EVALUATION OF THE POTENTIAL IMPACTS OF OFF-HOUR DELIVERIES

I. SAVADOGO[1] & A. BEZIAT[1]

[1] TRANSPORT URBAN PLANNING ECONOMICS LABORATORY – LYON, FRANCE

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STATEMENT

In recent years, there has been a growing awareness among city stakeholders (public and private) of the need to act on Urban Goods Movement (UGM) in order to reduce the negative effects of transport. Among these solutions, Off-hour Deliveries (OHD) consists in postponing deliveries to periods when urban traffic is less dense, outside peak passenger traffic periods. The expected effects are a reduction of : travel times, energy consumption, GHG and pollutant emissions, accidents, inconvenient parking, etc.

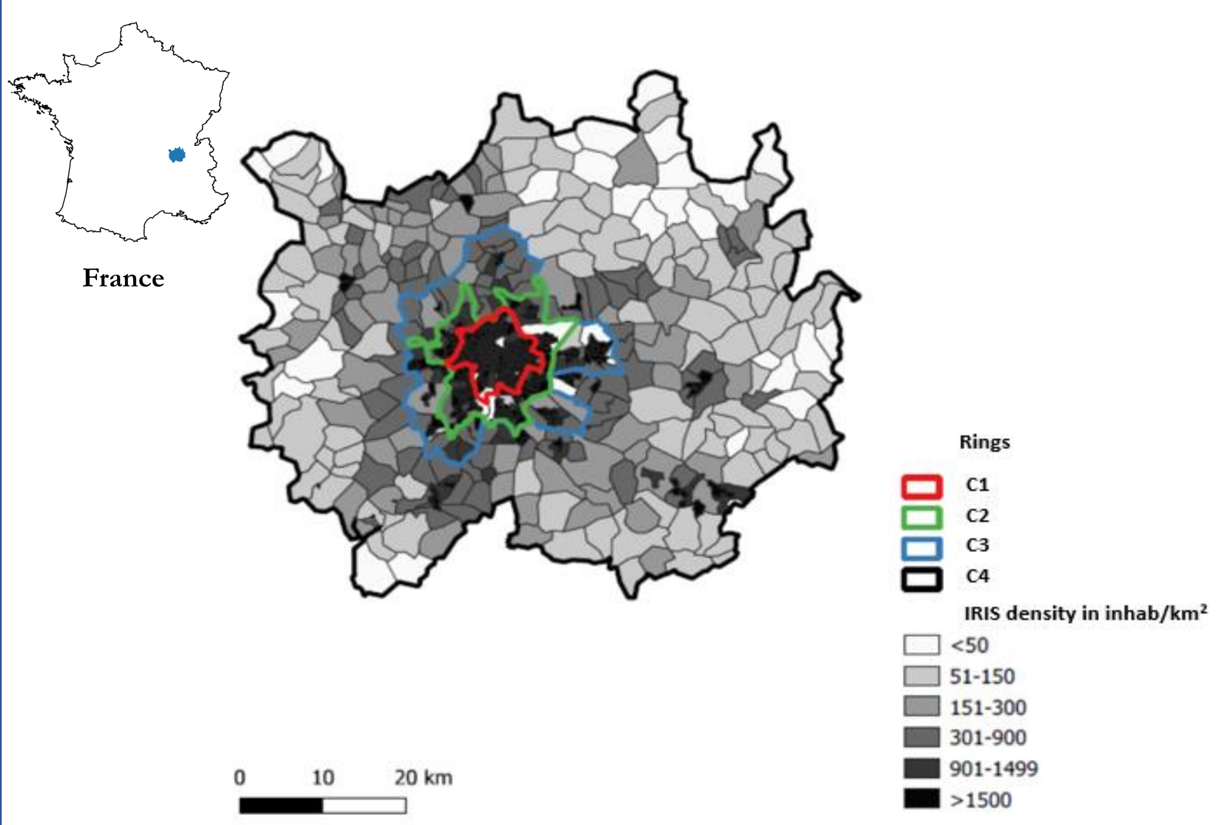
Several OHD experiments have been conducted in cities around the world. They lead to promising results, but they have been conducted mostly at small scale (in some streets or with a few establishments in the city). So it can be whether OHDs deployed at large-scale can be efficient to reduce emissions, since general traffic conditions will be affected.

RESEARCH QUESTION & STUDY PURPOSE

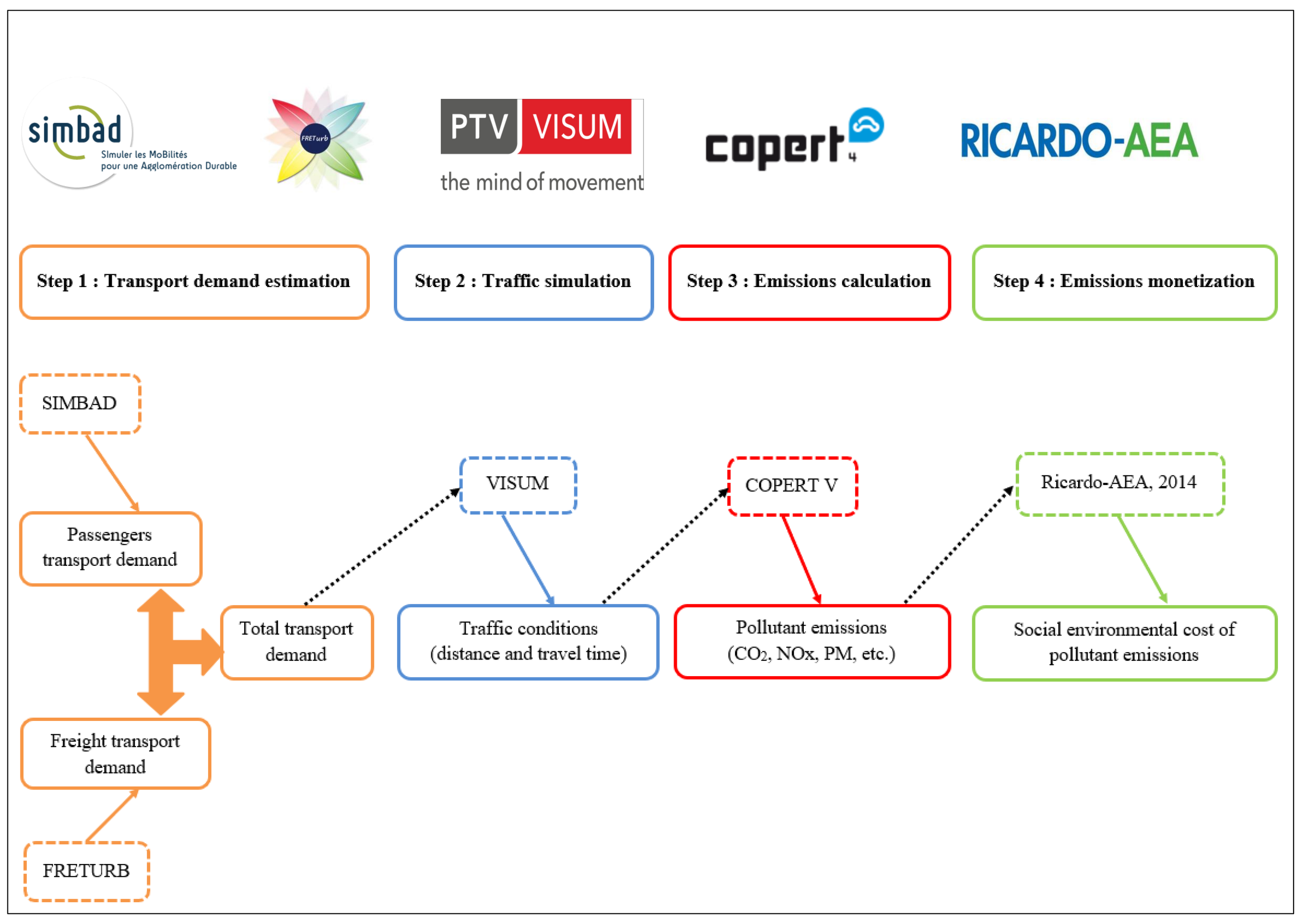
Based on a large-scale modeling of the urban area of Lyon (LUA), our purpose is to answer the following questions :

- ❑ Does postponing a large share of goods movements during the off-hours (OH) leads to a significant reduction of pollutant emissions ?
- ❑ Could this justify the economic and organizational changes that such a postponement would cause, while we know that these changes have a cost for all the actors involved in UGM ?

METHODOLOGY



Study scope : Lyon Urban Area (LUA) in its 1999 limits



Methodological framework

We use a 4-step methodological framework :

1. ***Transport demand estimation***: the area total transport demand is represented as OD matrix by adding freight transport demand and passenger transport demand.
2. ***Traffic simulation***: 4 periods are considered :
   - Morning peak hour HPAM (7-9am);
   - Afternoon peak hour HPPM (5-7pm);
   - Daytime off-hours HCJ (9am-5pm and 7pm-9pm);
   - Night (9pm-7am), corresponding to Off-hours.
3. ***Emissions calculation*** : We just focus on emissions from goods transport vehicles, based on the 2012 French National Fleet Surveys.
4. ***Emissions monetization*** : We use the European guideline on external transport costs for translating emissions into environmental social cost.

Five scenarios, according to the percentage of postponed flows, were built up in order to capture the effect of OHDs.

RESULTS

Limited environmental gains…

- ❑ **Environmental gains increase less than proportionally** to the share of postponed flows. Maximum gains are obtained when 100% OHD is reached.
- ❑ Inversely, when all deliveries are carried out during daytime (*Scen 0%*) all emissions would increase : 0.6% for CO2, 0.8% for NOx and 1.1% for PM.
- ❑ Gains are partly explained by the **relative improvement in traffic conditions as the percentage of OHD increases.**

	Scen 0%	Scen Ref	Scen 20%	Scen 50%	Scen 80%	Scen 100%
CO_2 (tons/year)	385,246	382,778	378,468	373,360	370,384	369,584
	0.6%		*-1.1%*	*-2.5%*	*-3.2%*	*-3.4%*
CO (tons/year)	197	195	191	186	183	183
	1.2%		*-2%*	*-4.4%*	*-5.8%*	*-6.1%*
NOx (tons/year)	2,481	2,462	2,428	2,388	2,364	2,358
	0.8%)		*-1.4%*	*-3%)*	*-4. %*	*-4.2%*
PM (tons/year)	9	8	8	8	8	8
	1.1%		*-2%*	*-4.3%*	*-5.6%*	*-5.9%*
COV (tons/year)	20	20	19	19	18	18
	1.4%		*-2.6%*	*-5.6%*	*-7.3%*	*-7.6%*
HCJ Speed (km/h)	41.7	42	42.5	43.2	43.9	44.3
	-0.6%		*1.2%*	*3%*	*4.5%*	*5.5%*
HPAM Speed (km/h)	35.5	35.9	36.6	37.6	38.6	39.3
	-1%		*1.9%*	*4.8%*	*7.6%*	*9.6%*
HPPM Speed (km/h)	37.7	37.9	38.2	38.6	39	39.3
	-0.4%		*0.8%*	*1.9%*	*3%*	*3.8%*
Night Speed (km/h)	46.8	46.8	46.7	46.5	46.1	45.7
	0.0%		*-0.1%*	*-0.6%*	*-1.5%*	*-2.4%*

CO2 and pollutant emissions

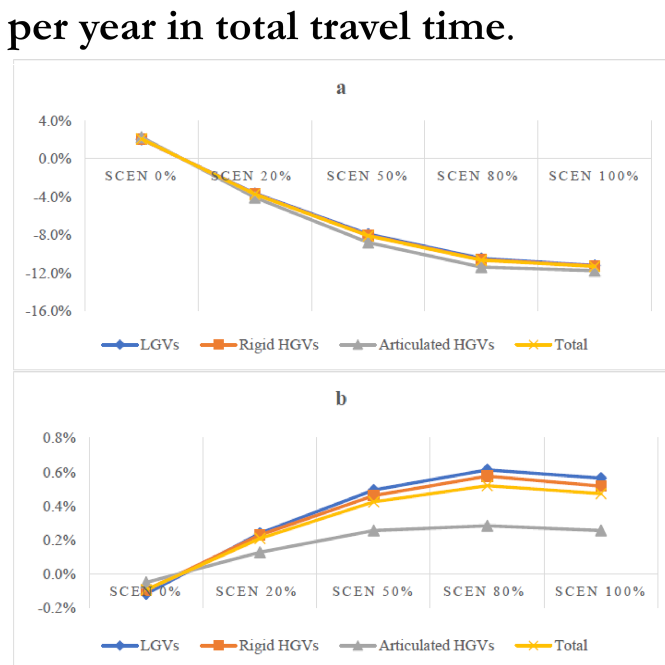
with positive effects on social costs…

- ❑ Maximum gain allowed by OHDs in the study area is € 2.59 million per year, *i.e.* **a decrease of 3.9%**

	Scen 0%	Scen Ref	Scen 20%	Scen 50%	Scen 80%	Scen 100%
CO_2	34.67	34.45	34.06	33.60	33.33	33.26
NOx	32.39	32.14	31.69	31.16	30.86	30.77
$PM_{2.5}$	0.57	0.57	0.55	0.54	0.53	0.53
COV	0.03	0.03	0.03	0.03	0.03	0.03
			Total cost by area			
LUA	67.67	67.19	66.44	65.34	64.75	64.59
	0.7%		*-1.3%*	*-2.8%*	*-3.6%*	*-3.9%*
C1	14.6	14.5	14.3	14.0	13.8	13.7
	1%		*-1.8%*	*-3.8%*	*-5.1%*	*-5.5%*
C2	9.7	9.6	9.4	9.3	9.2	9.1
	0.8%		*-1.5%*	*-3.2%*	*-4.3%*	*-4.6%*
C3	11.2	11.1	11.0	10.8	10.7	10.7
	0.7%		*-1.3%*	*-2.8%*	*-3.7%*	*-4%*
C4	32.2	32.0	31.7	31.3	31.1	31.1
	0.6%		*-1%*	*-2.1%*	*-2.7%*	*-2.9%*

Environmental social cost of emissions (€ M/year)

- ❑ OHDs allow to obtain a maximum gain of **2.5 million hours per year in total travel time.**



Variation of travel time (a) and distance traveled (b) in Vehicle kilometers (VKMs)

concentrated in the dense areas

	C1 : Emissions in tons/year and average speed in km/h						C4 :Emissions in tons/year and average speed in km/h					
	Scen 0%	Scen Ref	Scen 20%	Scen 50%	Scen 80%	Scen 100%	Scen 0%	Scen Ref	Scen 20%	Scen 50%	Scen 80%	Scen 100%
CO_2 (tons/year)	79,534	78,828	77,560	76,093	75,169	74,884	186,432	185,506	183,896	182,006	180,987	180,737
	0.9%		*-1.6%*	*-3.5%*	*-4.6%*	*-5%*	*0.5%*		*-0.9%*	*-1.9%*	*-2.4%*	*-2.6%*
CO (tons/year)	40	39	38	37	36	36	94	94	92	90	89	89
	1.5%		*-2.7%*	*-5.8%*	*-7.6%*	*-8.2%*	*0.9%*		*-1.6%*	*-3.6%*	*-4.6%*	*-4.8%*
NOx (tons/year)	554	548	538	526	518	516	1,172	1,164	1,152	1,137	1,129	1,127
	1%		*-1.9%*	*-4.1%*	*-5.4%*	*-5.8%*	*0.6%*		*-1.1%*	*-2.3%*	*-3%*	*-3.2%*
PM (tons/year)	2	2	2	2	2	2	4	4	4	4	4	4
	1.5%		*-2.7%*	*-5.8%*	*-7.8%*	*-8.3%*	*0.9%*		*-1.5%*	*-3.3%*	*-4.3%*	*-4.5%*
COV (tons/year)	4	4	4	4	4	4	9	9	9	9	9	9
	1.8%		*-3.3%*	*-7.1%*	*-9.4%*	*-10%*	*1.2%*		*-2.1%*	*-4.5%*	*-5.8%*	*-6%*
HCJ speed (km/h)	24.1	24.3	24.7	25.2	25.6	25.9	52.0	52.2	52.5	53.0	53.5	53.8
	-0.7%		*1.4%*	*3.5%*	*5.4%*	*6.5%*	*-0.3%*		*0.6%*	*1.7%*	*2.6%*	*3.1%*
HPAM speed (km/h)	18.9	19.2	19.8	20.7	21.5	22.1	49.0	49.1	49.4	49.9	50.3	50.6
	-1.6%		*3.1%*	*7.8%*	*12.4%*	*15.5%*	*-0.3%*		*0.7%*	*1.6%*	*2.4%*	*3.1%*
HPPM speed (km/h)	20.8	20.9	21.2	21.5	21.9	22.1	50.0	50.0	50.1	50.3	50.5	50.6
	-0.6%		*1.1%*	*2.9%*	*4.6%*	*5.8%*	*-0.1%*		*0.2%*	*0.5%*	*0.9%*	*1.2%*
Night speed (km/h)	28.4	28.4	28.3	28.1	27.7	27.5	55.4	55.4	55.4	55.2	54.8	54.6
	0.1%		*-0.3%*	*-1%*	*-2.2%*	*-3.2%*	*0.0%*		*-0.1%*	*-0.3%*	*-1%*	*-1.5%*

CO2 and pollutant emissions in C1 and C4

- ❑ **In C1, the densest ring, any increase in the percentage of OHD leads to a relatively larger decrease in CO2** and pollutant emissions than at the total area scale due to larger variations in speed at this scale than at the Lyon Urban Area scale.
- ❑ **In C4, the results show a low sensitivity** of the quantities of CO2 and pollutants emitted into this ring as the percentage of OHDs increases.

DISCUSSIONS & CONCLUSION

- ❑ **OHDs have a positive environmental impact in the case of Lyon Urban Area**, but much lower than those obtained in small-scale experiments. Indeed, with a maximum reduction of 3.4% in CO2 emissions, this is a far cry from the gains achieved of 13%, 64% and 48% per km travelled for Bogotá, NYC and Sao Paulo respectively.
- ❑ Therefore, the **magnitude of the environmental impact of OHDs depends strongly on the characteristics of the city** (e.g. traffic conditions, city size, number of inhabitants, density, etc.) in which they are implemented.
- ❑ The strong presence of 30 km/h zones in the city of Lyon tends to limit the speed differences that can be observed between day and night.

→In mid-size cities not very congested, OHDs could have a positive but low environmental impact.
However, the gains in travel time, since they are productivity gains, are a reason in favor of the adoption of OHDs.

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