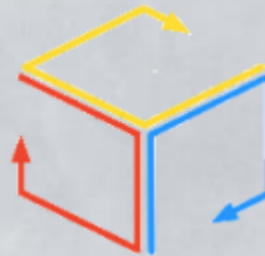


Developing a mesoscopic simulation model for examination of freight traffic of shopping malls in Budapest



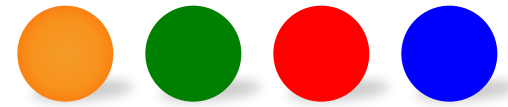
Budapest University of
Technology and
Economics,
Department of
Material Handling and
Logistics Systems

Krisztián Bóna PhD, Dávid Lajos Sárdi

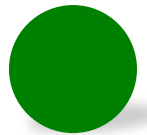


Smart Cities Symposium Prague 2017

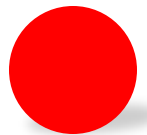
Agenda



Introduction



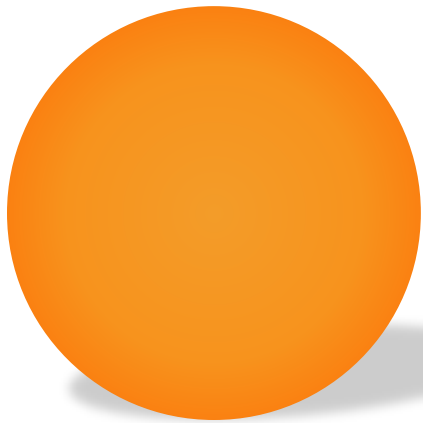
The simulation model



Results



Conclusions



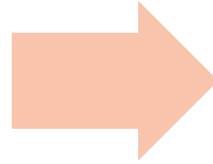
Introduction





Missing data

- How much?
- When?
- How often?
- Vehicles?
- ...



Methodology

- Exploratory research
- Questionnaire
- IEEE ICALT 2016
- WRITR 2017

Examination of shopping malls



3.

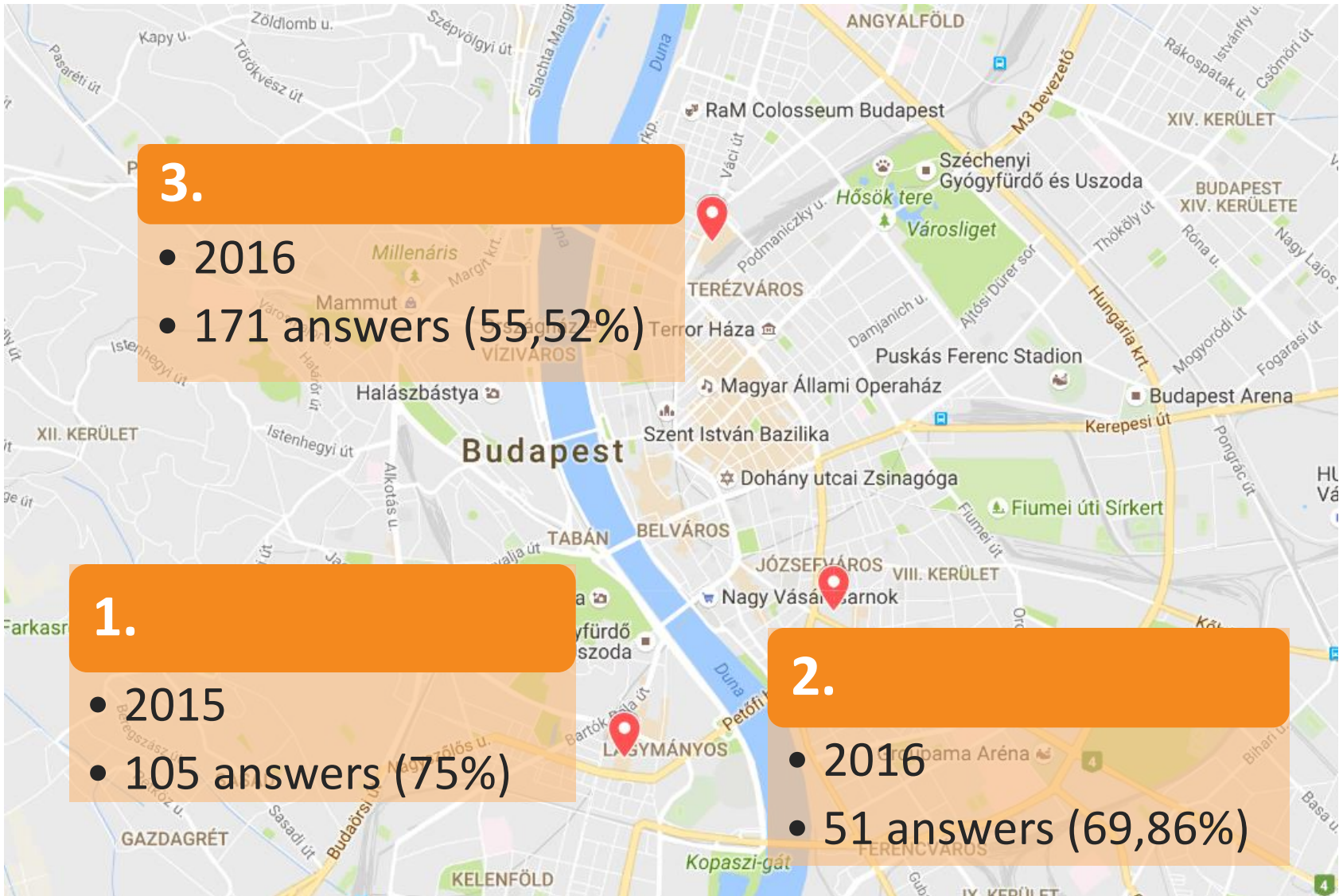
- 2016
- 171 answers (55,52%)

1.

- 2015
- 105 answers (75%)

2.

- 2016
- 51 answers (69,86%)



Problems



Lot of transactions

Small vehicles



**Small, non-standard sized
delivery units**



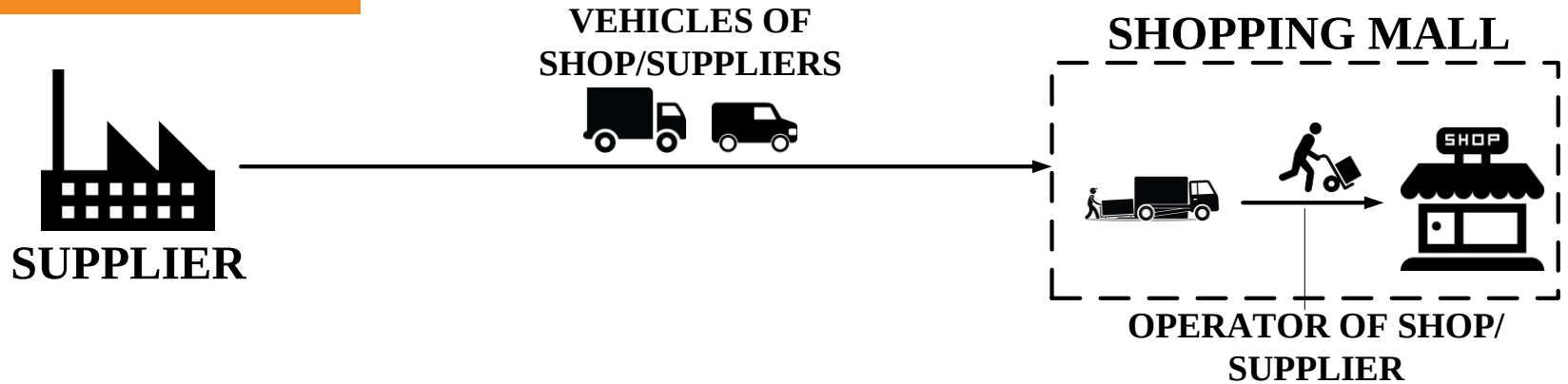
Big load for the roads

Big consumption

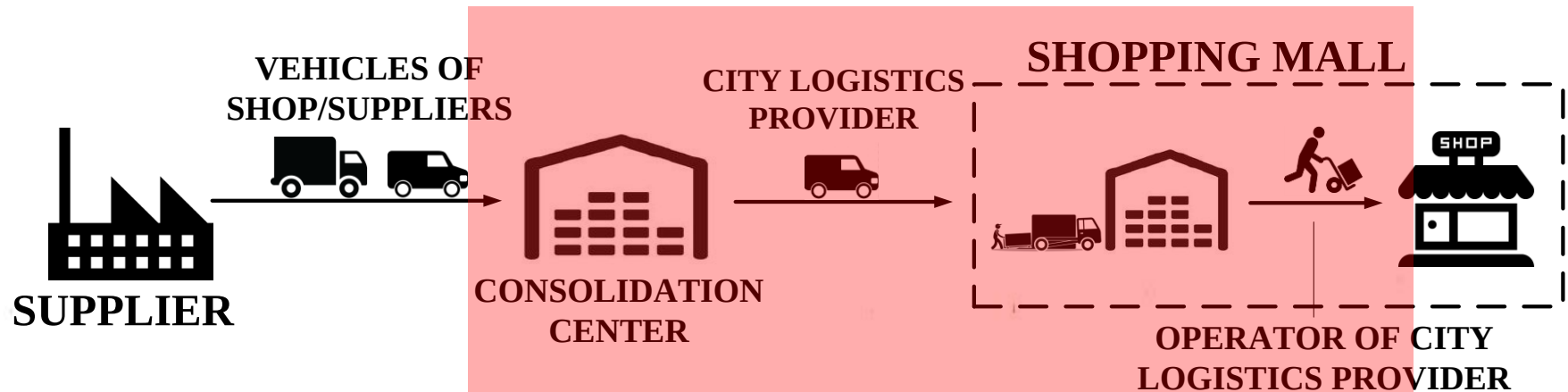
Delivery system

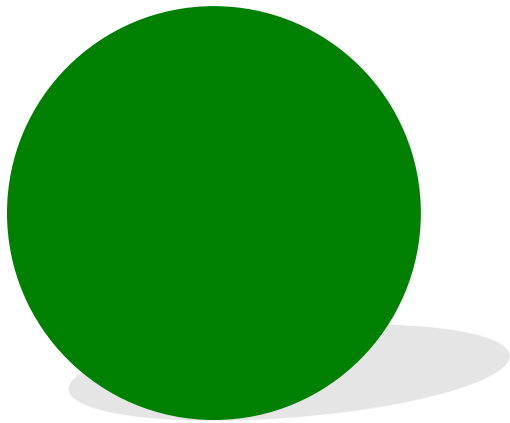


NOW



FUTURE





The simulation model





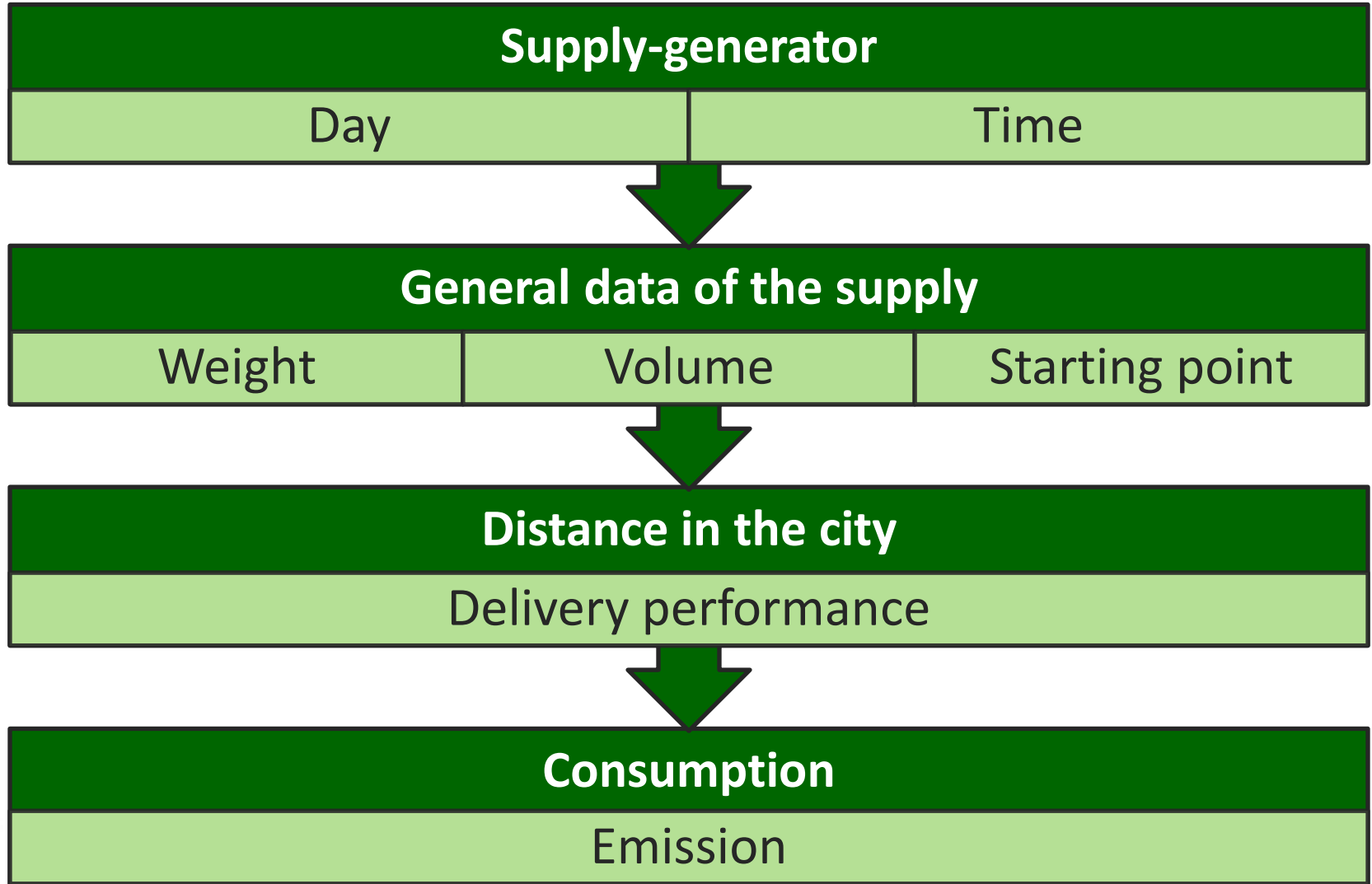
Input data

- 178 shops
- Deliveries
- Time window
- Goods
- Starting point of deliveries

Purpose of the modelling

- Number of deliveries
- Consumption
- Emission
- Stock of the CC

Modelling of present system



General data

Parameters of the generator

Delivery days

[illegible]

Time window
of the shop

Time of the supply
(day, hour)

SUPPLIES

Modelling of future system



Supply from the suppliers to the CC

Day

Time



General data of the supply

Weight

Volume

Starting point



Daily needs of the shops

Weight

Volume

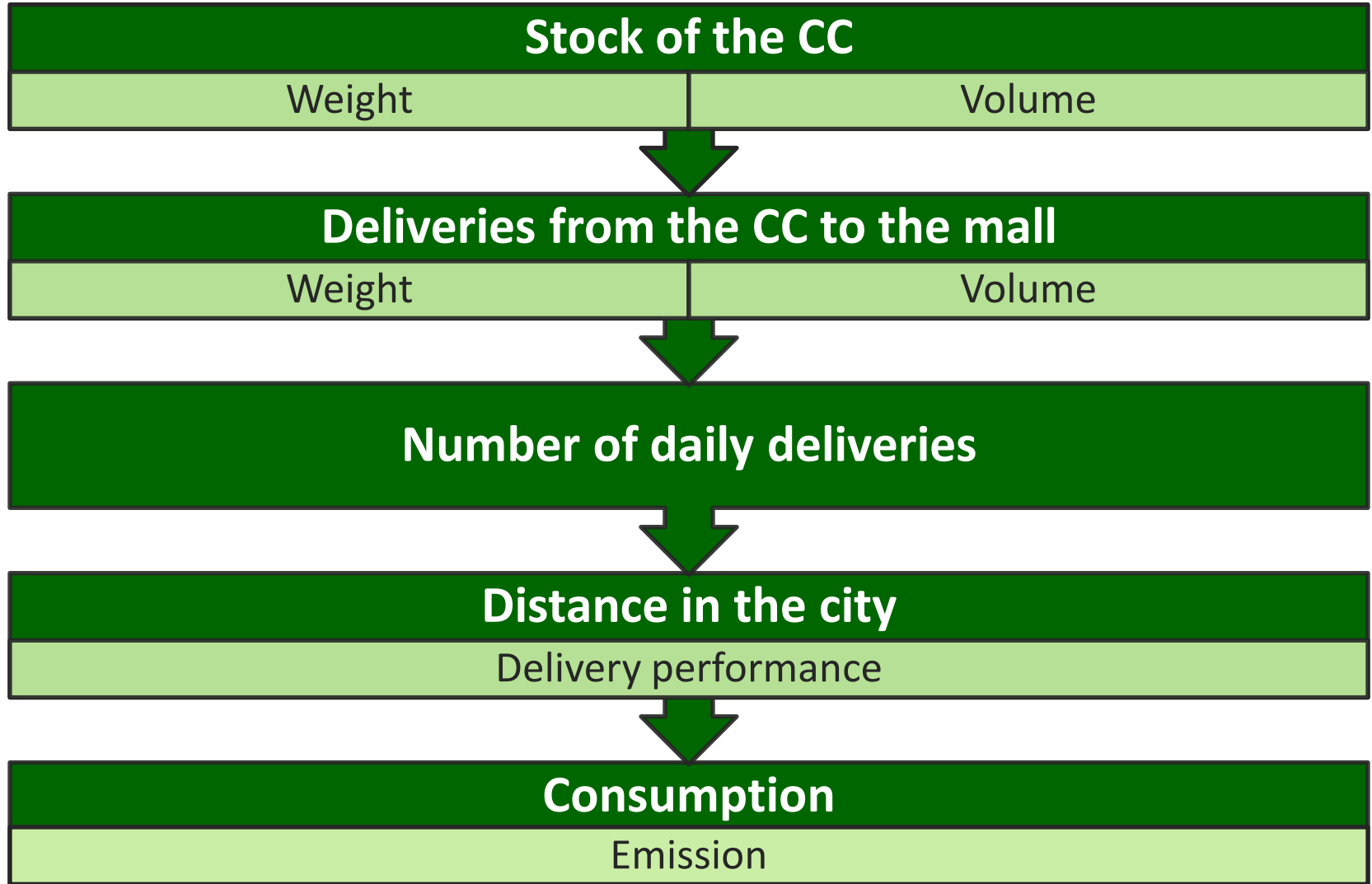


Stock of the CC

Weight

Volume

Modelling of future system



Delivery days

DELIVERIES

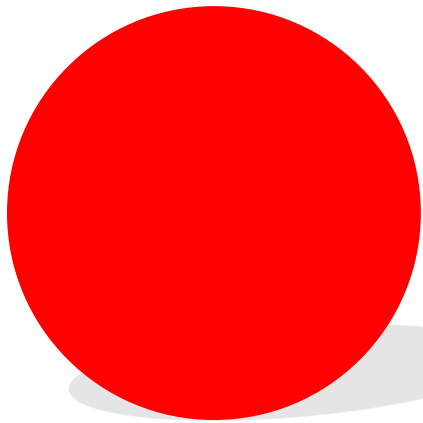
Stock of CC



Safety stock and
opening stock

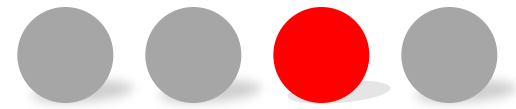
Daily closing stock

Mall ID	Supplier ID	Shop ID	SKU ID	Safety Stock	Opening stock	1	2	3	4	5	6	7	8	9	10	11	12
SM001	SUP0040	SH0040	SKU001	13	75	105	105	94	94	94	94	94	94	94	94	94	94
SM001	SUP0041	SH0041	SKU001	30	90	120	96	96	74	74	74	74	53	78	106	98	110
SM001	SUP0042	SH0042	SKU001	8	45	53	53	53	53	53	56	46	46	46	46	46	46
SM001	SUP0043	SH0043	SKU001	530	1060	1590	1590	2051	2594	2189	2189	2528	2528	2528	3183	3183	2489
SM001	SUP0044	SH0044	SKU001	180	540	672	656	771	716	701	658	602	583	570	536	651	611
SM001	SUP0045	SH0045	SKU001	120	360	445	425	398	369	352	315	281	267	254	295	259	222
SM001	SUP0046	SH0046	SKU001	30	180	210	210	210	241	241	280	280	234	234	234	234	234
SM001	SUP0047	SH0047	SKU001	300	900	1149	1089	974	866	770	705	670	551	544	477	366	604
SM001	SUP0048	SH0048	SKU001	612	1224	1708	1466	1213	950	1007	928	626	398	298	40	0	0
SM001	SUP0049	SH0049	SKU001	10	60	88	104	104	91	91	101	119	127	127	127	112	112
SM001	SUP0050	SH0050	SKU001	200	600	800	911	941	941	1002	1002	1184	1184	1299	1299	1192	1192
SM001	SUP0051	SH0051	SKU001	2000	2000	4000	4000	4000	4502	3584	3584	3584	2876	3807	4410	4207	3580
SM001	SUP0052	SH0052	SKU001	20	60	78	73	73	68	59	59	68	73	73	79	69	80
SM001	SUP0053	SH0053	SKU001	60000	60000	109695	101593	87060	113393	94515	89683	76905	105364	148045	139625	153767	140644
SM001	SUP0054	SH0054	SKU001	280	840	1177	1398	1398	1564	1667	1778	1638	1638	1638	1638	1524	1524
SM001	SUP0055	SH0055	SKU001	2700	2700	5115	4938	6336	6515	7615	6458	5819	5588	5672	4822	6846	7164
SM001	SUP0056	SH0056	SKU001	680	1360	2229	2229	2036	1806	1806	1961	1961	2572	2295	2592	2433	2759
SM001	SUP0057	SH0057	SKU001	200	600	841	779	945	874	874	805	912	912	1004	947	890	865
SM001	SUP0058	SH0058	SKU001	45	135	175	168	204	199	200	216	211	232	223	251	282	277
SM001	SUP0059	SH0059	SKU001	30	90	111	111	111	98	111	96	96	96	86	95	118	118



Results





Comparing
the weights

2,13%
difference

Comparable
systems

Results of the simulation



Number of deliveries: 92% ↓, 96% ↓
Delivery performance: 40% ↓, 10% ↓

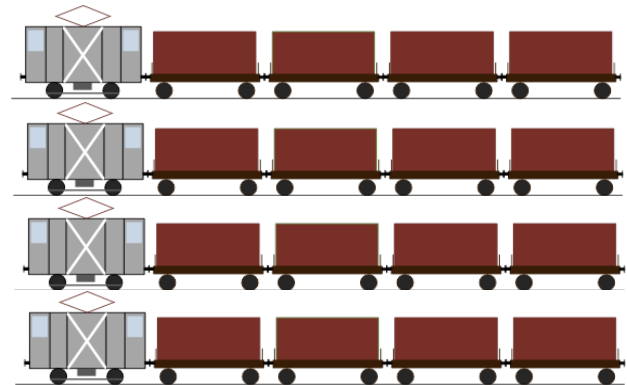
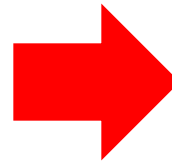
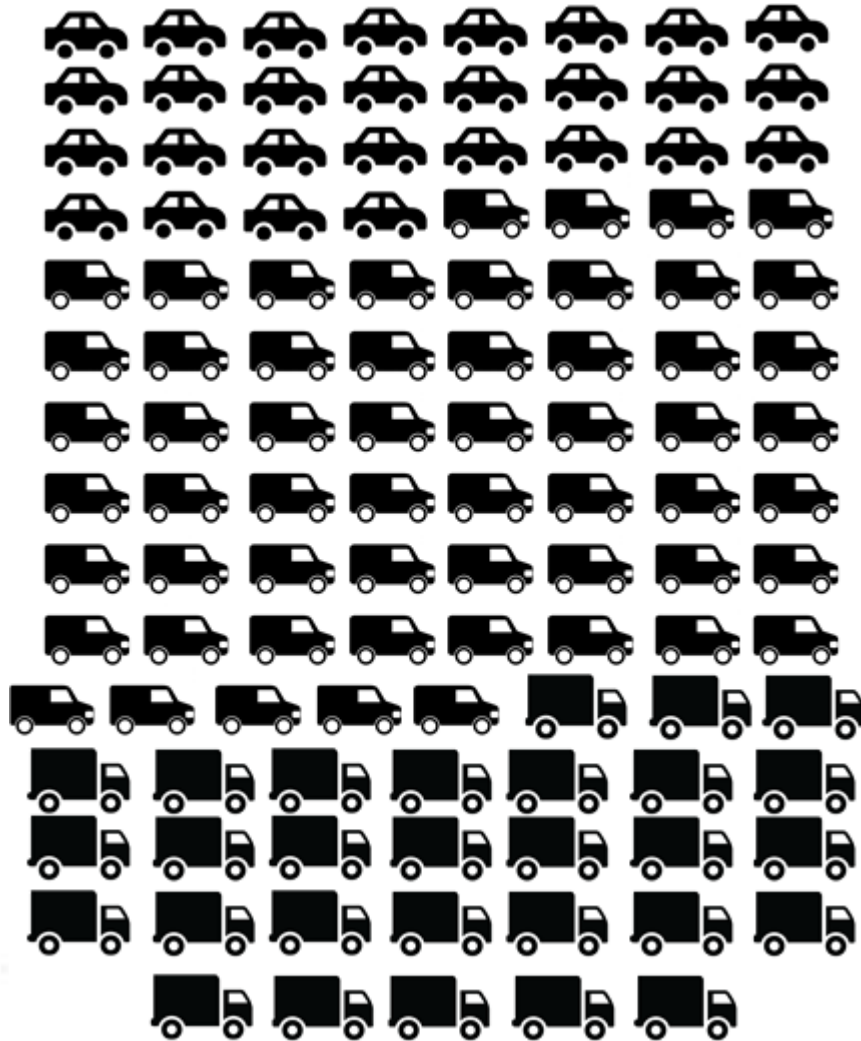


Consumption: 93% ↓, 75% ↓
Emission: 85-93% ↓

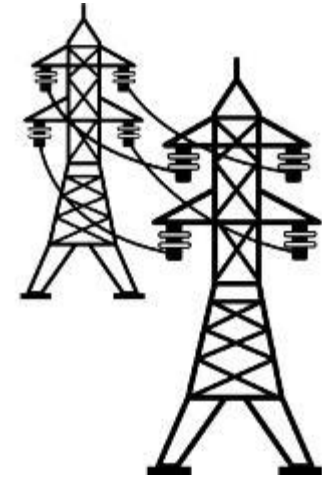
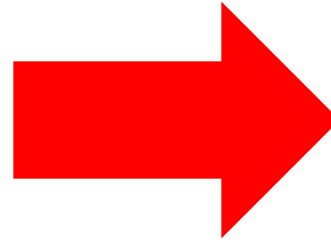


$Q_{avg} = 600,2 \text{ t (v=13 day)}$
 $Q_{avg} = 3747,9 \text{ m}^3 \text{ (v=14,7 day)}$

Number of deliveries



Consumption

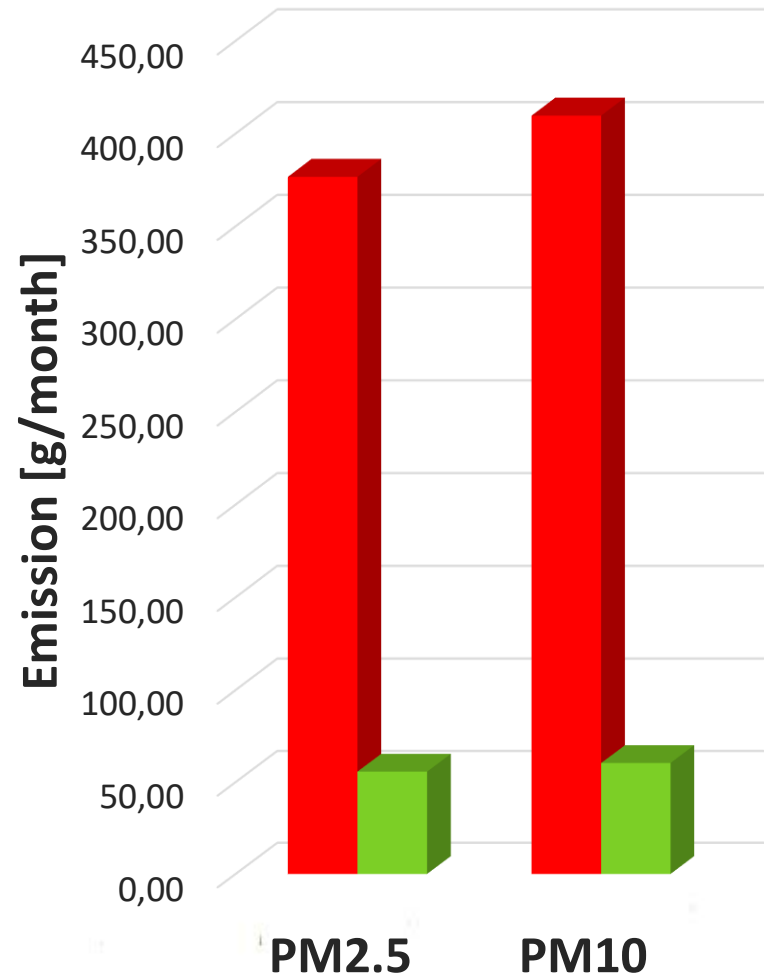
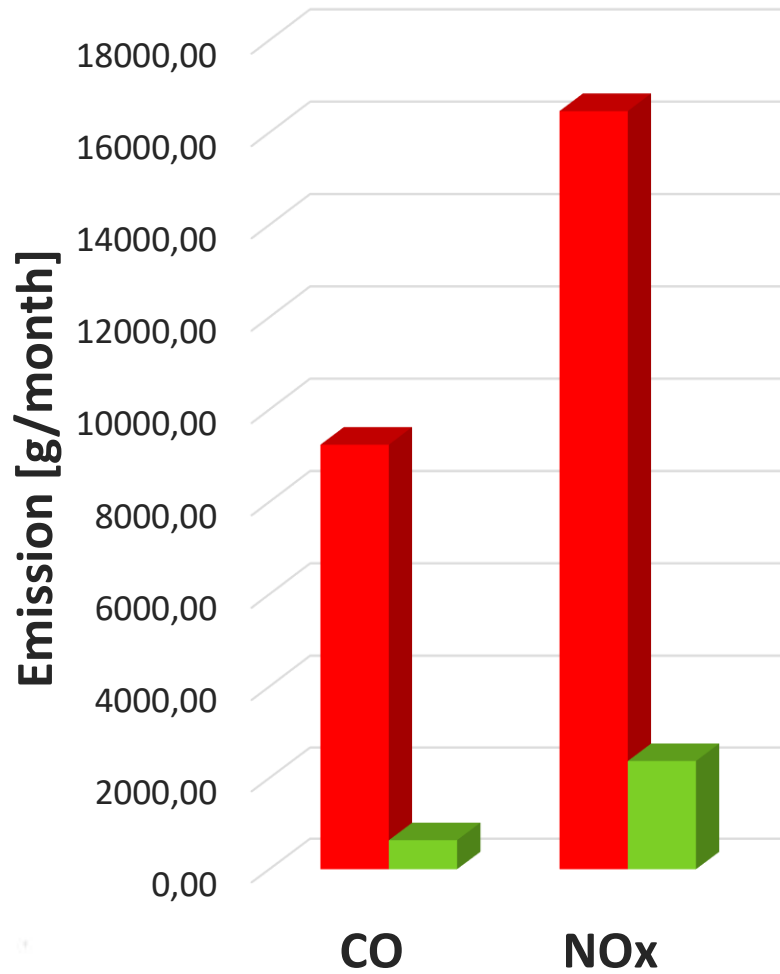


3.916 EUR/month

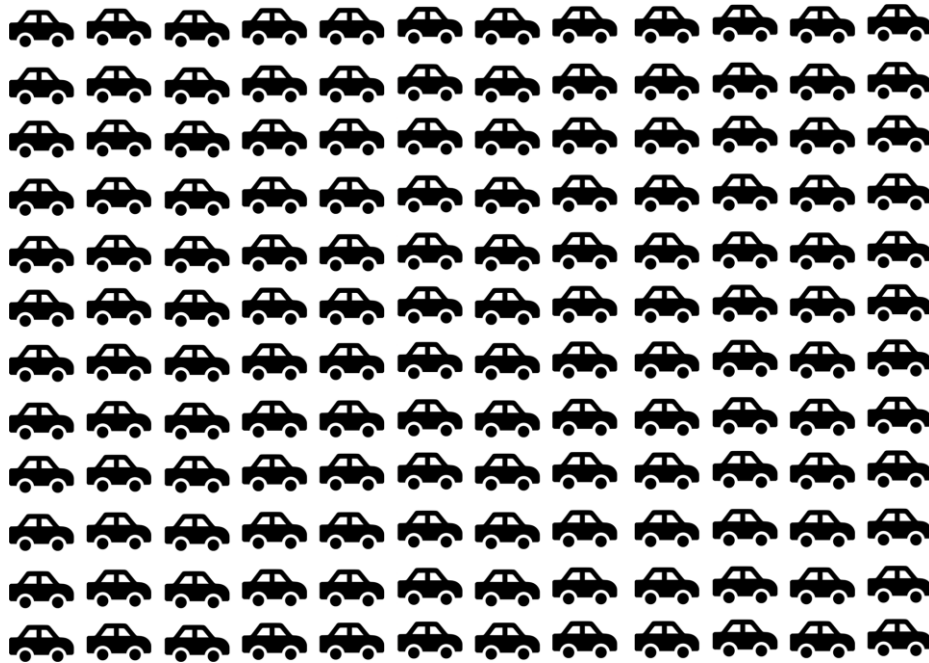


942 EUR/month

Emission



Analogy

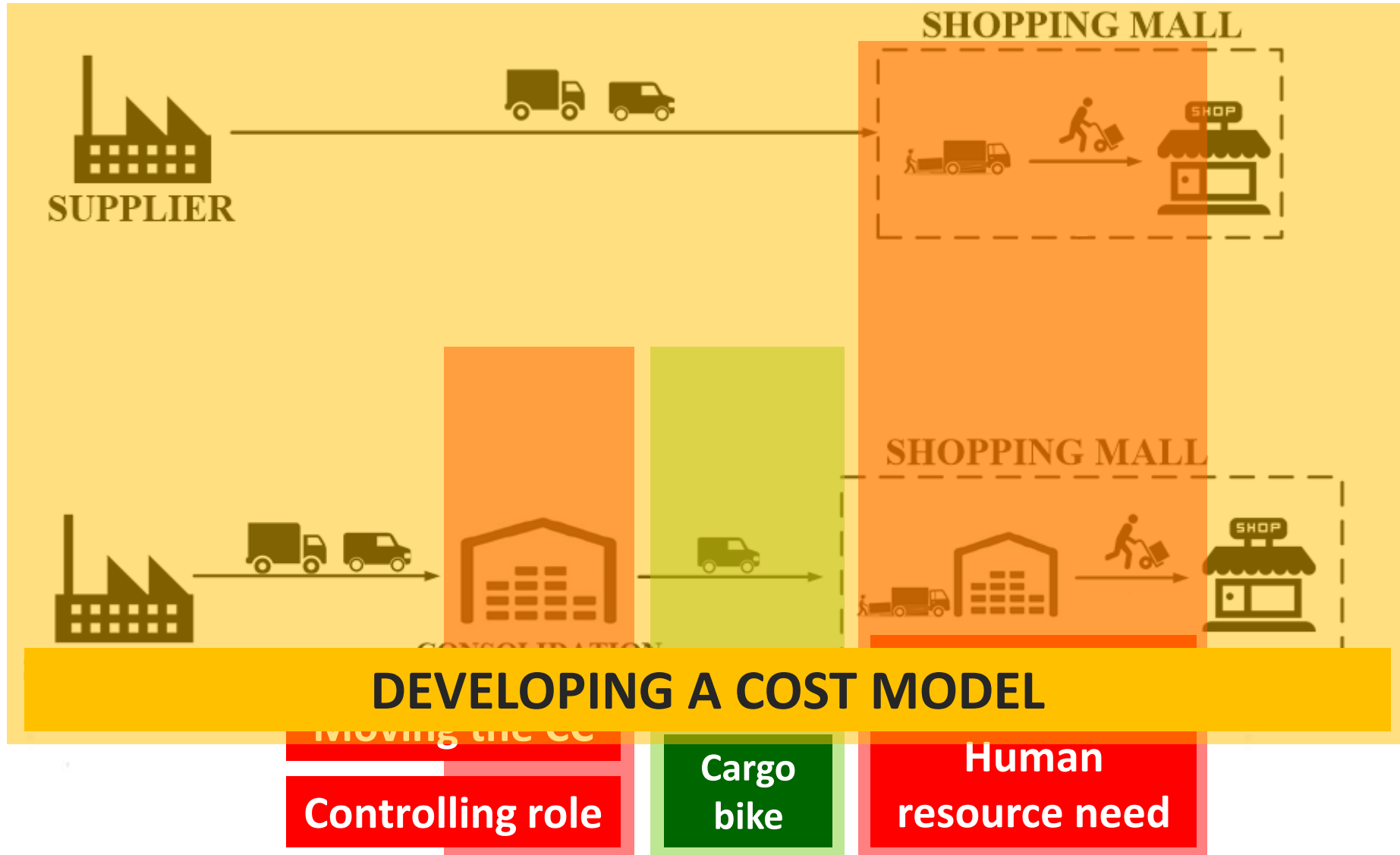


144 car



1 tram

Next steps



Use of cargo bikes



Macroscopic
model

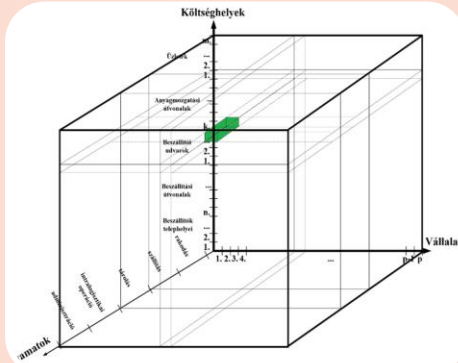
System for
Budapest

- 18 shopping malls

Use of green
vehicles

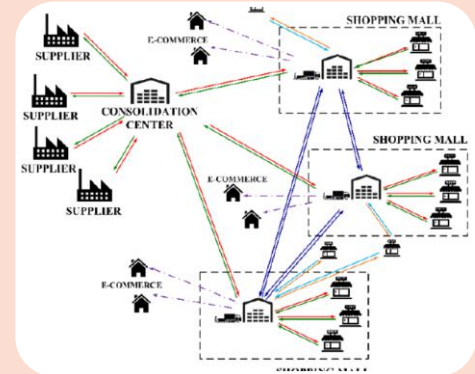
- Cargo bikes
- Green lorries

Cost model



$$C_{i,j}(LTL) = C_{F,LTL2,S,i,b} + C_{t,i,j}$$

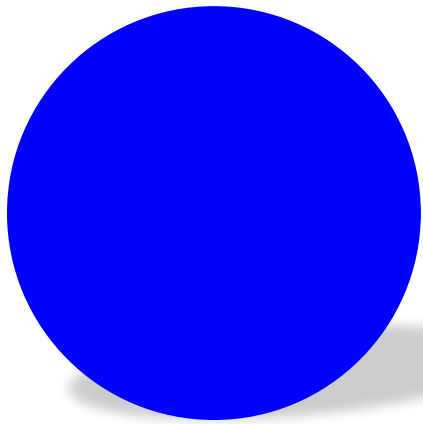
$$C_{i,j}(LTL) = \sum_{b=1}^B C_{2,S,i,b}(LTL)$$



3D cost
structure
Mathematical
model

Cost model
for the
current
system:
ready

Cost model
for the
future
systems: **in
progress**



Conclusions



Mesoscopic simulation model

Comparsion

Modelling of the future system

Developing a mesoscopic simulation model for examination of freight traffic of shopping malls in Budapest



**Budapest University of Technology and
Economics, Department of Material
Handling and Logistics Systems**

Krisztián Bóna PhD
krisztian.bona.@logisztika.bme.hu

Dávid Lajos Sárdi
david.sardi@logisztika.bme.hu