OTTO VON GUERICKE UNIVERSITÄT MAGDEBURG

ILM INSTITUT FÜR LOGISTIK UND MATERIALFLUSSTECHNIK

Model for efficient container sizes in cargobike crossdocking systems

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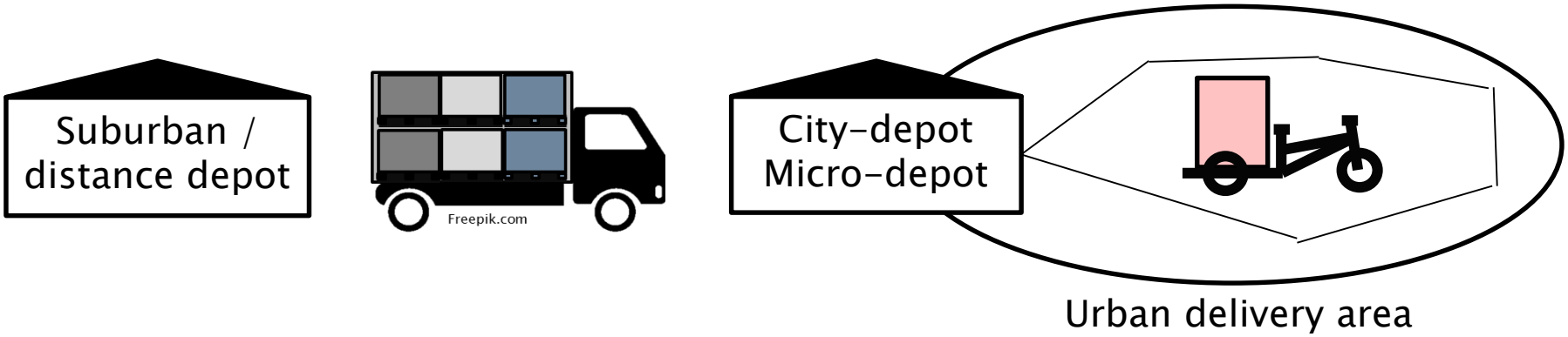
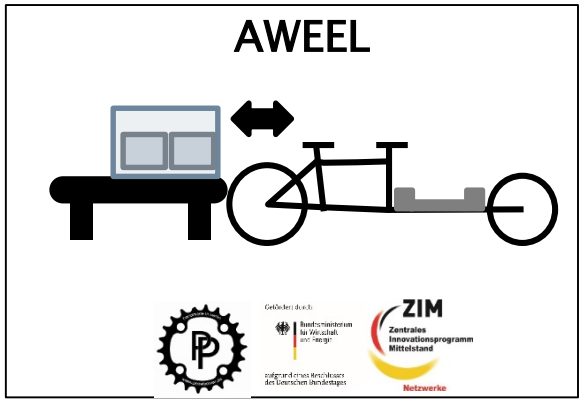
Transshipment schemes for cargobikes

A status quo intermodal chain for cargobikes

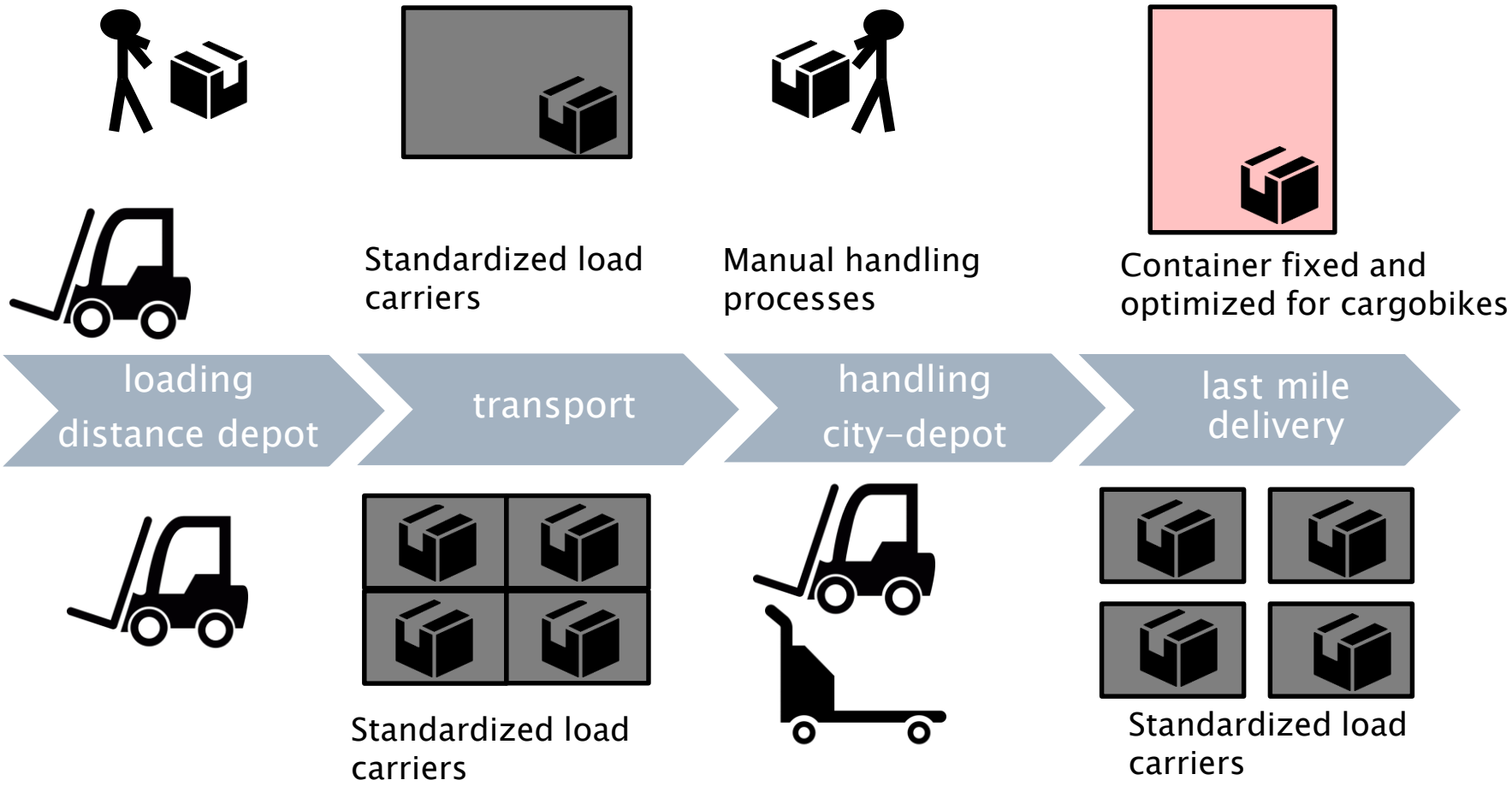


Velove.se



Gali (2015)

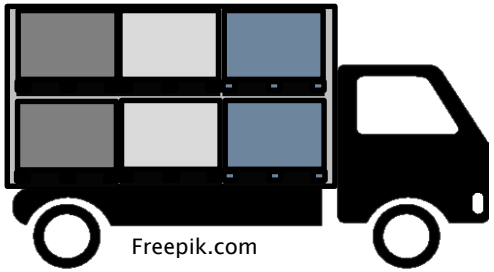
The difference between classic transshipment and crossdocking



One unit of container and freight is shipped through the whole chain.

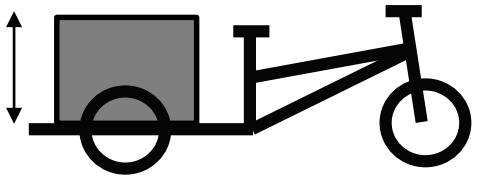
The Trade Off between utilizing the tranport carriers

Option 1
Lorry-opt



100% Volume utilization

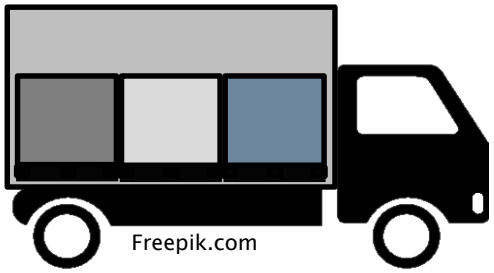
EUL I
1200mm



80% Volume utilization

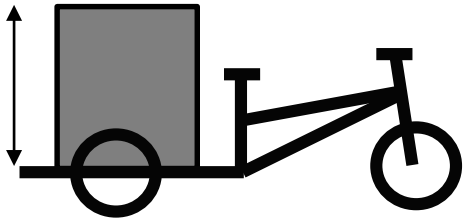
City-Hub

Option 2
CargoBike-opt



62,5% Volume utilization

1500mm

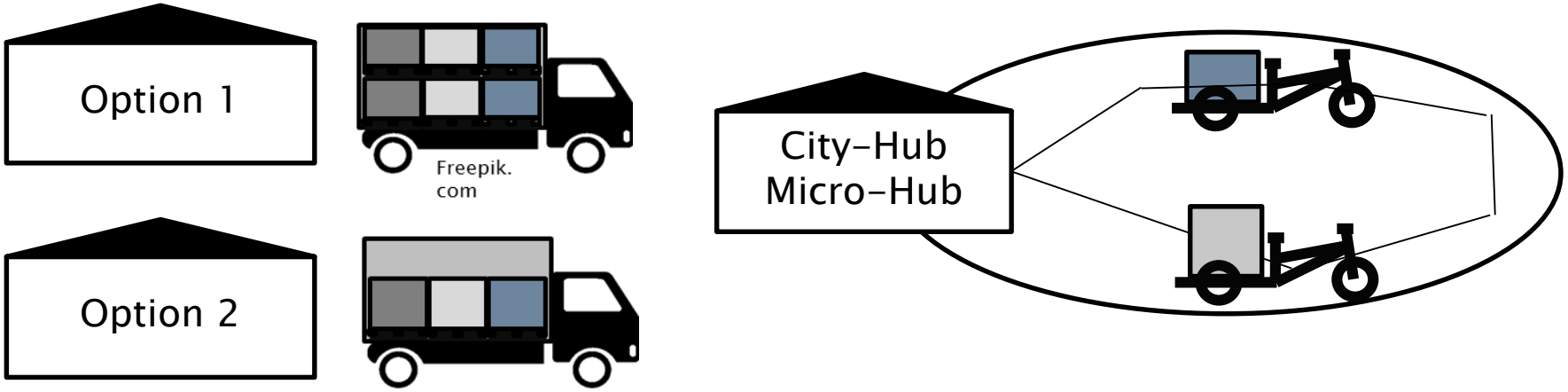


100% Volume utilization

When is it economically viable to either fully utilize the lorry or the cargo-bike?

Based on 2,7m high standard lorry in Germany and a three-wheeled cargobike with 1,5m possible height of load

The basic principle of the model



Variables

distance lorry
1 – 250km

distance cargobike
1 – 60km

amount of deliveries

300 – 5700 deliveries

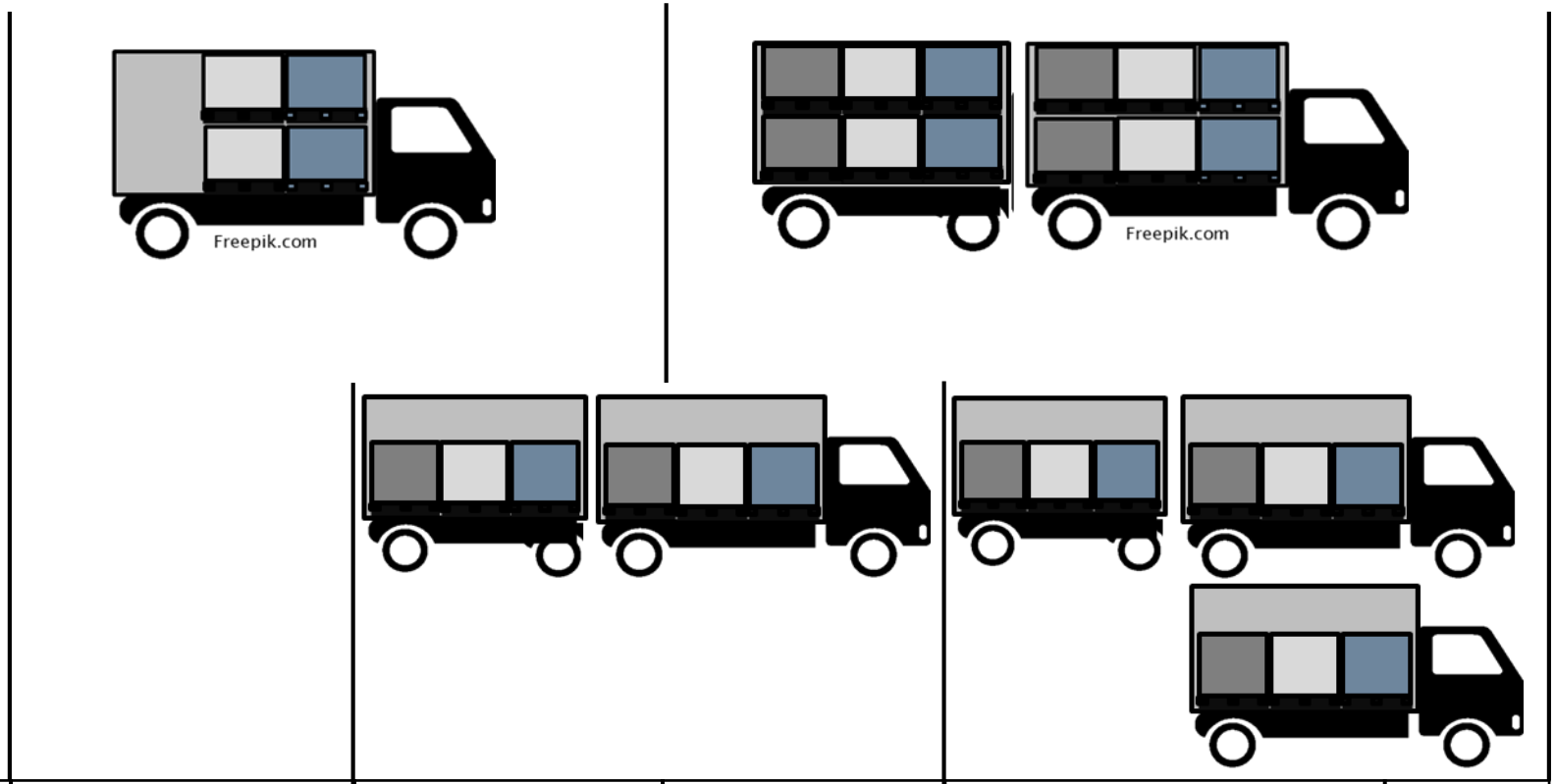
size of packages

0,01 – 0,1 m³

Cost Calculation
n = 50000 variations

$$c = \frac{C(Lorry) + C(CargoBike)}{amount\ of\ deliveries}$$

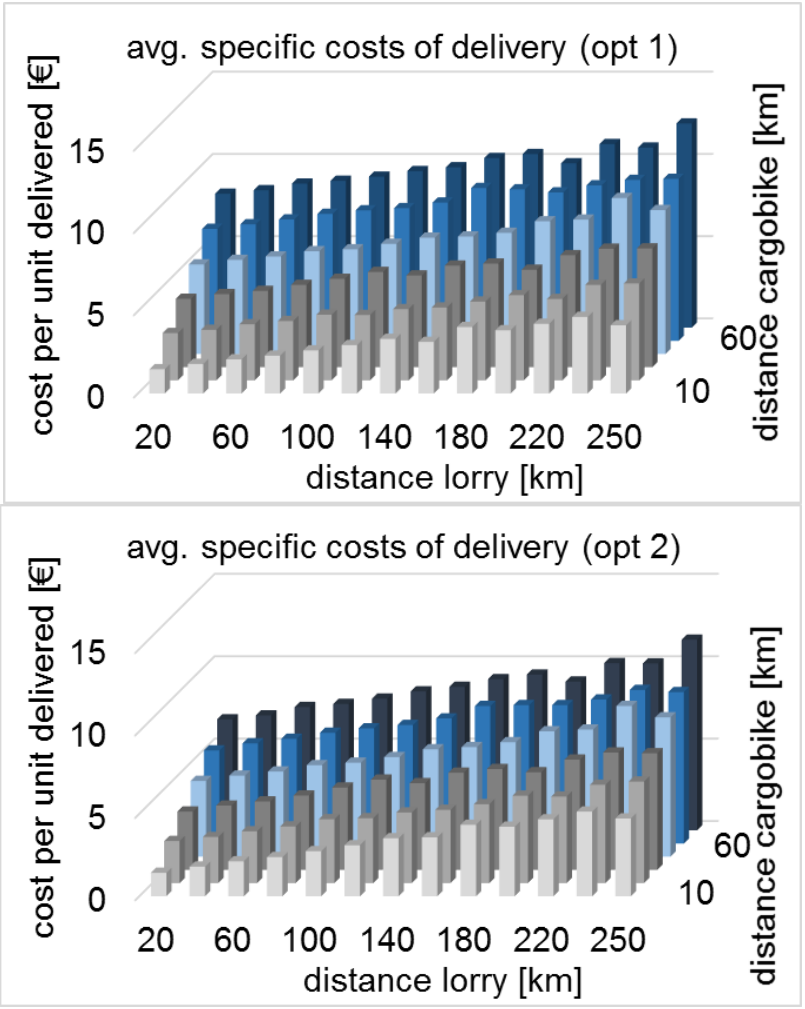
Hypothesis 2: The influence of the amount of container



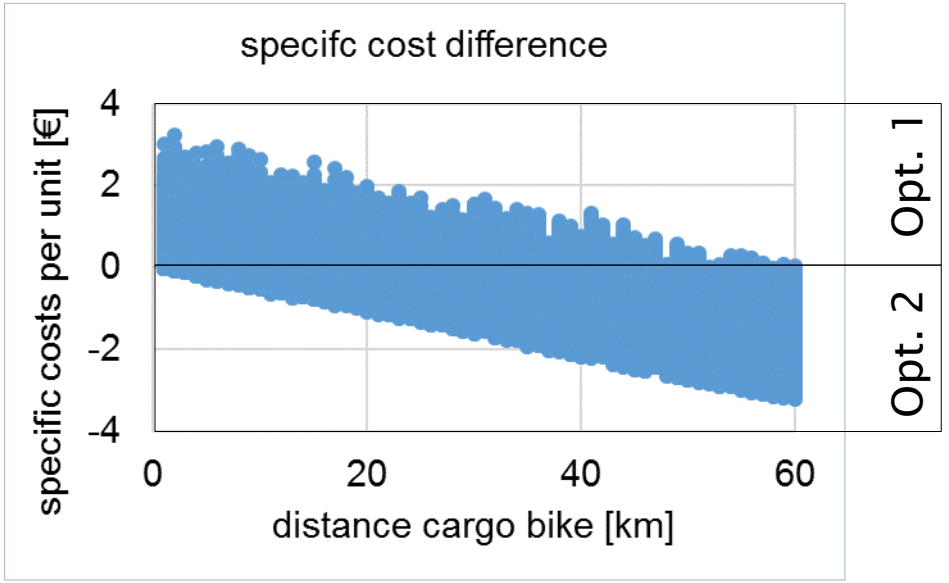
deliveries Size = 0,05m²	102	408	629	731	1122
Opt. 1	6	24	37	43	66
Opt. 2	5	19	29	34	51

General results

Total costs

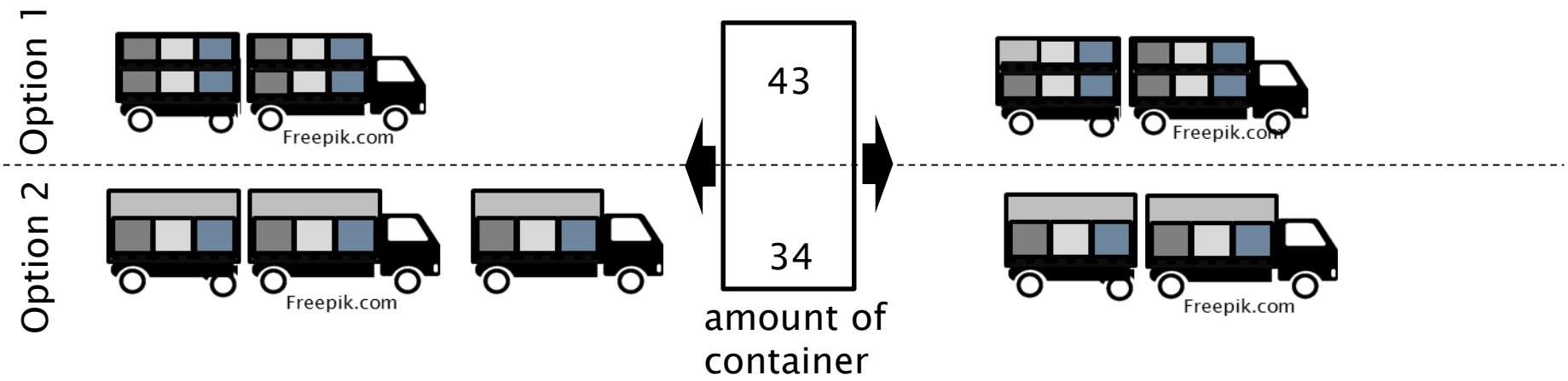


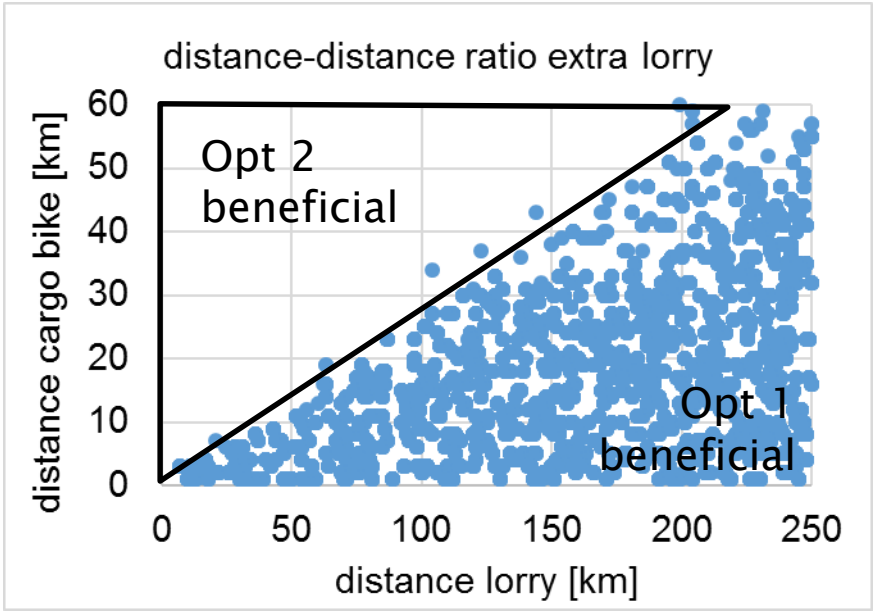
Cost – distance relation

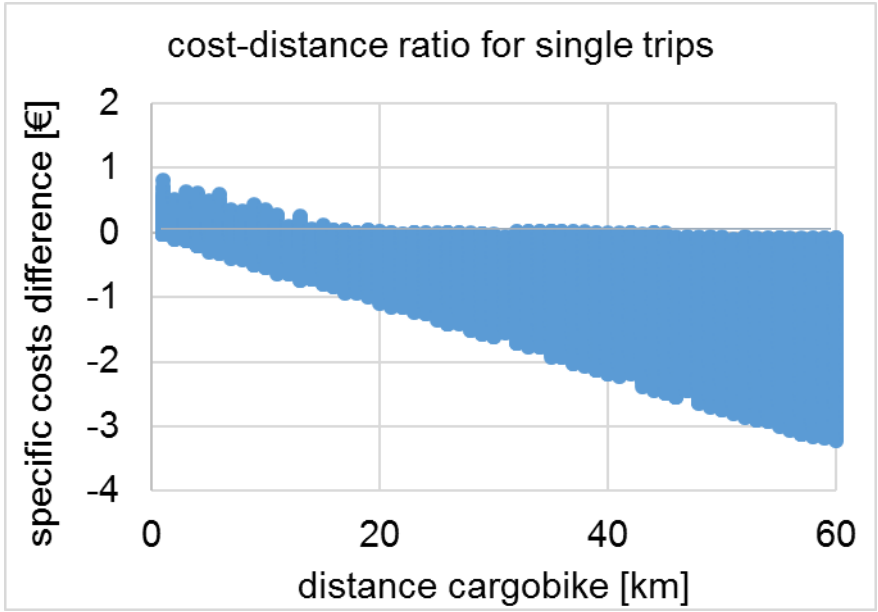


Pearson correlation bike distance to cost difference	-0,63
Pearson correlation lorry distance to cost difference	0,25
Effect of package size	Increases amplitude of the difference

The effect of additional lorries







Conclusion and outlook

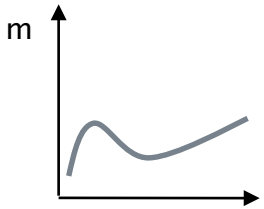
- As long as the same amount of lorries is used it is more economically viable to fully utilize the load area of the cargo bike

- A cargo bike optimal container height is beneficial when just one lorry is used

- Standards (EUL 1) from conventional logistics do make sense when a second lorry is avoided and the right distance ration between lorry and cargobike is realised.

Outlook

generic approach



volatile demand

European cost data

Questions? Discussion!

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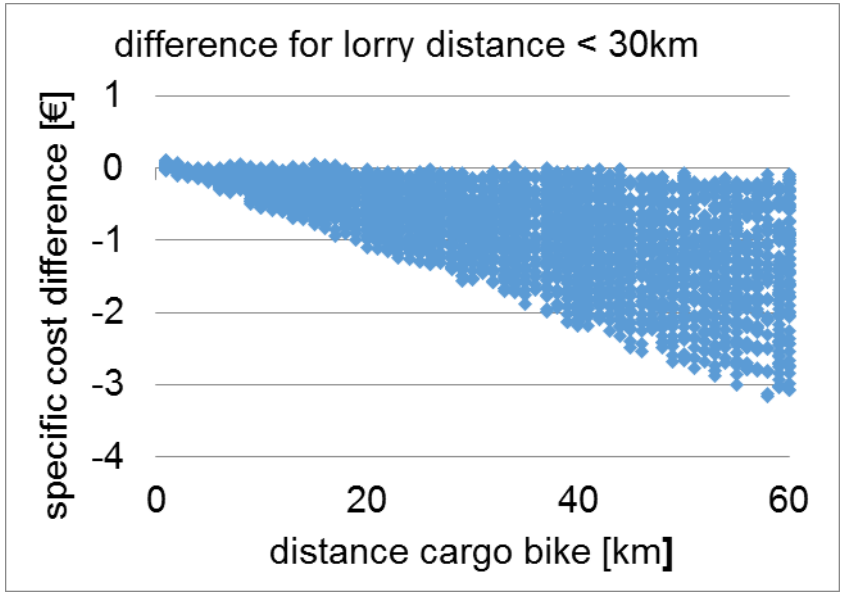
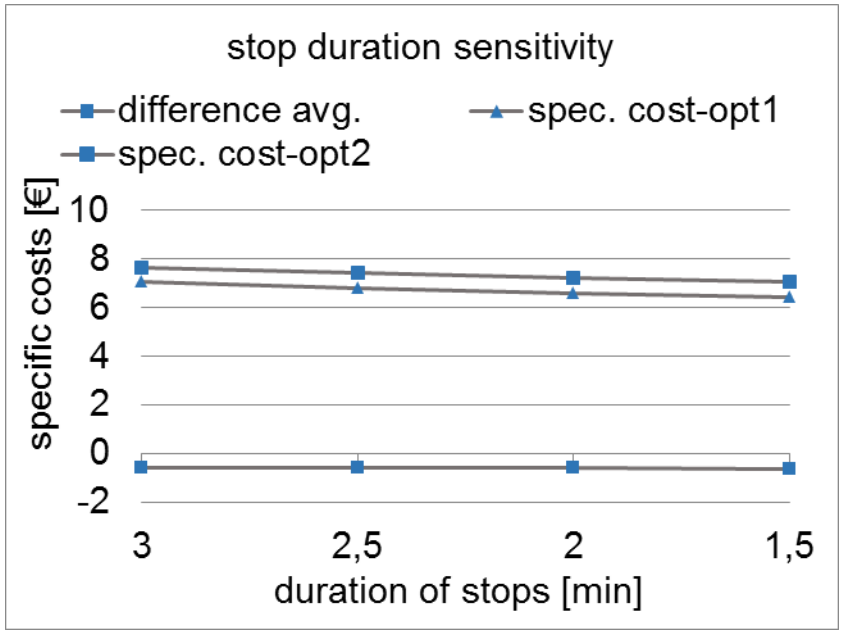
Input Data (CargoBike Calculation)

max. working time driver	10	h	Like truck driver
depreciation bike	7	years	(BMF 2000)
investment cargobike	5000	€	(Assmann 2016)
avg. Speed	15	km/h	(Hertel et al. 2014, Leonardi et al. 2012)
duration of stops	3	min/stop	Assumed from (Routhier & Toilier 2014)
avg wage of driver	20	€/h	(Balm 2016, own calculation)
driver surplus factor	1,3		(BGL 2017)
working days	300	Mon - Sat	Like CEP-Service
break time of driver	0,5	h	assumption
costs of electricity	0,24	€/kWh	(Pro-e-bike 2015)
demand for electricity	0,0065	kWh/km	(Pro-e-bike 2015)
general costs	6	%	Derived from (BGL 2017)
non delivery factor	0,9		(Gevaers et al. 2014)

diesel costs	1,07	€/l	(Statista 2017)
general costs	0,13		(BGL 2017)
driver wage	26	€/h	(Statistisches Bundesamt 2016)
driver surplus factor	1,3		(BGL 2017)
toll	0,135	€/km	(Toll Collect 2017)
toll share	0,65		(BGL 2017)
tire factor	1,01		(Wittenbrink 2011)
break time driver	0,5	h	Assumption
yearly driving distance	80000		(BGL 2017)
investment Lorry	100000	€	(Wittenbrink 2011)
investment articulated lorry	65000	€	(Wittenbrink 2011)
depreciation lorry	9	years	(BMF 2000)
avg. speed lorry	50	km/h	(Christian Kille & Norbert Schmidt 2008)
diesel consumption lorry	32	l/100km	(Wittenbrink 2011)
diesel consumption articulated lorry	25	l/100km	(Wittenbrink 2011)


difference for lorry distance < 30km
specific cost difference [€]
1
0
-1
-2
-3
-4
0
20
40
60
distance cargo bike [km]


stop duration sensitivity
difference avg.
spec. cost-opt1
spec. cost-opt2
specific costs [€]
10
8
6
4
2
0
-2
3
2,5
2
1,5
duration of stops [min]