

A case study of off-hour delivery collaboration and cost-sharing between freight receivers and carriers



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Urban areas...

3%

of earth's land

75%

of carbon emissions

In 2016...

91%

of people (in urban areas)
were breathing unsafe air

50%

with pollution levels 2.5
times higher than
acceptable level

Sustainable Development Goals



Reducing air pollution...



Reducing air pollution...



Commercial vehicles delivering
in urban areas during regular
hours

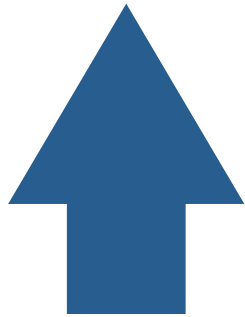


Congestion in urban areas



Carbon emissions in urban
areas

Reducing air pollution...



Off-hour deliveries in urban areas

Change receiver logistics behaviour





Photo by David Ritchie

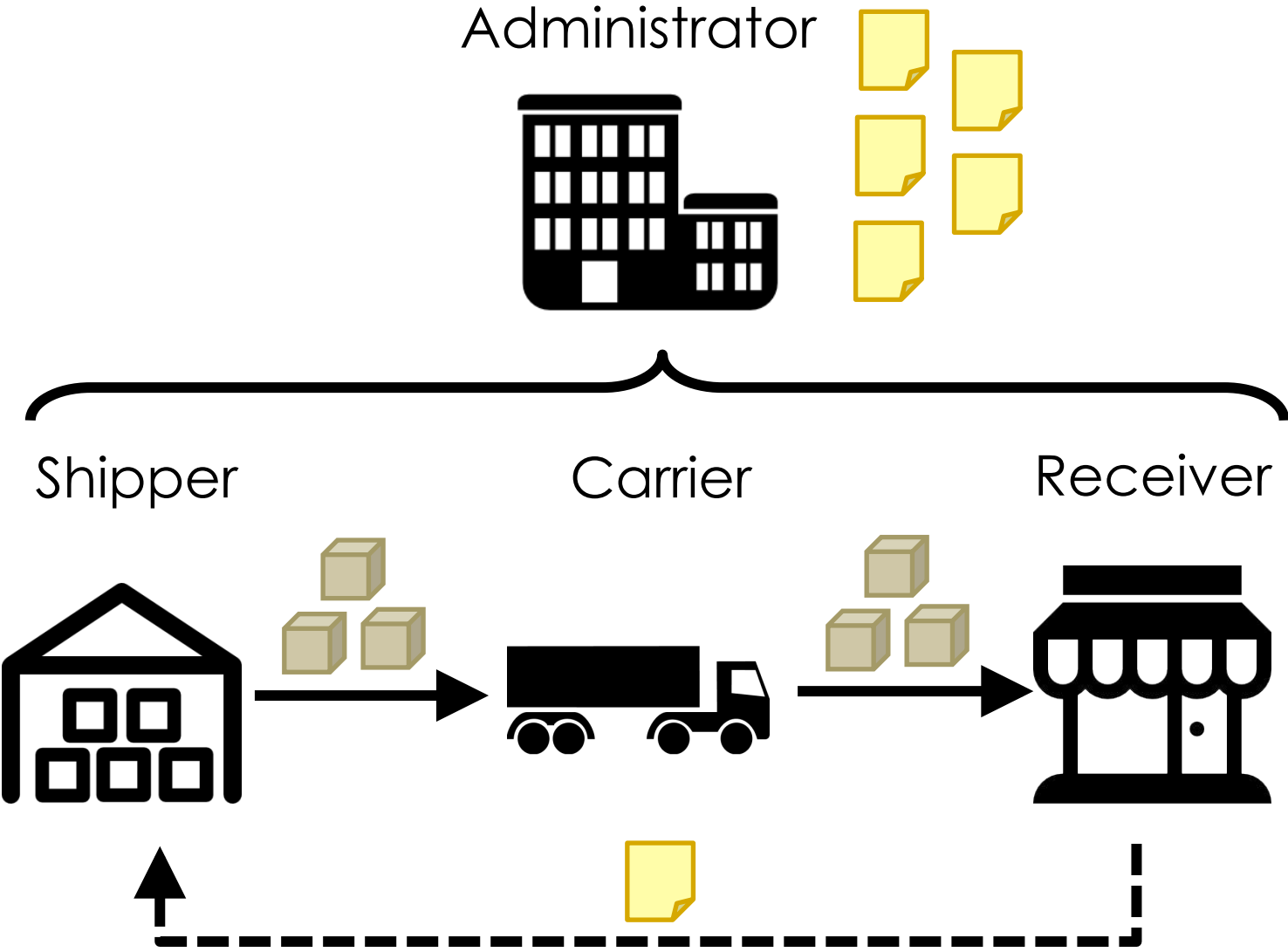
Off-hour deliveries in the City of Cape Town

Pilot tests can be useful tools to better understand the **potential impacts** on stakeholders.

Implementing in practice can be **difficult** and (sometimes) **disruptive**.

Agent-based simulation provides a safe environment to investigate the **potential impacts** (for example MATSim).

Urban Freight **stakeholders**

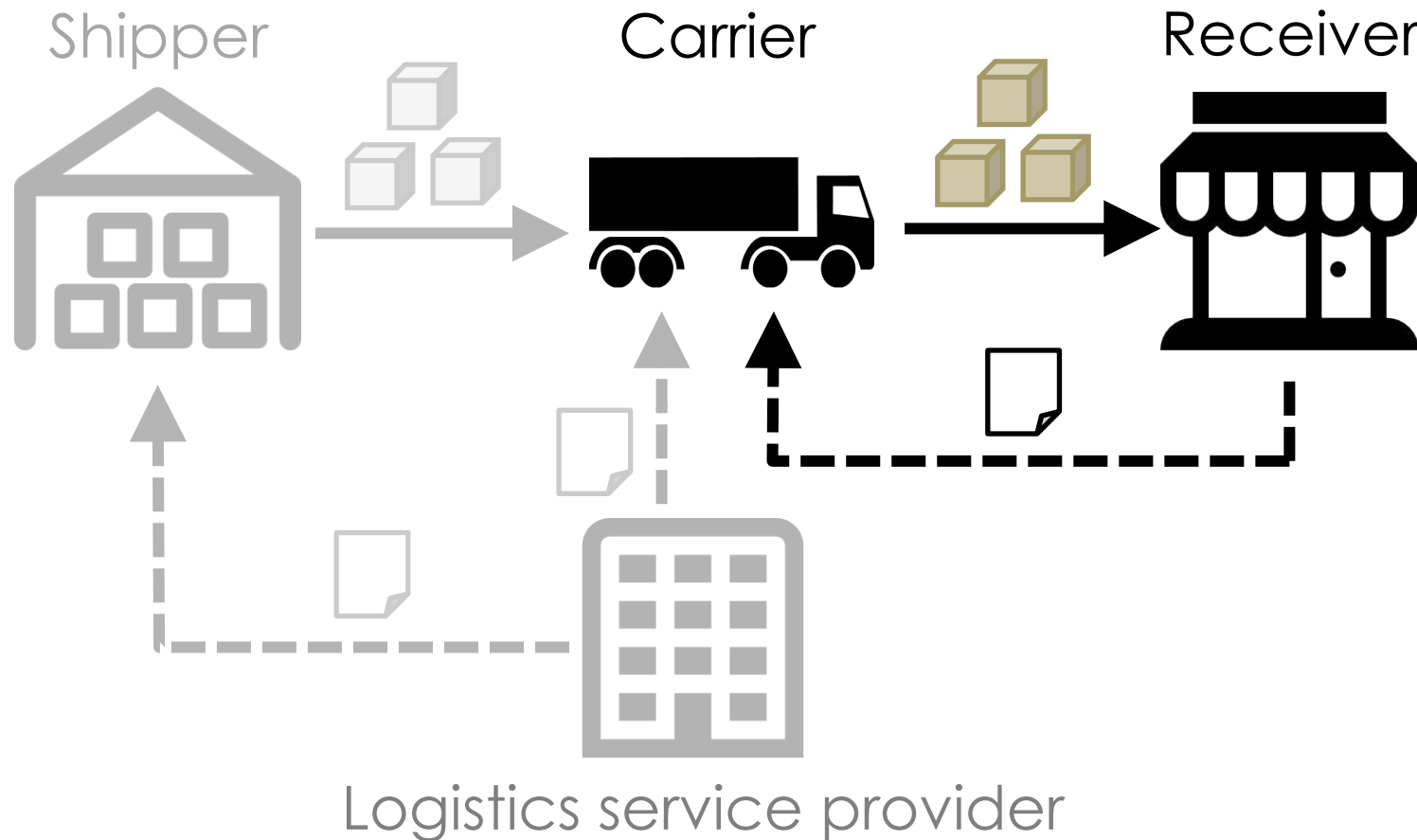


Freight modelling in MATSim

Model freight **movements based on GPS records** as additional load on network.

Including freight agents as **behaviourally rich agents** into the simulation.

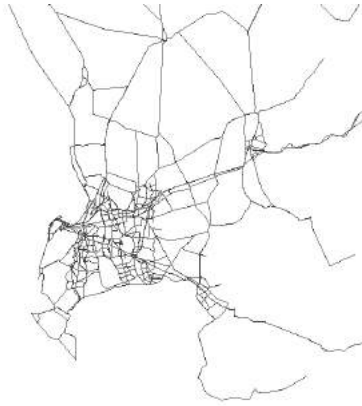
MATSim freight agents



Schroeder, S., Zilske, M., Liedtke, G., and Nagel, K. (2012). Towards a multi-agent logistics and commercial transport model: The transport service provider's view. *Procedia Social and Behavioral Sciences*, 39, 649-663.

Bean, W.L. and Joubert, J.W. (2019). Modelling receiver logistics behaviour. *Procedia Computer Science*, 151, 763-768.

Model and method



Cape Town **road network**



Receiver locations → Large retailer store locations (87 stores)



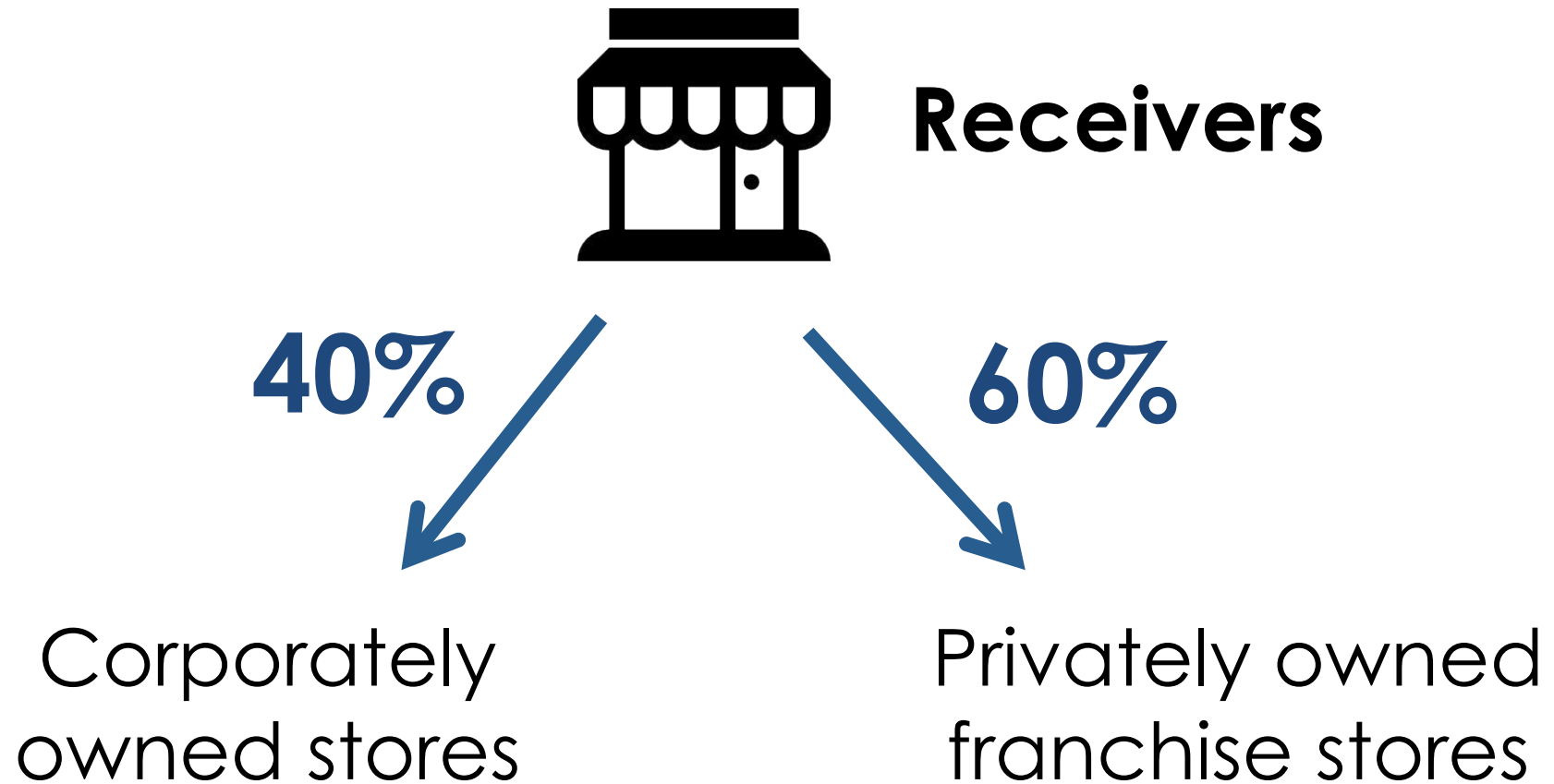
Carrier depot location → Retailer distribution centre



© OpenStreetMap contributors

Simunto
MATSim
Multi-Agent Transport Simulation

Model and method



Model and method

Corporately owned stores



Grand coalition members



May **accept off-hour** deliveries

Privately owned franchise stores

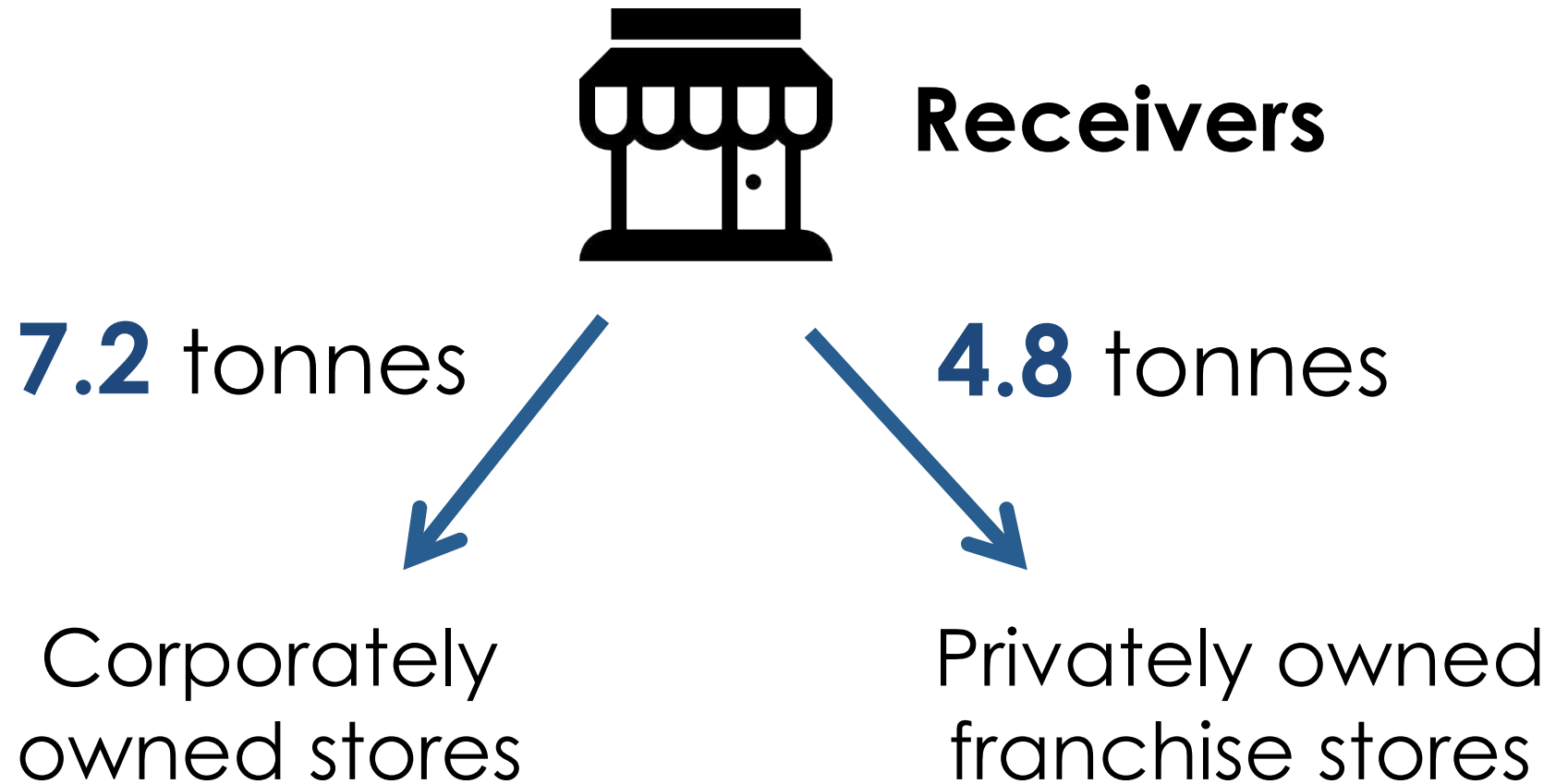


Non-grand coalition members

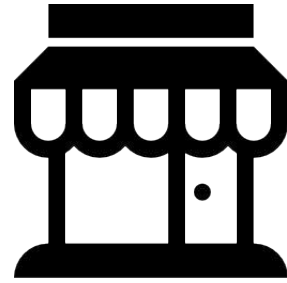


Only **accept daytime** deliveries

Model and method



Model and method



Receivers

Daily deliveries

Delivery **time windows**

Time window **hourly cost**

Model and method



8 tonnes



14 tonnes



26 tonnes

Model and method



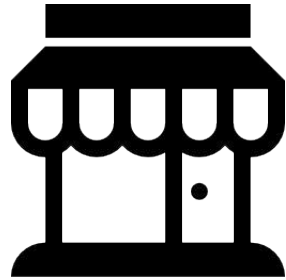
Carrier

Transportation cost

Missed time window penalty cost

Time cost

Regular-hour delivery case



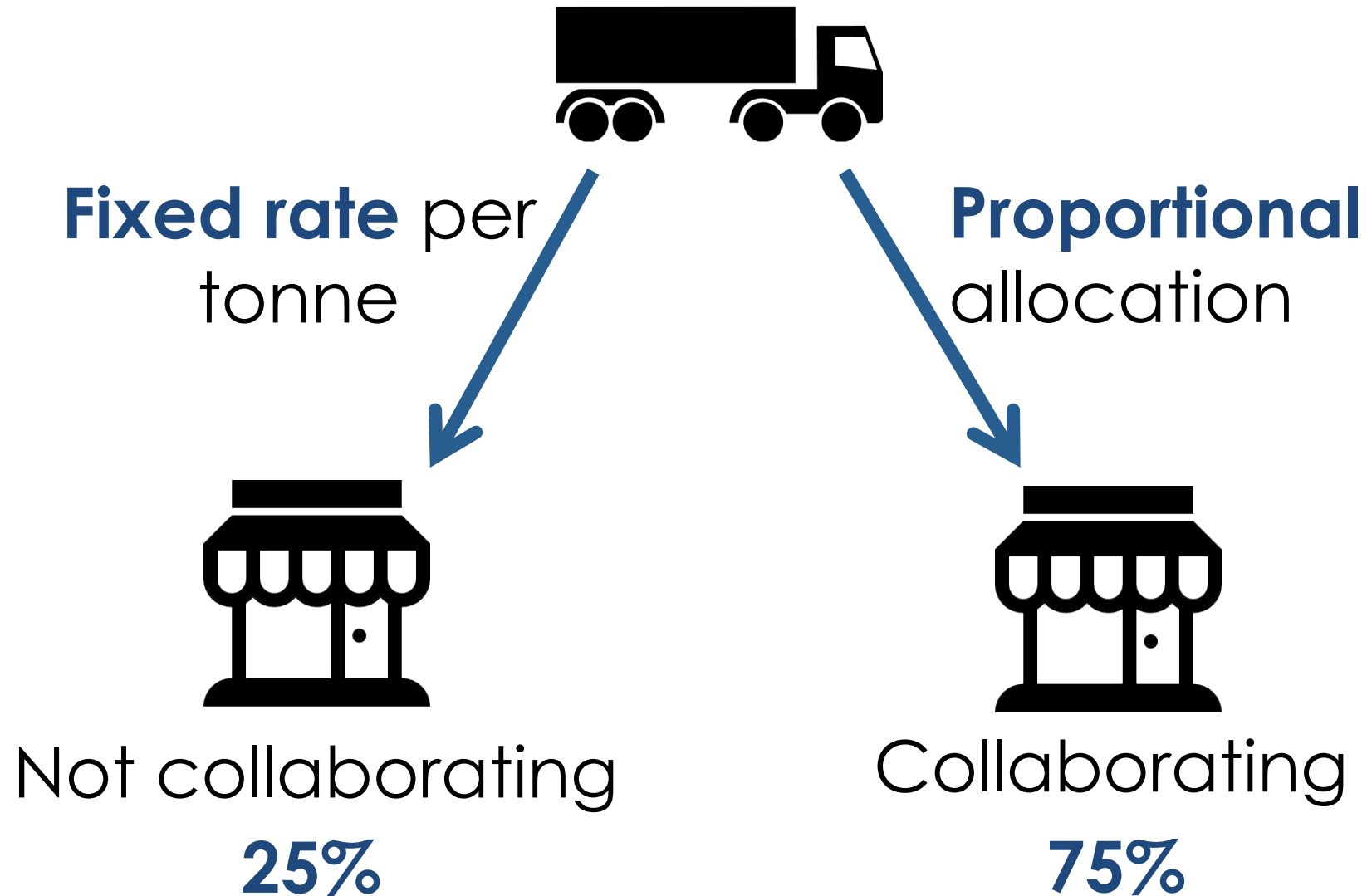
Receivers

Only daytime delivery time windows
between 06:00 and 18:00

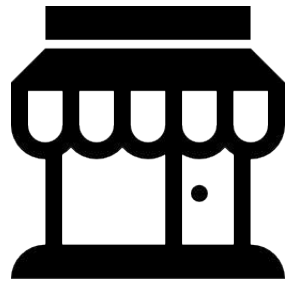
Increasing or decreasing time window
durations.

Leaving or joining sub-coalitions (only
grand coalition members).

Carrier cost allocation



Off-hour delivery case



Receivers

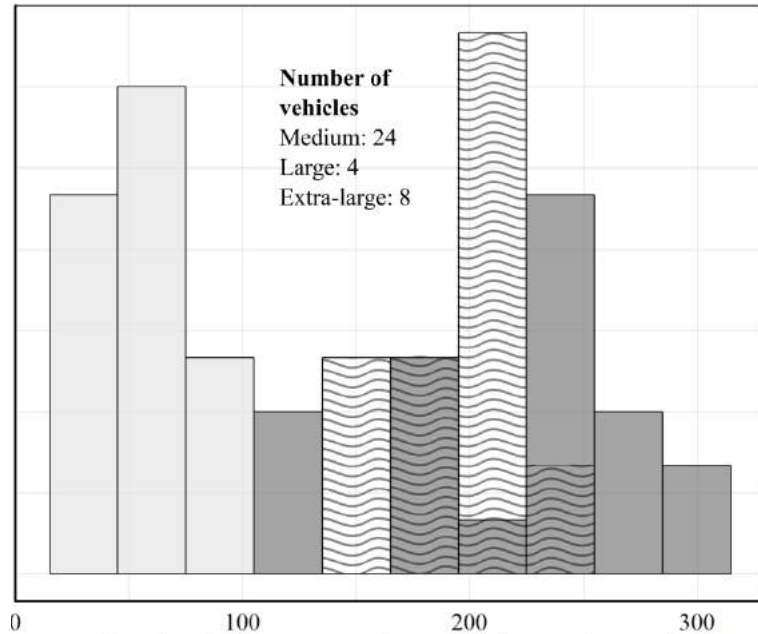
Daytime delivery time windows for **non-**
collaborators.

Off-hour delivery time windows
between 18:00 and 06:00 for
collaborators.

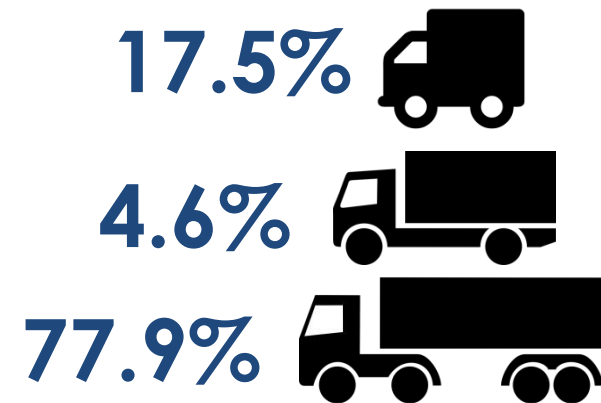
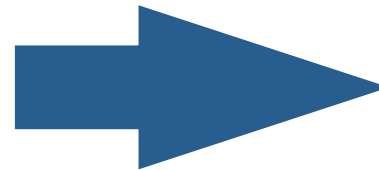
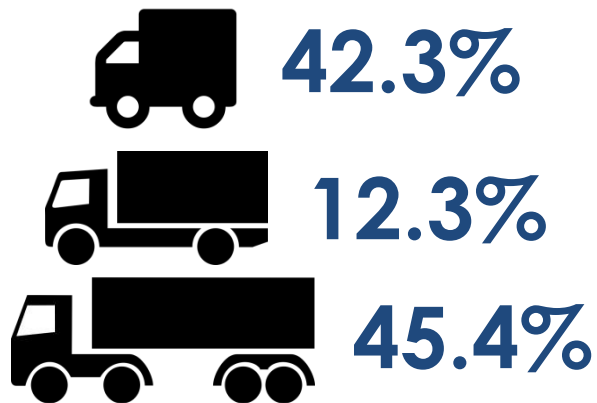
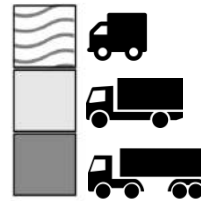
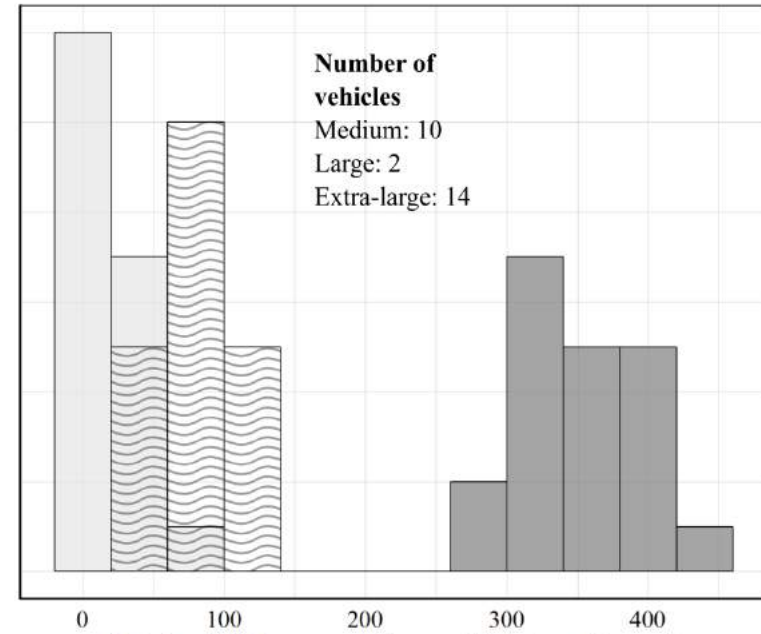
Results

Total weight transported per type (tonnes)

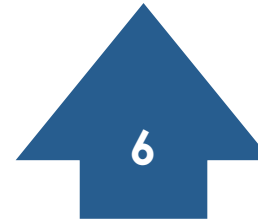
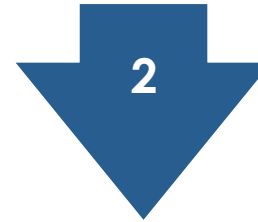
Regular-hour deliveries



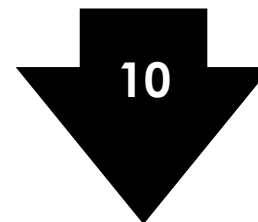
Off-hour deliveries



Results



Total fleet size

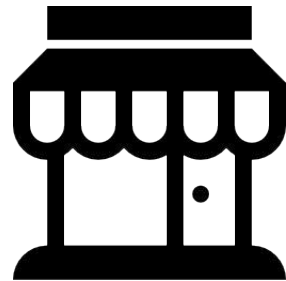


Results



Carrier

15.6% reduction in total delivery cost



Receivers

28.8% reduction in delivery cost charged
and time window cost

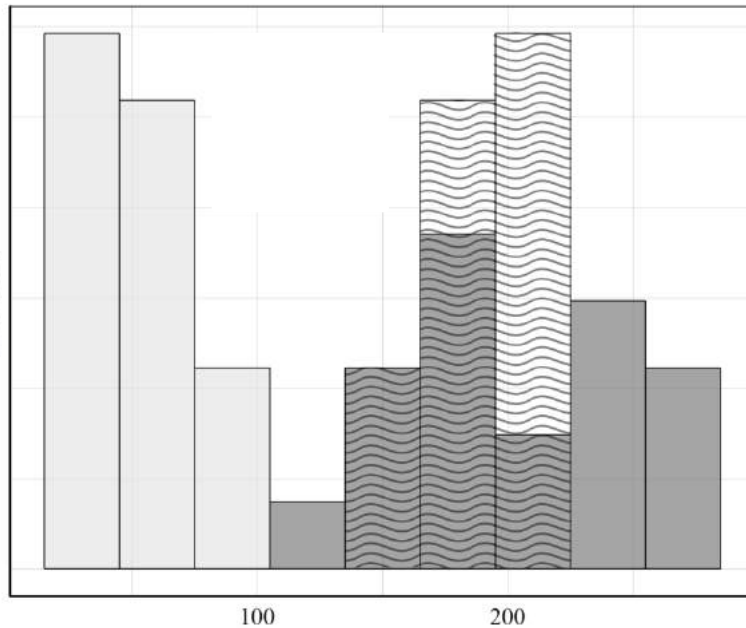


Photo by David Ritchie

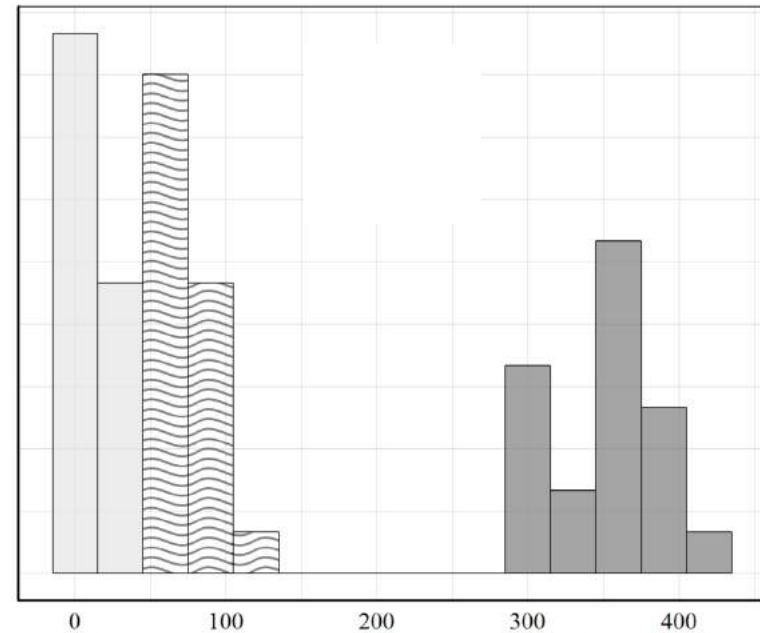
Results (with passenger traffic)




Total weight transported per type (tonnes)

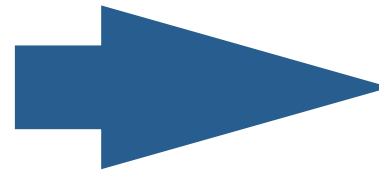
Regular-hour deliveries






Off-hour deliveries

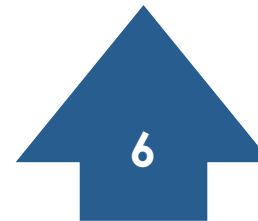


 **42.5%**
 **12.7%**
 **44.8%**

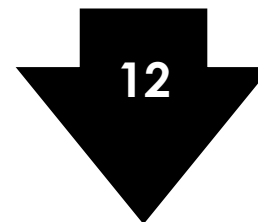


17.0% 
3.6% 
79.4% 

Results (with passenger traffic)



Total fleet size

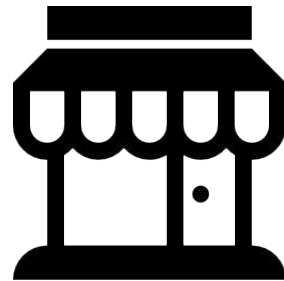


Results (with passenger traffic)



Carrier

15.8% reduction in total delivery cost



Receivers

28.4% reduction in delivery cost charged and time window cost

Conclusion

Carrier **delivery cost reduced significantly** with off-hour deliveries.

Majority of **receivers were willing to collaborate** and accept off-hour deliveries.

Fixed **delivery fee** charged to non-collaborators had a **major impact**.

Future work.

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