INTERMODALISM IN URBAN LOGISTICS: AN ENVIRONMENTAL ASSESSMENT OF CARGO TRICYCLE USED FOR BEVERAGE DISTRIBUTION IN RIO DE JANEIRO CITY

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Table of content

Table of content

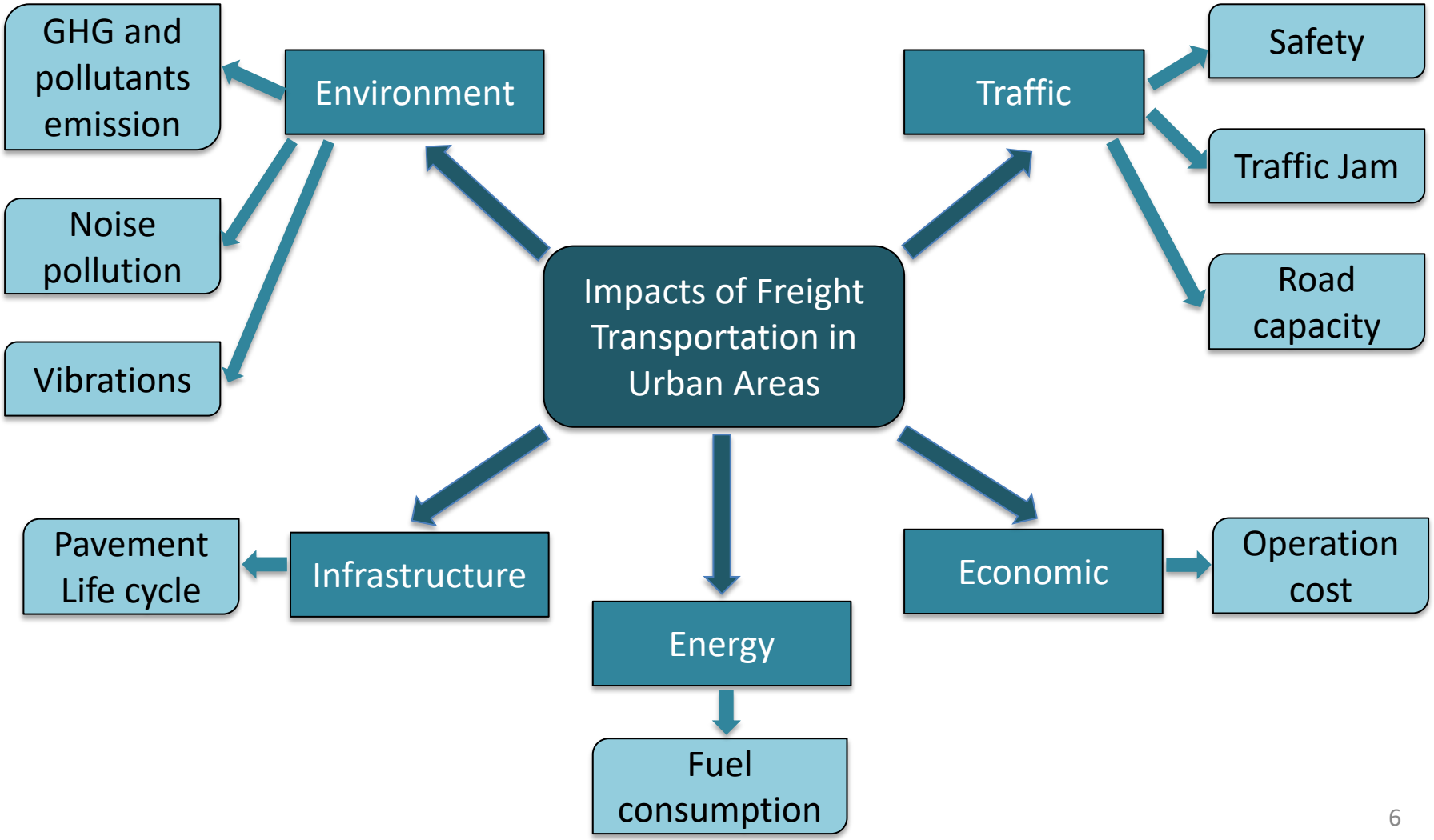
Brazil and Rio de Janeiro

- Brazilian population living in urban areas:
  - **85.8%** (2015);
  - **90%** (2035);
  - **96.7%** (↑ Rio de Janeiro State);
- Rio de Janeiro is one of the 31 world **Megacities** (12,200,000 inhabitants).

Source: United Nations, 2016

Table of content

Freight Transportation impact



Restrictions

Freight vehicles access restrictions

Polygon 1 (north and west zone)

Working days: 6am - 11am and 5pm - 9 pm.

Saturdays: 6am - 2 pm.

Polygon 2 (center and south zone)

Working days: 6am – 9pm.

Saturdays: 6am - 2pm.

Brazil avenue

Working days: 6am – 10am and 5pm - 9 pm.

Yellow line

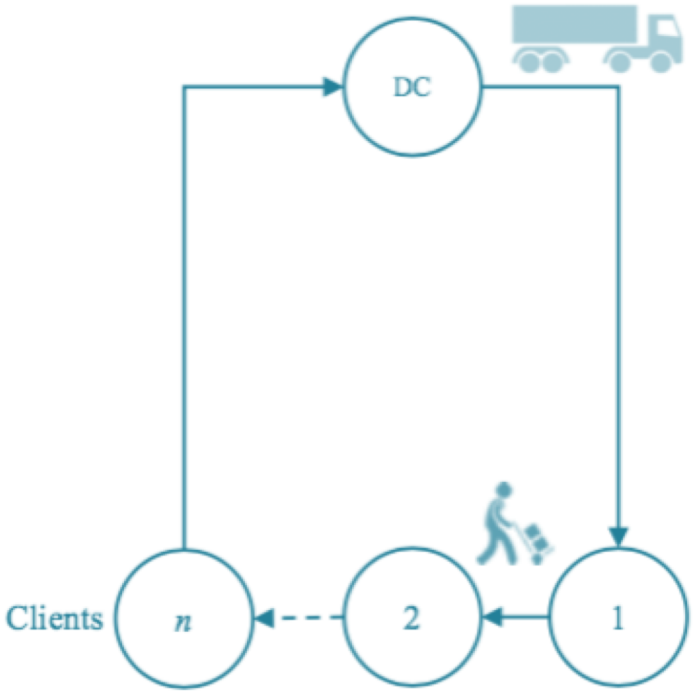
All days: 6am – 11am and 5pm - 9 pm.

Red line

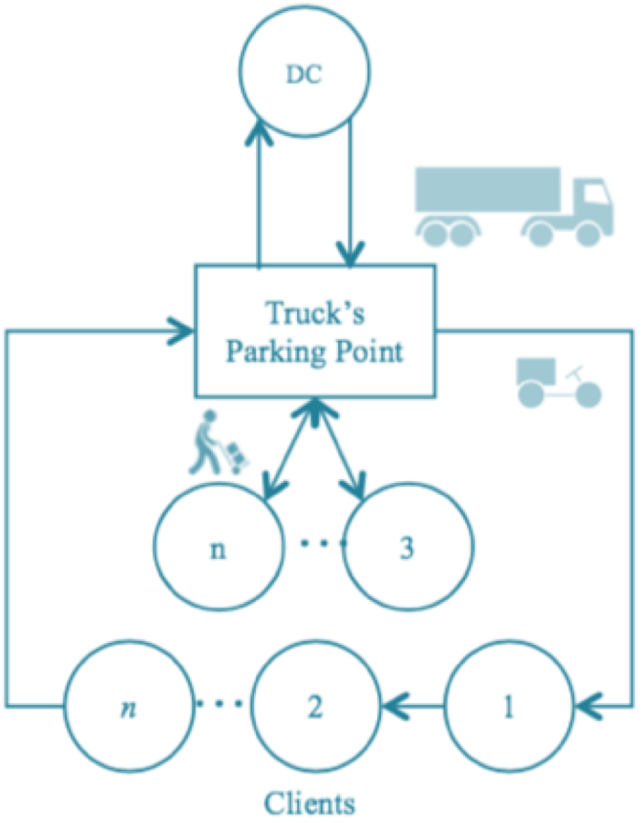
24 hours per day.

Source: Rio de Janeiro City Hall website

Alternative operation



Operational scheme of truck route for direct delivery



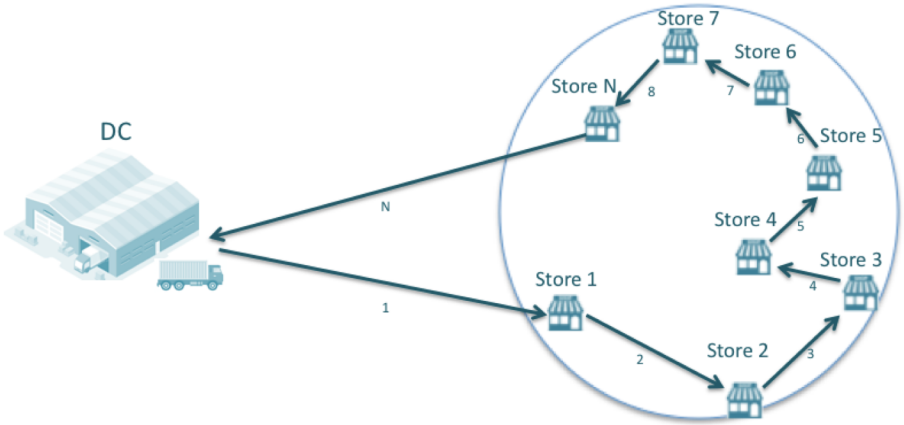
Operational scheme tricycle + truck route

Alternative operation

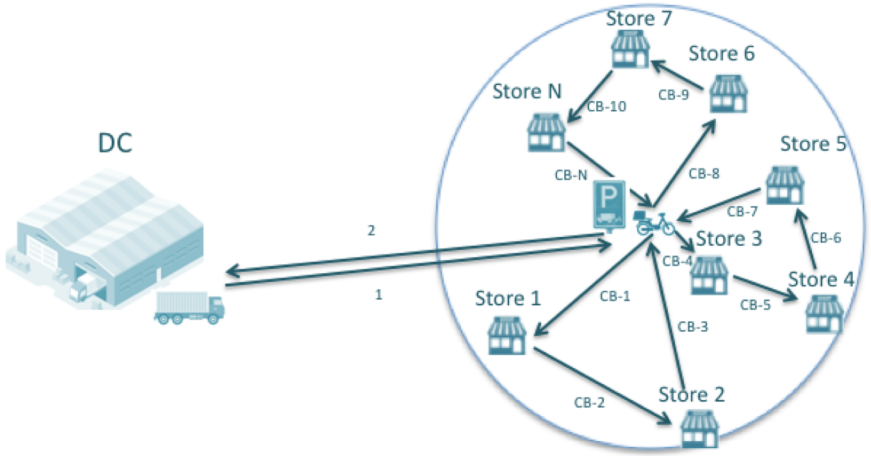
Table of content

Environmental and economic performance

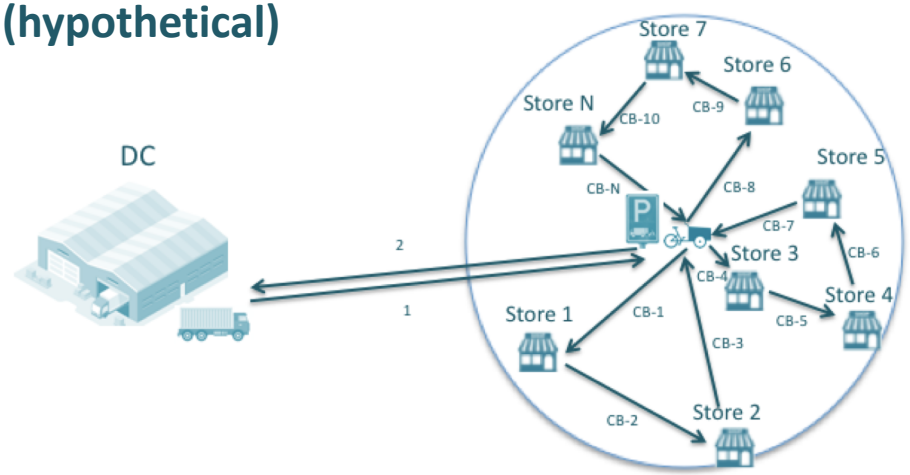
Traditional Truck-based delivery



Truck as a mobile depot + Motorized tricycle



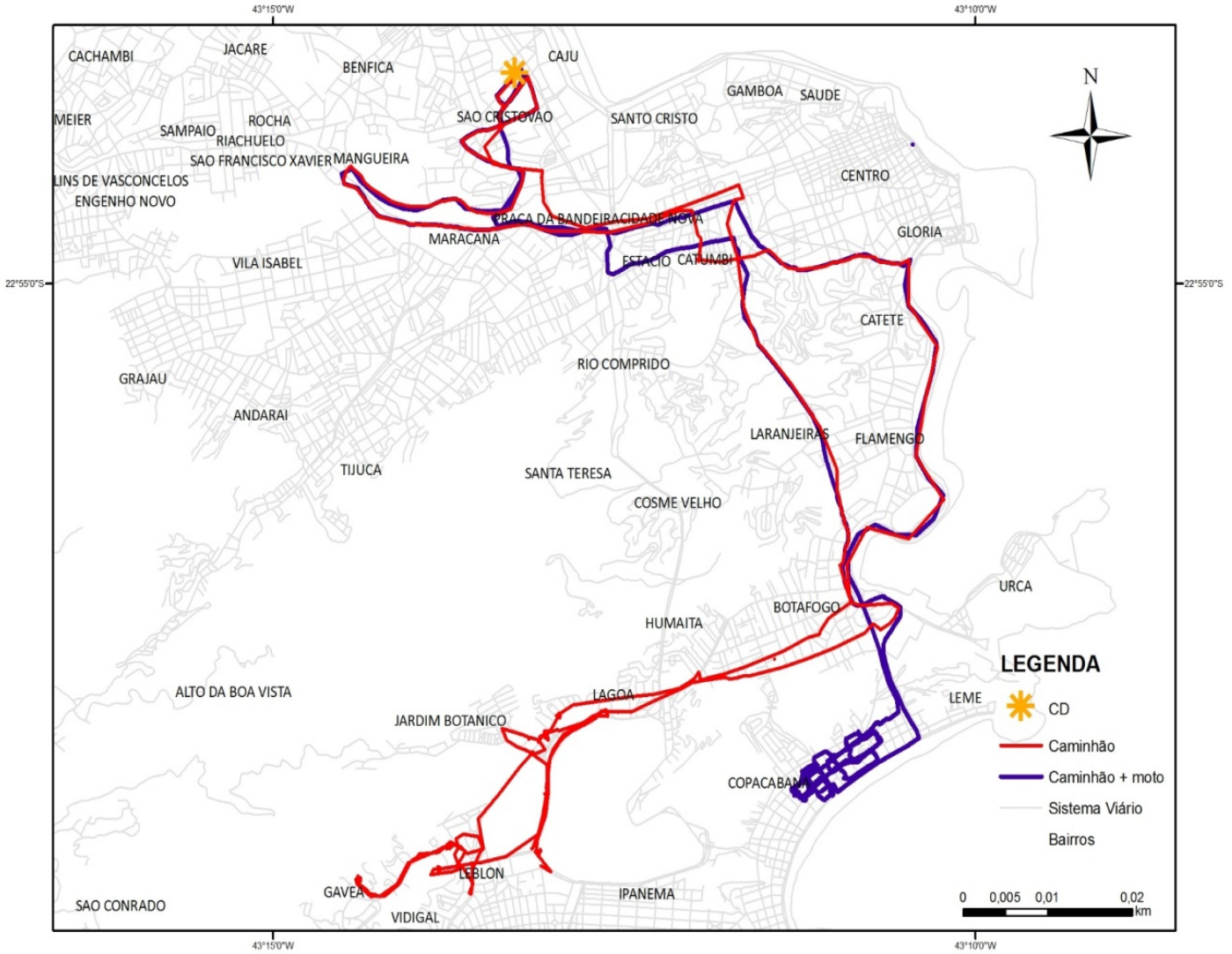
Truck as a mobile depot + Pedal cargo tricycle (hypothetical)



Environmental and economic performance

Scenarios			
Load and unload time.	50 min	13 min	13 min
Average time between two clientes (truck) or between departure from and return to transshipment point (truck + tricycle).	11 min	49 min	49 min
Average distance between two clientes (truck) or between departure from and return to transshipment point (truck + tricycle).	2,21 km	3,80 km	3,80 km
Average speed between two clientes (truck) or between departure from and return to transshipment point (truck + tricycle).	12 km/h	4.65 km/h	4.65 km/h
Average number of stops per day.	9	5	5
Total time traveled (departure until return to DC).	11h 36 min	11h 8 min	11h 8 min
Total distance traveled	59.7 km	127 km	127 km
Workforce per vehicle	Driver + 2 helpers	Driver + 2 helpers + tricycle driver	Driver + 2 helpers + tricycle driver

Routes


43°15'0"W
43°10'0"W
22°55'0"S
CACHAMBI
JACARE
BENFICA
CAJU
GAMBOA
SAUDE
MEIER
SAMPAIO
ROCHA
RIACHUELO
SAO CRISTOVAO
SANTO CRISTO
SAO FRANCISCO XAVIER
MANGUEIRA
LINS DE VASCONCELOS
ENGENHO NOVO
CENTRO
PRACA DA BANDEIRA
CIDADE NOVA
MARACANA
GLORIA
VILA ISABEL
ESTACIO
CATUMBI
CATETE
GRAJAU
RIO COMPRIDO
ANDARAI
LARANJEIRAS
FLAMENGO
TIJUCA
SANTA TERESA
COSME VELHO
URCA
BOTAFOGO
HUMAITA
ALTO DA BOA VISTA
LAGOA
LEME
JARDIM BOTANICO
COPACABANA
LEBLON
GAVEA
IPANEMA
SAO CONRADO
VIDIGAL
N
LEGENDA
CD
Caminhão
Caminhão + moto
Sistema Viário
Bairros
0 0,005 0,01 0,02
km

Emission Factors

EMISSION FACTORS	CO2 (kg/km)	Atmospheric pollutants (g/km)				Fuel Consumption (km/l)
Vehicle	CO2	CO	NOx	NMHC	PM	
Medium truck	0.85	1.11	2.40	0.21	0.02	3.2 km/l
Motorcycle (after 2010)	0.11	0.73	0.07	0.14	0.0035	19 km/l
Bicycle or tricycle (electric or not)	0.00	0.00	0.00	0.00	0.00	No fuel needed

Source: Inventário Nacional de Emissões Atmosféricas por Veículos Automotores Rodoviários, 2013

Table of content

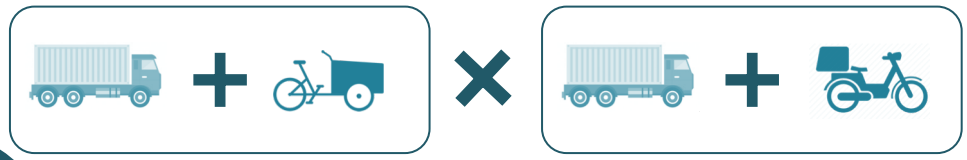
Emission results

CO2 = ⬇ 20% NMHC = ⬇ 20%

CO = ⬇ 19% PM = ⬇ 20%

NOx = ⬇ 20%

% kg/day
% g/day



CO2 = ⬇ 16% NMHC = ⬇ 50%

CO = ⬇ 49% PM = ⬇ 20%

NOx = ⬇ 4%

CO2 = ⬇ 60% NMHC = ⬇ 60%

CO = ⬇ 59% PM = ⬇ 60%

NOx = ⬇ 58%

% kg/km
% g/km

CO2 = ⬇ 16% NMHC = ⬇ 50%

CO = ⬇ 49% PM = ⬇ 21%

NOx = ⬇ 1%

Costs results

Costs	Truck	Truck + motorized tricycle	Truck + pedal tricycle
Fixed cost (vehicle) USD/month	**$411**	Truck = $411 Tricycle = $39 **Total = $450**	Truck = $411 Tricycle = $17 **Total = $428**
Variable cost (fuel)	$14/day **$420/month**	Truck = $11/day Tricycle = $3/day Total = $14/day – **$420/month**	Truck = $11/day Tricycle = $0/day Total = $11/day – **$330/month**
Total USD/month	**$831**	**$870**	**$758**

- Maintenance costs;

- Governmental tax costs;

- Insurances cost;

- Fluctuations in fuel cost;

- Etc.

Table of content

Conclusions

- **60%⬇** emission (kg/km) {truck};
- Service level and logistic operation **unaffected**;
- Significant **reduction** in environmental impact (all emission and both scenarios);
- **9%** to **13%⬇** analyzed costs.
- **High potential** to reduce total cost of operation.


Thanks for listening!