	10.6
Large gas/petrol, city	7.6
Liquid Petroleum Gas (LPG)	8.9
Diesel	10.2

CALCULATION EQUATION FOR CARS / MOTORBIKES	
Step 1: Total fuel use	$\frac{DISTANCE\ TRAVELLED\ (KM)}{FUEL\ EFFICIENCY\ (KM\ PER\ LITER\ FUEL)}$
Step 2: Individual fuel use per trip	$\frac{TOTAL\ FUEL\ USE\ (LITER)}{NUMBER\ OF\ PASSENGER}$
Step 3: Individual emission per trip	$INDIVIDUAL\ FUEL\ USE * CO2\ EMISSION\ FACTOR$

CALCULATION EQUATION FOR TREE SEQUESTRATION	
Amounts of trees needed for sequestration	$\frac{TOTAL\ EMISSION\ RELEASE}{TREE\ SEQUESTRATION\ RATE * TIME}$

EXAMPLE EMISSIONS CALCULATION RESULTS	
Individual emission from ride-hailing in medium-sized petrol car	***7.0*** *KM (Example average distance of ride-hailing trip [4]) /* ***9.3*** *KM/LITER (Fuel efficiency) /* ***2*** *(number of riders) * 2.34 KG CO2/LITER (CO2 emission factor) =* ***0.88 KG CO2***
Individual emission from total 5KM ride in sharing ride-hailing in medium-sized petrol car with 3 riders	***Passenger A:*** ***2*** *KM / 9.3 KM/LITER ** ***2.34*** *KG CO2/LITER /* ***1*** *(Number of riders in leg 1) +* ***2*** *KM /* ***9.3*** *KM/LITER ** ***2.34*** *KG CO2/LITER /* ***2*** *(Number of riders in leg 2) +* ***1*** *KM /* ***9.3*** *KM/LITER ** ***2.34*** *KG CO2/LITER /* ***3*** *(Number of riders in leg 3) =* ***0.83 KG CO2*** ***Passenger B:*** ***2*** *KM / 9.3 KM/LITER ** ***2.34*** *KG CO2/LITER / 2 (Number of riders in leg 2) +* ***1*** *KM /* ***9.3*** *KM/LITER ** ***2.34*** *KG CO2/LITER /* ***3*** *(Number of riders in leg 3) +* ***2*** *KM /* ***9.3*** *KM/LITER ** ***2.34*** *KG CO2/LITER / 2 (Number of riders in leg 4) =* ***0.58 KG CO2*** ***Passenger C:*** ***1*** *KM / 9.3 KM/LITER ** ***2.34*** *KG CO2/LITER / 3 (Number of riders in leg 3) +* ***2*** *KM /* ***9.3*** *KM/LITER ** ***2.34*** *KG CO2/LITER /* ***2*** *(Number of riders in leg 4) +* ***2*** *KM /* ***9.3*** *KM/LITER ** ***2.34*** *KG CO2/LITER /* ***1*** *(Number of riders in leg 5) =* ***0.83 KG CO2*** ***Total emissions for 3 people using shared ride-hailing: 2.24 KG of CO2***
Example of emissions saved from sharing ride-hailing service.	***Emissions saved compared to 3 separate trips with 5 KM****: (0.88*3) – 2.24 =* ***0.4 KG of CO2*** ***15% emissions saved!***

CASE EXAMPLE – RIDE SHARING TO EMISSIONS OFFSET	
TOTAL car ride-hailing-related annual emissions	***750 Million*** *KM (Example assumed total annual distance travelled by ride-hailing car [5]) /* ***9.3*** *KM/LITER (Average fuel efficiency of medium-sized petrol car) /* ***1*** *(number of riders) ** ***2.34*** *KG CO2/LITER (CO2 emission factor) =* ***188.7 Million KG CO2***
Emission Saved from 20% of rides[6] using shared ride-hailing (using example calculation as assumption)	***(188.7 million*** *KG of CO2* ***– 188.7 million*** *KG of CO2 * 20%) +* ***188.7 million*** *KG of CO2 *20% *15% (Emission from 20% of rides with sharing ride-hailing car) =* ***183.04 Million KG CO2*** ***5.66 Million KG of CO2 saved!***
Number of trees required for total sequestration of ride-hailing car's total annual emissions	*MANGO TREE:* ***188.7 million*** *KG CO2 (Total annual ride-hailing car emission) /* ***445*** *KG CO2 per year[7] (Annual sequestration rate) =* ***424,044 Trees planted per year*** *FICUS TREE:* ***188.7 million*** *KG CO2 (Total annual ride-hailing car emission) /* ***535.9*** *KG CO2 per year[7] (Annual sequestration rate) =* ***352,117 Trees planted per year*** *YLANG YLANG TREE:* ***188.7 million*** *KG CO2 (Total annual ride-hailing car emission) /* ***756.6*** *KG CO2 per year[7] (Annual sequestration rate) =* ***249,405 Trees planted per year***

RESULTS AND CONCLUSION:

- Through the Emissions Calculator, with the assumption of 750 million KM distance, we found that car ride-hailing total annual emissions would be ***188.7 million KG CO2.***
- Through the example of shared car ride-hailing emission release, we can see that there is a good potential of avoiding **5.66 Million KG CO2.**
- That is the equivalent to the yearly carbon sequestration rate of **12,722 mango trees**.
- Implementing shared ride-hailing and other emission-reducing services and mixed with carbon offsetting measures, provides enormous opportunity for ride-hailing companies to be **leaders for sustainability** in transportation and mobility industry.
- **Greater accuracy** can be incorporated if the Emission Calculator can be used in tandem with ride-hailing industry model data, allowing for accurate emission tracking of individual driver's vehicles.

REFERENCES:

1) Source: Energy Information Administration, Emissions of Greenhouse Gases in the United States 2000, Appendix B, Table B1

2) "Source for diesel: Bureau of Transportation, National Transportation Statistics for 2000. Source for CNG: Revised IPCC, 1996, Vol. 2, Table 1-2."

3) Source: miles per gallon for typical vehicles based on averages from US EPA 2001 Guide. http://www.epa.gov/autoemissions.

4) Calculations based on use of ride-hailing in WRI internally

5) WRI calculations based on road vehicles quantity

6) A ballpark potential number taken from surveys

7) WRI Emissions Calculator Tree Reference