

*Leslie Sheng J.*

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# VRP applied in waste collection logistics

@NordConsNet Workshop 2017

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# optimisation

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**optimization** | ɒptɪmɪ'zeɪʃ(ə)n | (also **optimisation**)

**noun** [*mass noun*]

the action of making the best or most effective use of a situation or resource: *companies interested in the optimization of the business* | [*count noun*] : *the developers know many optimizations can be made.*

guess



# resources

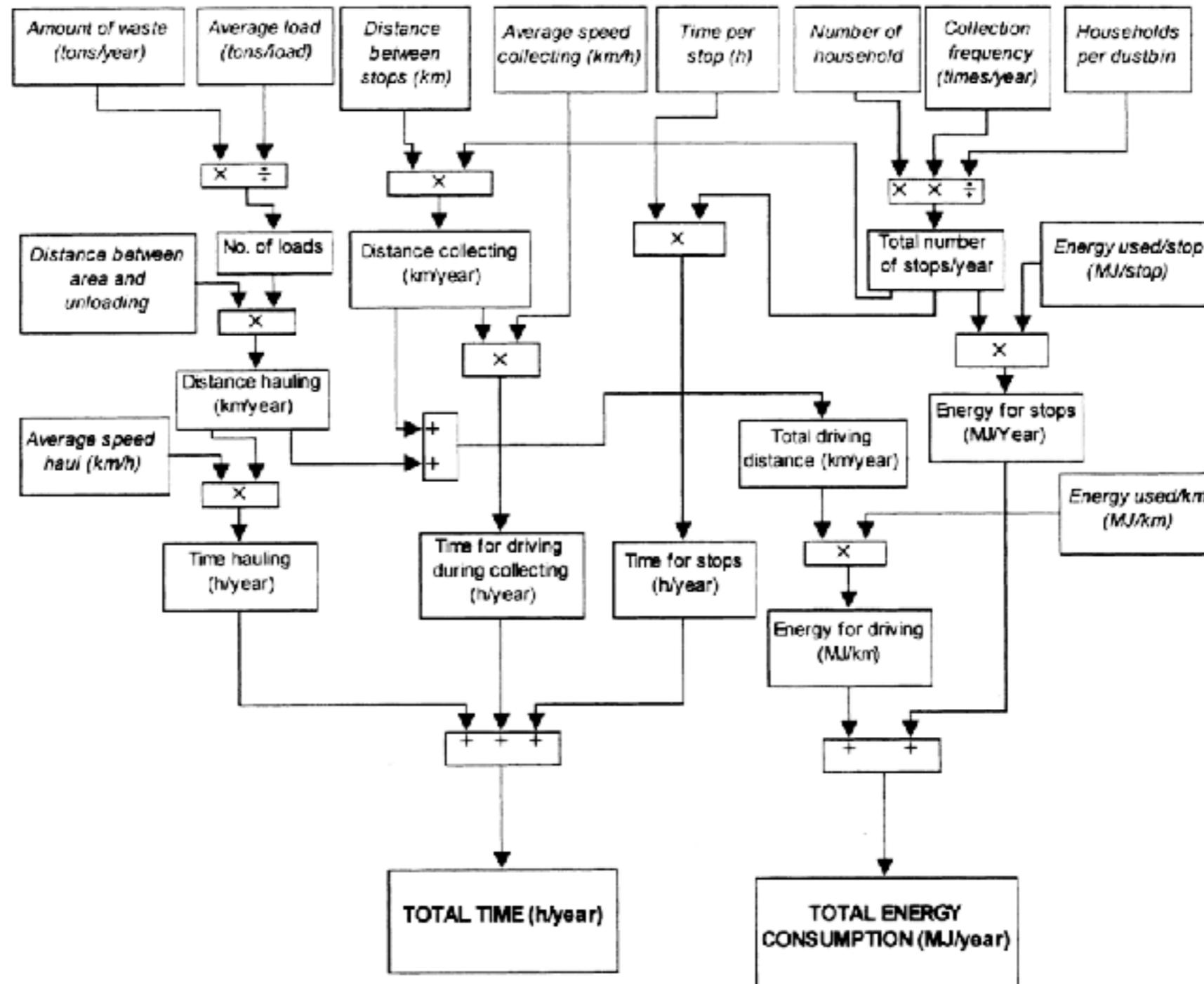


Fig. 2. The collection transport model. Boxes with text in italics are input data parameters, the two boxes with bold capital letters are the results from the model.

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# experimental policies

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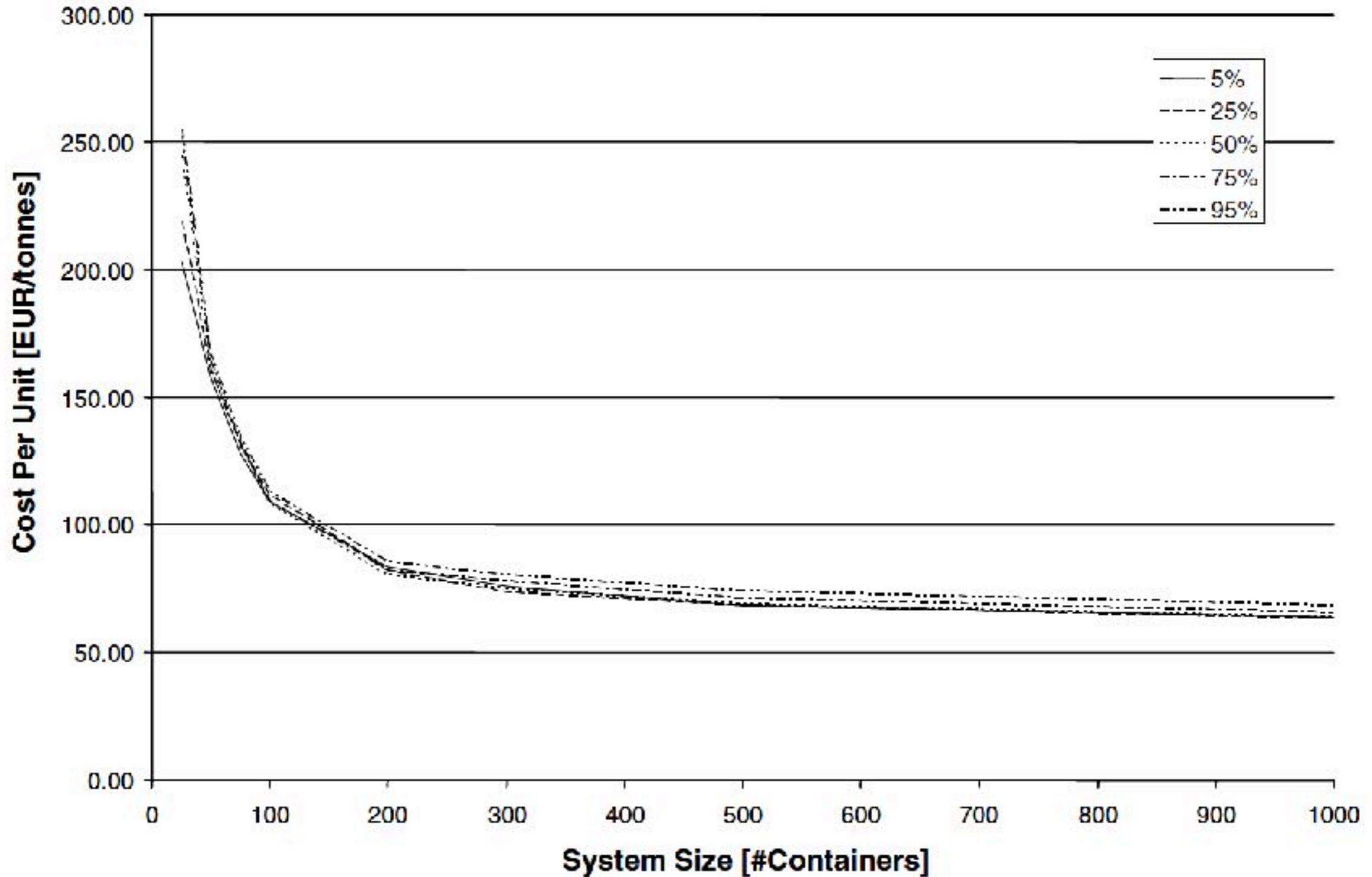
Policy 1: Static scheduling and static routing

Policy 2: Dynamic scheduling and dynamic routing to full containers

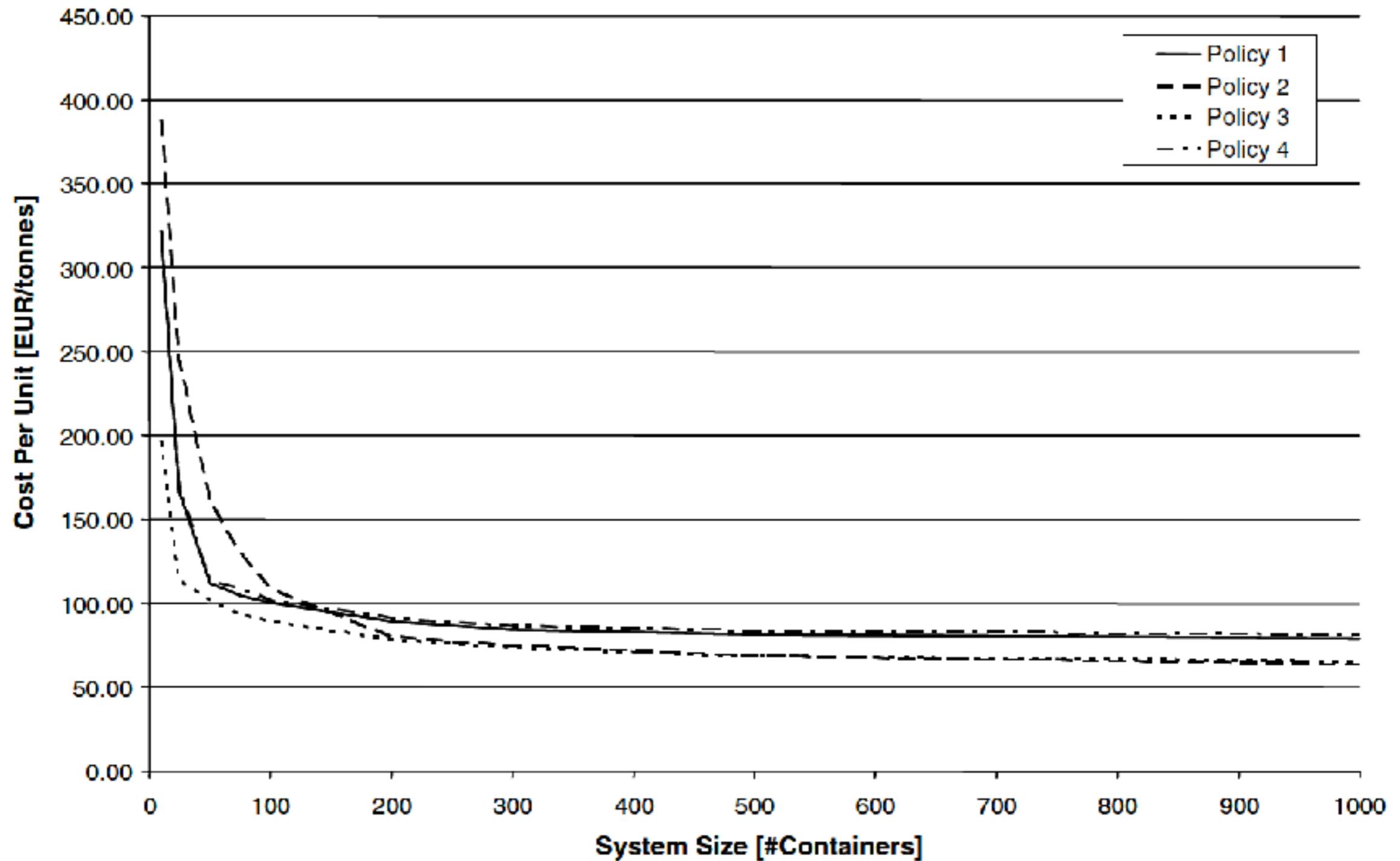
Policy 3: Dynamic scheduling and dynamic routing to “almost” full containers

Policy 4: Static scheduling and dynamic routing to “almost” full containers

# when last tried



# optimum



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# fact-check

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The level sensors are no longer in use and the logistics is done in the traditional way, i.e. with fixed collection frequencies. The intention of the sensors was never to improve the logistics, but to check the quality of the operator responsible for the collection

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we simplify



‘What is This Theory of Constraints Stuff?’

Minimum



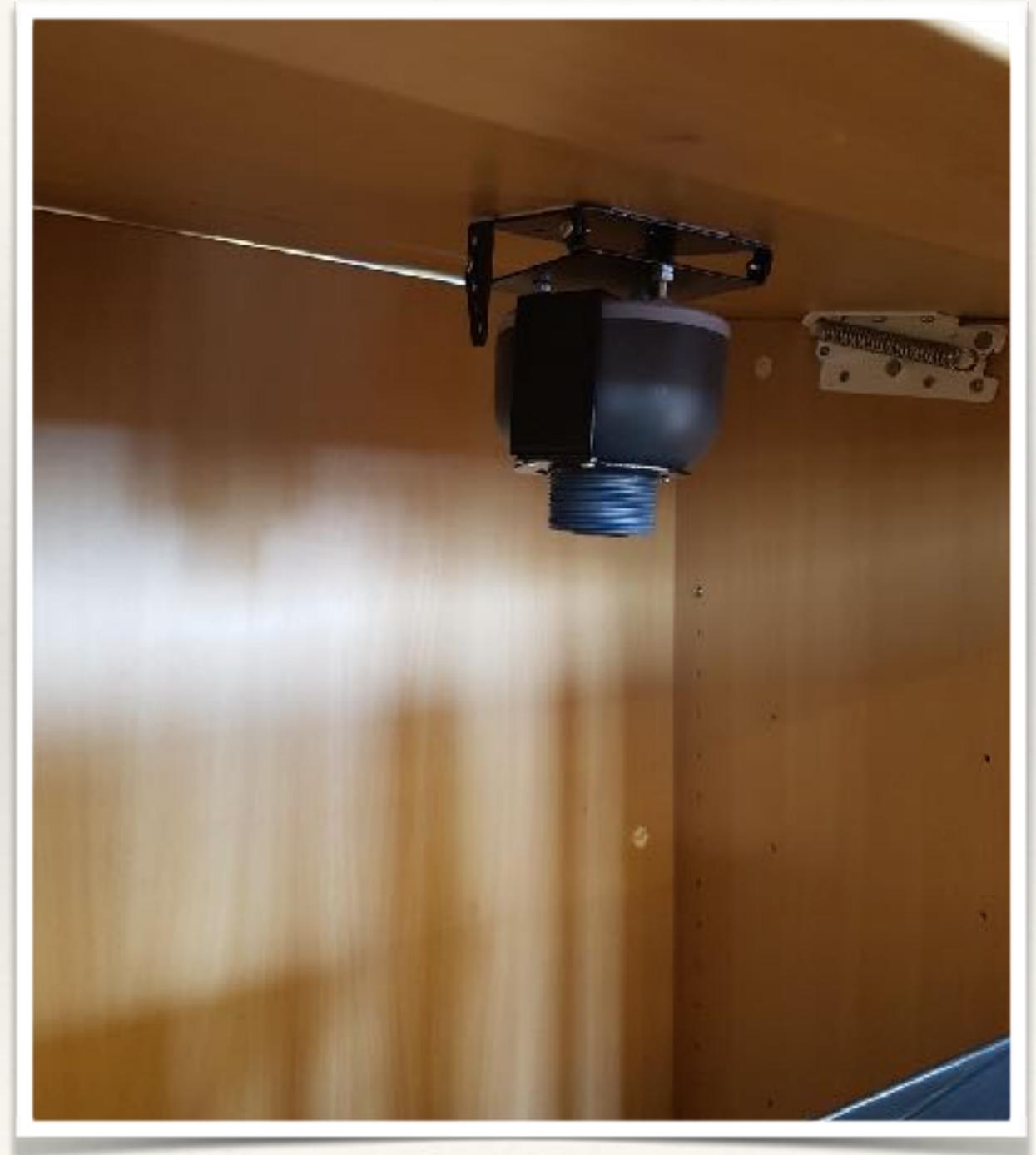
“Liebig’s Barrel”  
from Wikipedia on  
“Liebig’s Law of the Minimum”

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# demo

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- ❖ ultrasonic sensor
- ❖ pilot test in Ekonomikum
- ❖ understand the essential of waste data
- ❖ again, keep it simple



# any ideas?

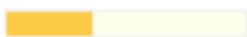
UPPSALA UNIVERSITET

Overview Data Products Users Support

## Overview

Real-time monitoring and route optimization

Filtered Products (10) Unfiltered Products (0)

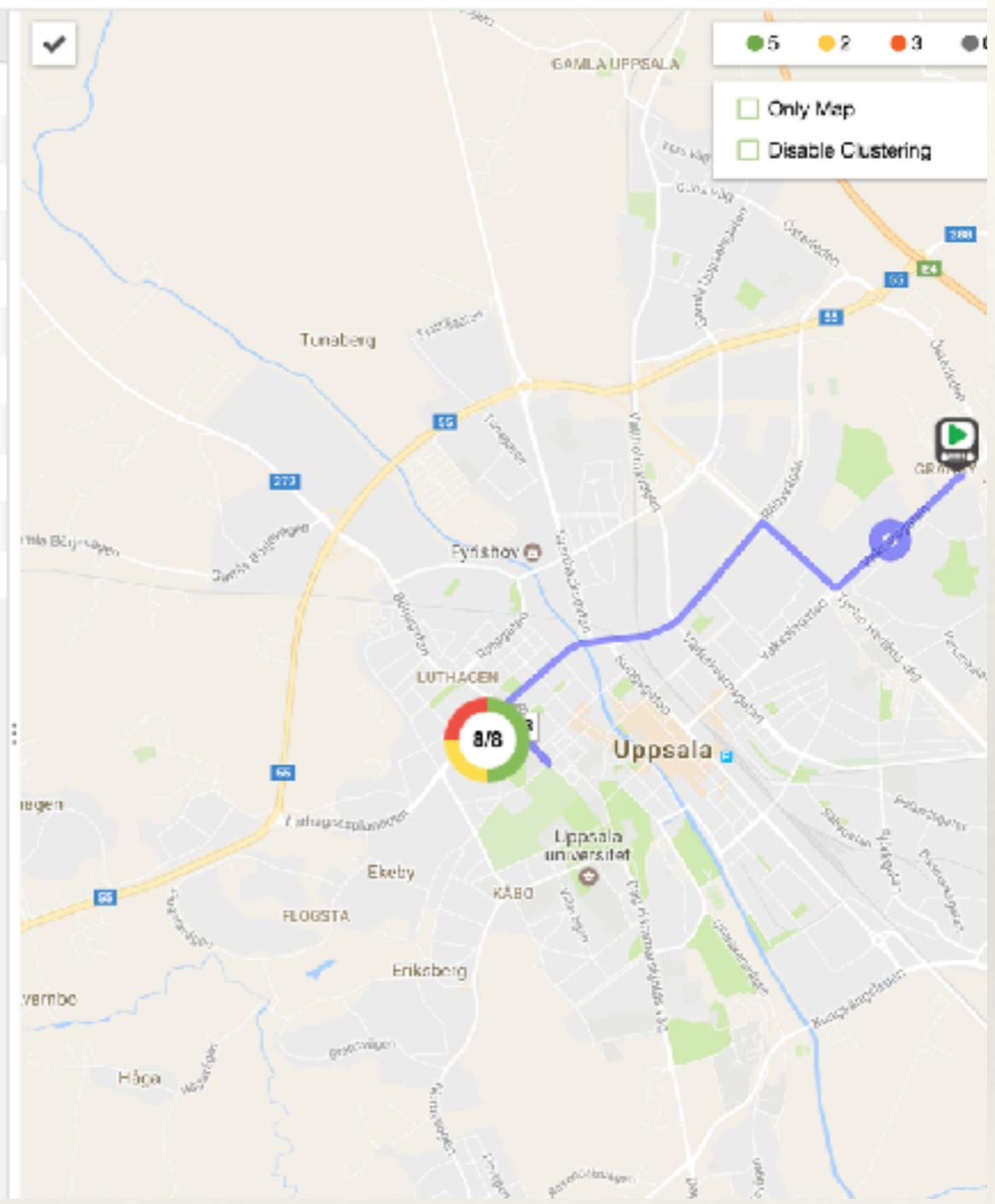
<input type="checkbox"/>	Description	Fill-level	Last Collection	Address
<input type="checkbox"/>	OB1000001703AA61	100% 	Sat, 20/5/17 05:16 PM	Ekonomikum, 753 13 Uppsala, Sweden
<input type="checkbox"/>	OB1000001703AA62	35% 	Wed, 17/5/17 11:29 AM	Ekonomikum, 753 13 Uppsala, Sweden
<input type="checkbox"/>	OB1000001703AA63	16% 	Wed, 17/5/17 10:10 AM	Ekonomikum, 753 13 Uppsala, Sweden
<input type="checkbox"/>	OB1000001703AA65	10% 	Mon, 22/5/17 06:03 AM	Rackarbergsgatan 15, 752 35 Uppsala, Sweden
<input type="checkbox"/>	OB1000001703AA66	100% 	N/A	Rackarbergsgatan 15, 752 35 Uppsala, Sweden
<input type="checkbox"/>	OB1000001703AA67	0% 	N/A	Rackarbergsgatan 15, 752 35 Uppsala, Sweden
<input type="checkbox"/>	OB1000001703AA68	0% 	N/A	
<input type="checkbox"/>	OB1000001703AA80	100% 	N/A	
<input type="checkbox"/>	OB1000001703AA82	0% 	N/A	Ekonomikum, 753 13 Uppsala, Sweden
<input type="checkbox"/>	OB1000001703AA86	40% 	Mon, 22/5/17 12:58 AM	Kyrkogårdsgatan 12, 753 13 Uppsala, Sweden

# Overview

Real-time monitoring and route optimization

[.CSV Export \(8\)](#)
[Set Start Point](#)
[Update Route \(8\)](#)
[Clear Route](#)

Filtered Products (10)					Unfiltered Products (0)				
<input type="checkbox"/>	Description	Fill-level	Last Collection	Address	<input type="checkbox"/>	Description	Fill-level	Last Collection	Address
<input checked="" type="checkbox"/>	OB1000001703AA61	100%	Sat, 20/5/17 05:16 PM	Ekonomikum, 753 13 Uppsala, Sweden	<input type="checkbox"/>				
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<input checked="" type="checkbox"/>	OB1000001703AA63	16%	Wed, 17/5/17 10:10 AM	Ekonomikum, 753 13 Uppsala, Sweden	<input type="checkbox"/>				
<input checked="" type="checkbox"/>	OB1000001703AA65	10%	Mon, 22/5/17 06:03 AM	Rackarbergsgatan 15, 752 35 Uppsala, Sweden	<input type="checkbox"/>				
<input checked="" type="checkbox"/>	OB1000001703AA66	100%	N/A	Rackarbergsgatan 15, 752 35 Uppsala, Sweden	<input type="checkbox"/>				
<input checked="" type="checkbox"/>	OB1000001703AA67	0%	N/A	Rackarbergsgatan 15, 752 35 Uppsala, Sweden	<input type="checkbox"/>				
<input type="checkbox"/>	OB1000001703AA68	0%	N/A		<input type="checkbox"/>				
<input type="checkbox"/>	OB1000001703AA69	100%	N/A		<input type="checkbox"/>				
<input checked="" type="checkbox"/>	OB1000001703AA82	0%	N/A	Ekonomikum, 753 13 Uppsala, Sweden	<input type="checkbox"/>				
<input checked="" type="checkbox"/>	OB1000001703AA95	40%	Mon, 22/5/17 12:58 AM	Kyrkogårdsgatan 12, 753 13 Uppsala, Sweden	<input type="checkbox"/>				



## Collection Performance

Average collection frequency and efficiency at collection

Product Selection

.CSV Export

12/05/2017 - 18/05/2017

Submit (10)

Inefficient collection frequency

**0.1 times** (0 per bin)

600% more inefficient collections on **Wednesday** than the days of week average

100% less inefficient collections on **Saturday** than the days of week average

Collection efficiency

**71.8%**

39% more collection efficiency on **Sunday** than the days of week average

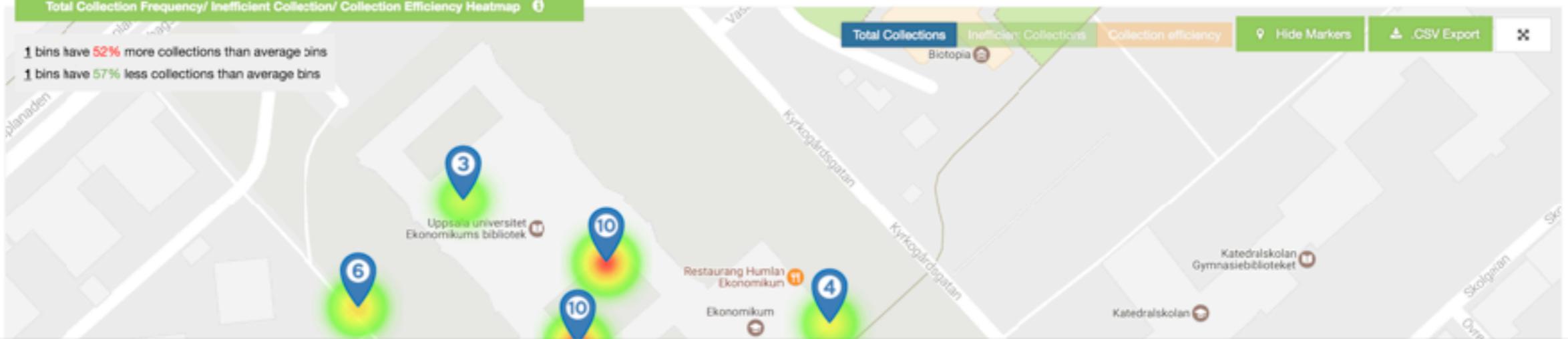
30% less collection efficiency on **Wednesday** than the days of week average



Total Collection Frequency/ Inefficient Collection/ Collection Efficiency Heatmap

1 bins have 52% more collections than average bins

1 bins have 57% less collections than average bins



*concentration mapping*

other factors

keep it as 'research questions'

# urban planning



Overview

Data

Products

Users

Support



luuko  
luuko@outlook.com

## Waste Overflow

Total And Average Waste Overflow Frequency / Amount / Response Time

Product Selection

09/05/2017 - 15/05/2017

Submit (0)

### Total Waste Overflow Frequency / Volume

Overflow frequency

# 8 times

163% more overflow incidents occurred on **12 May** than the daily average

100% less overflow incidents occurred on **09 May** than the daily average

Overflow volume

# 212.84L

318% more overflow volume was generated on **13 May** than the daily average

100% less overflow volume was generated on **09 May** than the daily average



### Hourly Average Overflow Frequency / Volume

Overflow frequency

# 0.1 times

 (0 per bin)

500% more overflow incidents occurred from **6 AM** than the hourly average

100% less overflow incidents occurred from **1 AM** than the hourly average

Overflow volume

# 1.3L

 (0.1 per bin)

364% more overflow volume was generated from **1 AM** than the hourly average

100% less overflow volume was generated from **9 AM** than the hourly average



# relocation of resources

The screenshot displays a dashboard for resource management. At the top, there is a navigation bar with 'Overview', 'Data', 'Products', 'Users', and 'Support'. The main header shows 'Overview' and a sub-header 'Real-time monitoring and route optimization'. A green bar at the top right contains buttons for 'CSV Export (0)', 'Set Start Point', 'Update Route (0)', and 'Clear Route'. A teal notification bar at the top center reads: 'CB1000001703AA86 (OB1000001703AA86) :: Kyrkogårdegatan 12, 758 13 Uppsala, Sweden'. Below this is a map showing the location of 'Uppsala universitet Ekonomikurs bibliotek' and 'Restaurang Human Ekonomikum'. To the right of the map is a 'Comparison of Weekly Stats' table:

	Last week	This week
Daily average waste generation	26L	79L
Overflow frequency	0 times	2 times
Collection efficiency	60%	77%

Below the map is a 'Fill-level History' section with a 'CSV Export' button and a date range '08/05/2017 - 10/05/2017'. The chart shows fill levels over time from May 8th to May 11th. A red horizontal line is drawn at the 80% mark, and a yellow horizontal line is at the 30% mark. The fill level starts at 80% on May 8th, drops to 30% by May 9th, rises to 80% by May 10th, and then drops to 30% by May 11th. A small inset image shows the interior of a bin with a sensor. At the bottom left, there is a 'Fill-level H' section with a volume of 25% and a 'Battery Health' indicator showing 'Normal'. At the bottom right, there is a 'Recent Collection Log' section with a 'View' button. A map of the world is visible in the background on the right side.

Acknowledge



European Commission



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INNOVATION