HARMONY
SPATIAL & TRANSPORT PLANNING FOR A NEW MOBILITY ERA

HARMONY

Tactical Freight Simulator

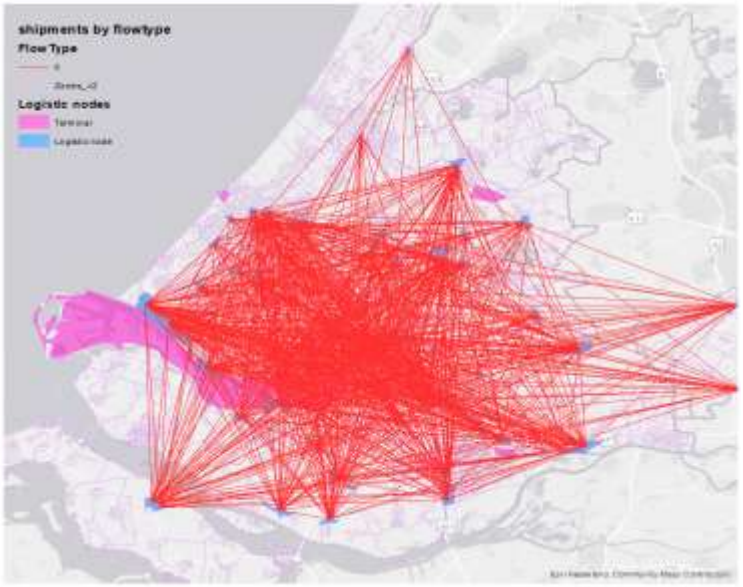
1st September 2021 – ICTR 2021

Michiel de Bok, Ioanna Kourounioti, Lorant Tavasszy,
Sebastiaan Thoen, Larissa Eggers

www.harmony-h2020.eu
Harmony-H2020
Harmony_H2020
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 815269
CIVITAS
Sustainable and smart mobility for all

Outline

1. Introduction
2. Data
3. Tactical Freight Simulator



The story of Jos..

E commerce

Road user charges

Globalisation

Internet of Things

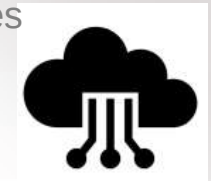
Logistic developments

Logistic hub’s

ZE vehicles

Truckplatooning

Emission zones



‘Urban transport planner’

Keep the city accessible

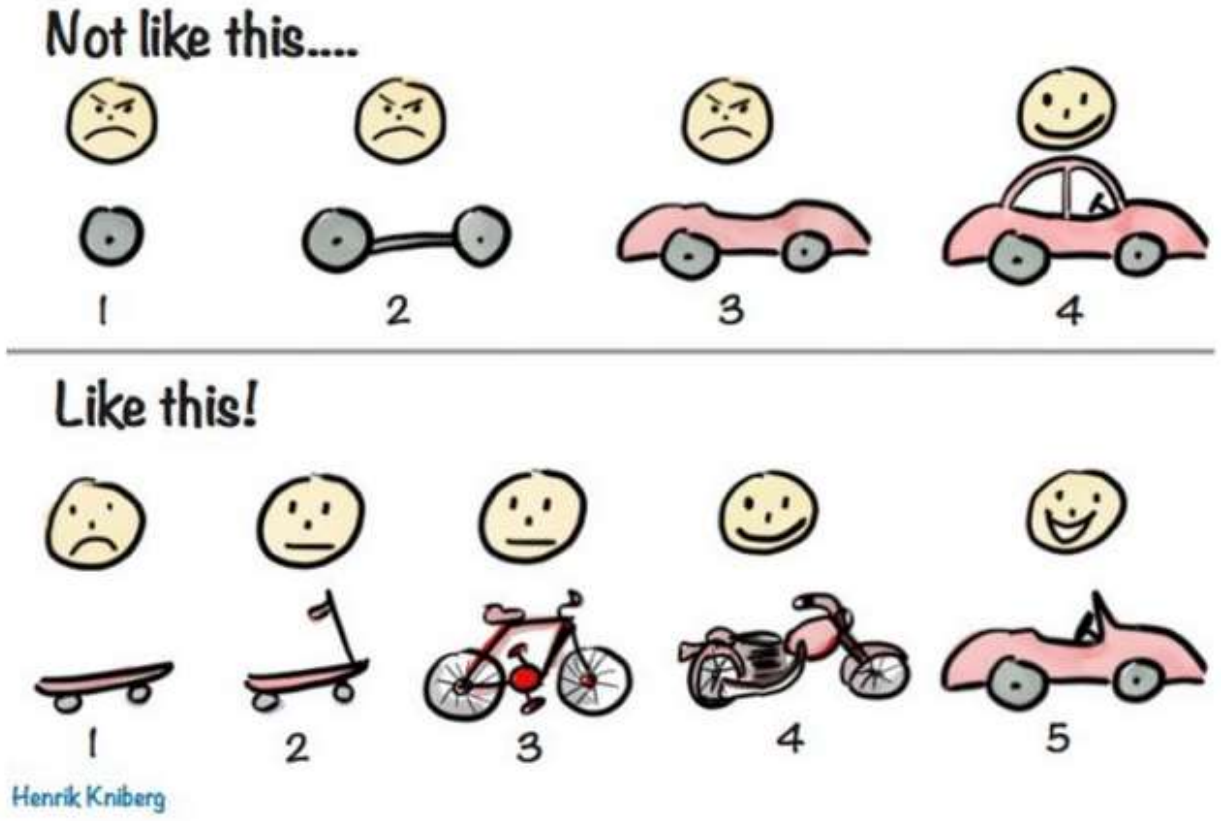
Reduce CO2 emissions

Policy objectives

Keep the city livable

Use land efficiently

To manage complexity during model development we apply the '***minimum viable product principle***'



DATA

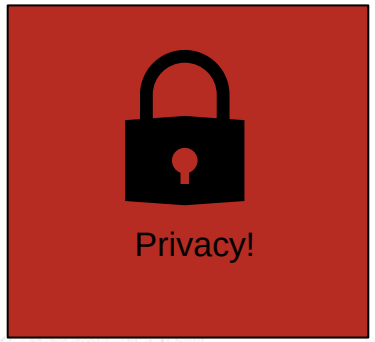
XML data from Statistics Netherlands (CBS)

- Automated collection from Transport Management System (TMS)
- +2M individual trips in raw data
- Offers huge potential for development of microscopic freight demand models

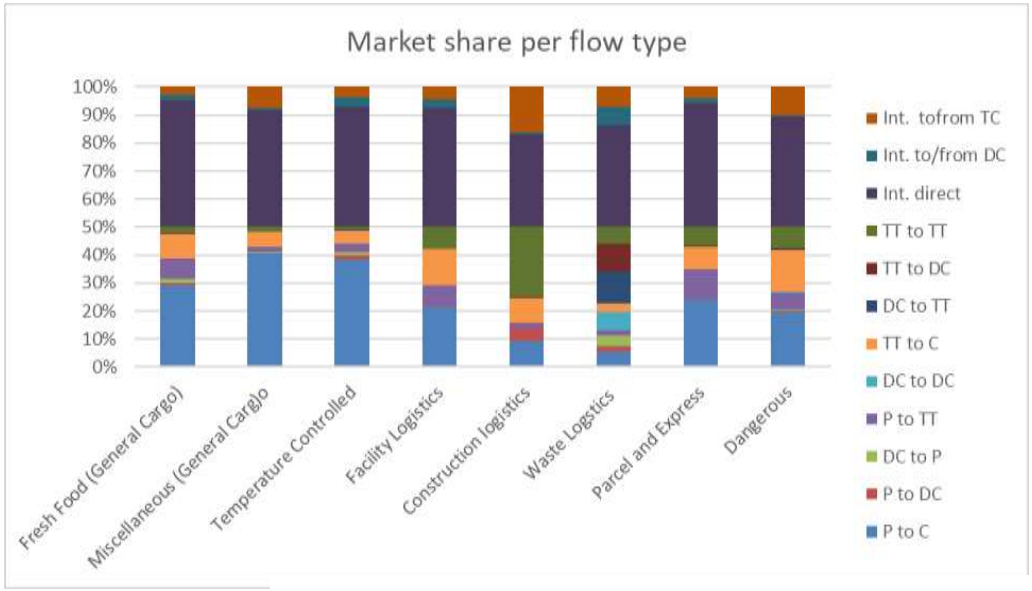
opgaveId (Truck)
License plate
Year & week
In BasGoed sample [yes/no]
Transporting company
Ownership type *Owned, hired, leased, or not owned anymore*
Fuel consumption [L per 100 km]
Home base *Country* *ZIP* *Town* *LatLon*
Carrying capacity [kg]
Vehicle type

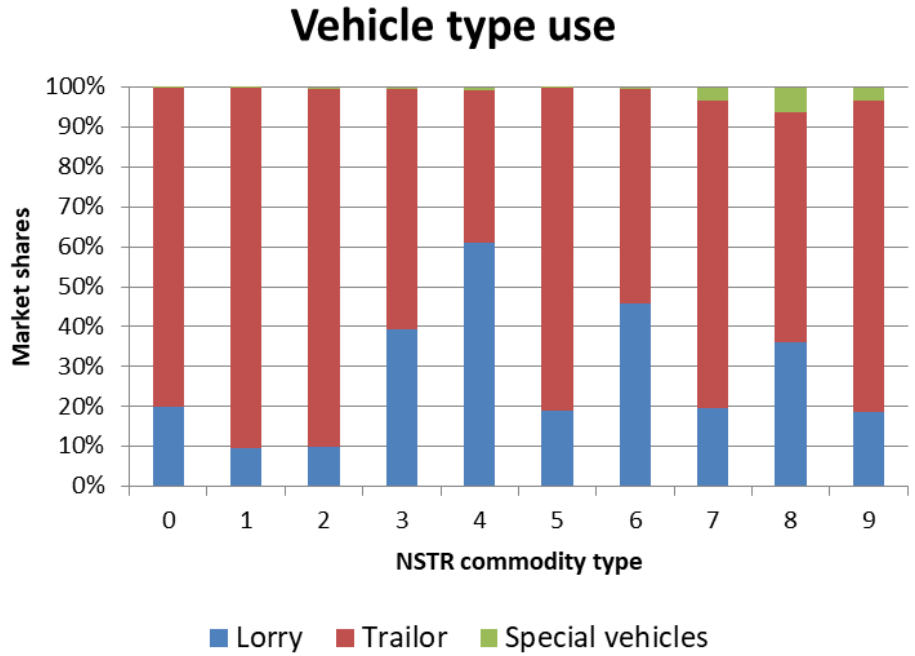
ritId (Tour)
Serial tour number *Describes order of tours for a truck*
Distance [km] *From origin to destination of tour*
Date & time *Start* *End*
Origin & destination *Country* *ZIP* *Town* *LatLon*
Operator type *Hired carrier or own-account*
Capacity utilization *% m2* *% m3*
Border crossing *Country* *LatLon*

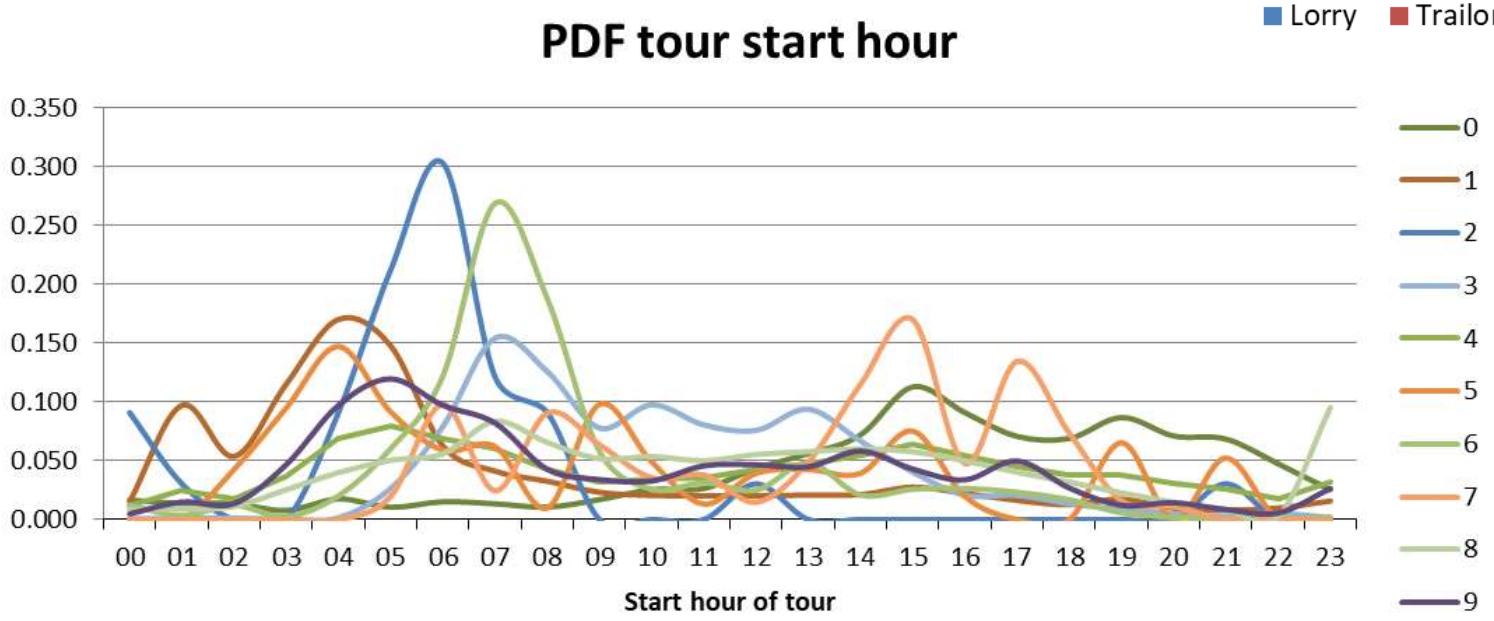
zendingId (Shipment)
Serial shipment number *Describes order of shipments for a tour*
Distance [km] *From loading to unloading point*
Gross weight [kg]
Shape *Fluid, solid bulk, sea containers, other containers, pallets, hanging goods, goods in ropes, mobile units with own power, or other mobile units.*
Loading and unloading location *Country* *ZIP* *Town* *LatLon*
Loading and unloading location type *Production, consumption/processing, retail, seaport, inner port, rail terminal, airport, distribution/wholesale, or home base.*
Goods type *Description* *NSTR* *NST2007* *Hazardous [yes/no]*
Invoice value [€]
Volume [L or m3]



Descriptive statistics

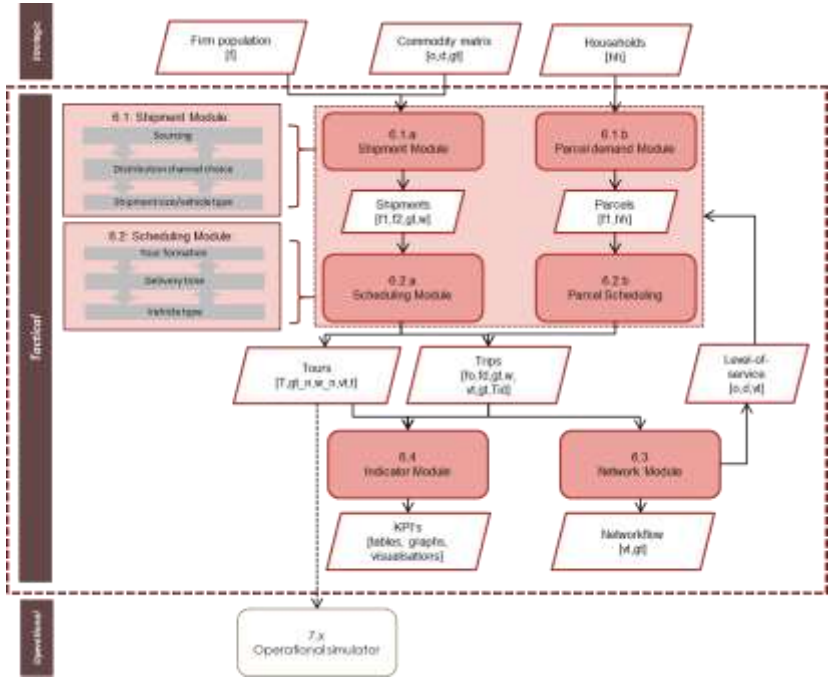


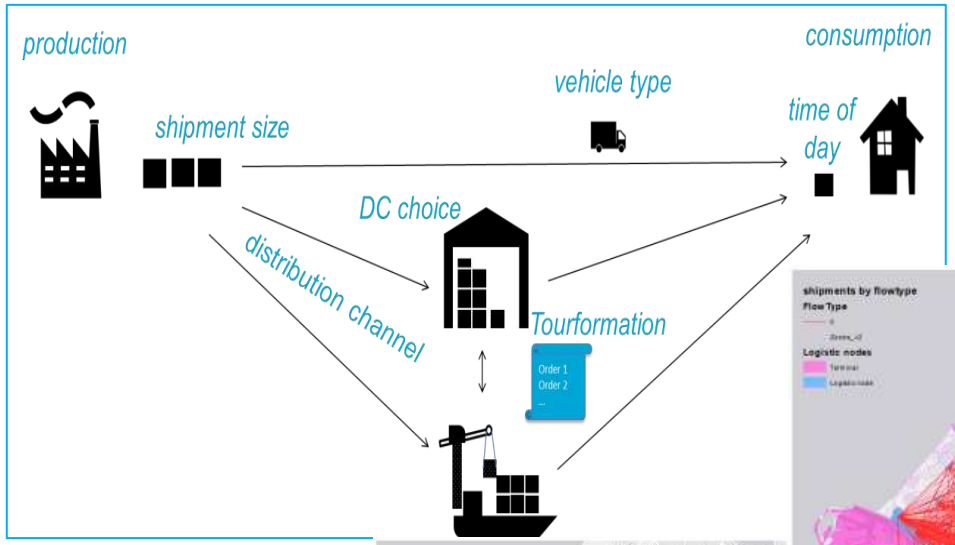


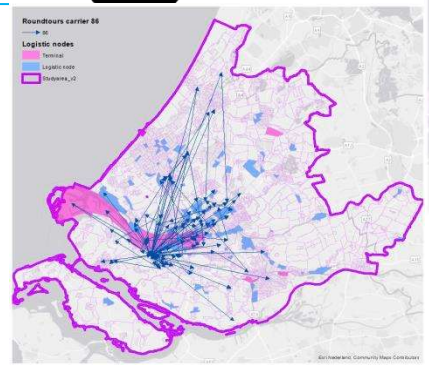


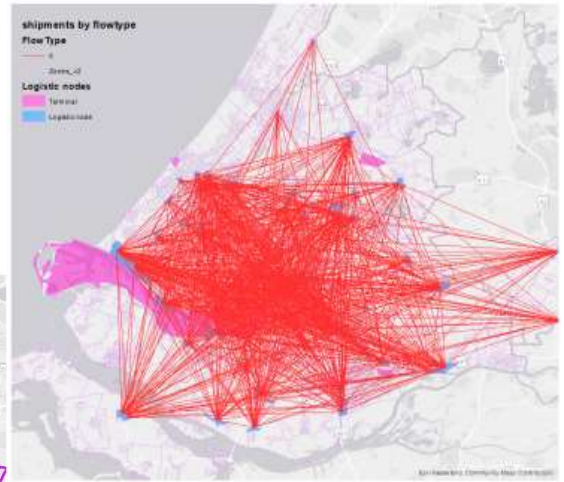
HARMONY

Tactical Freight Simulator TFS









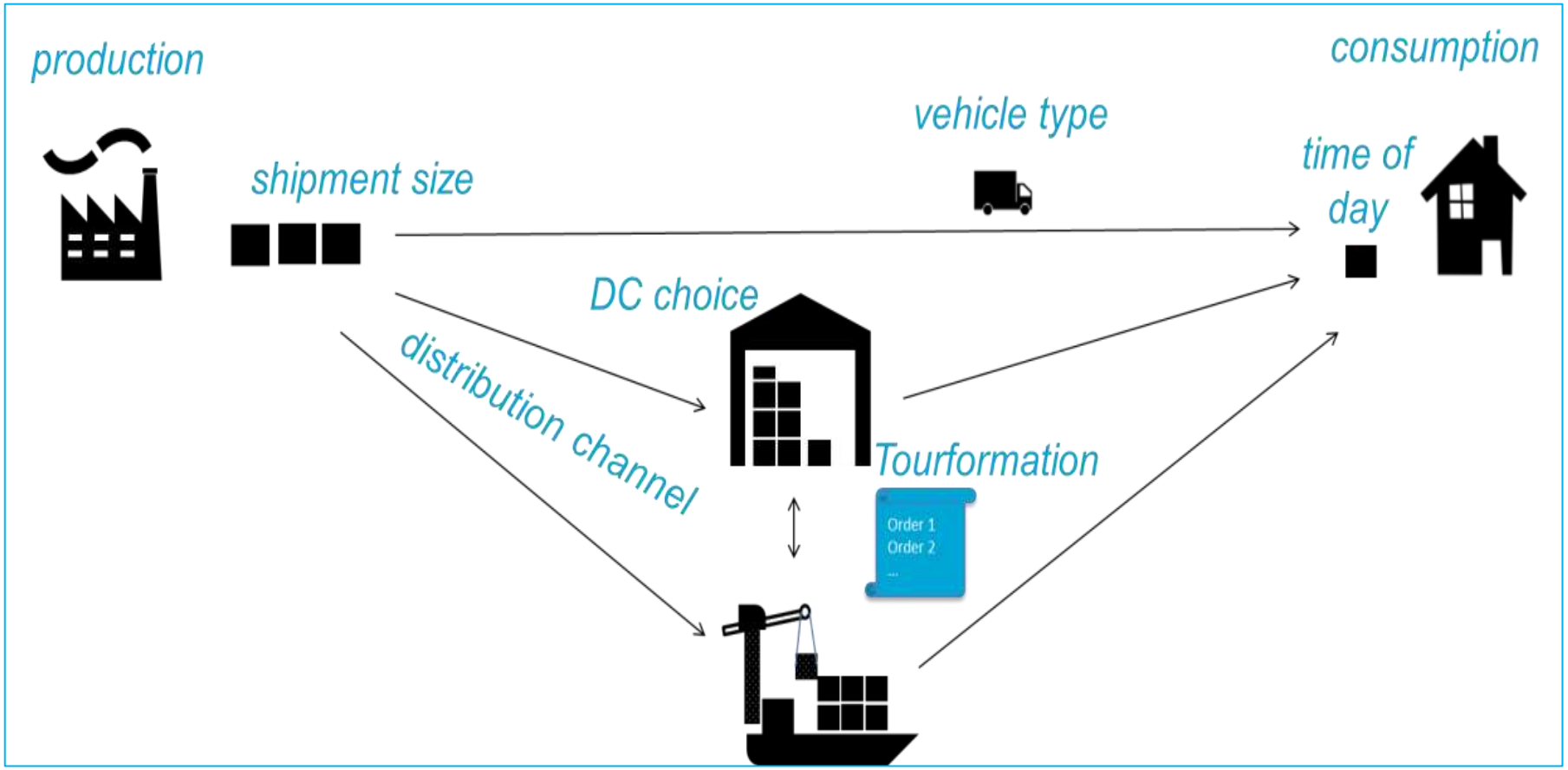
www.harmony-h2020.eu

Harmony-H2020

Harmony_H2020

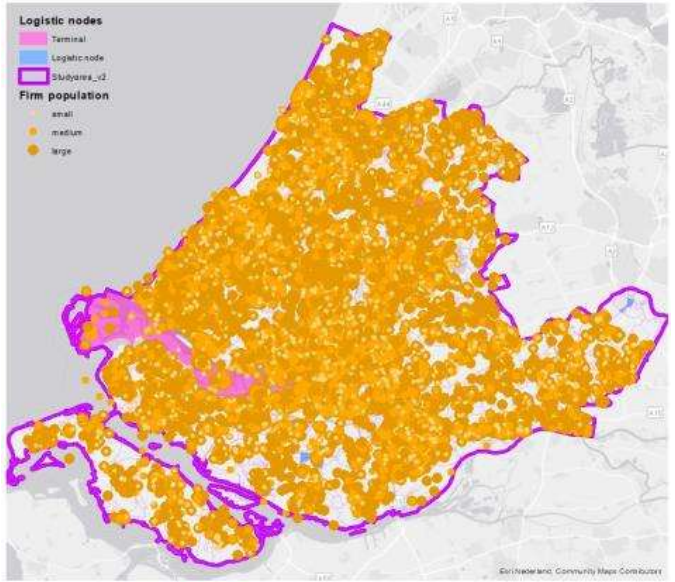
HARMONY

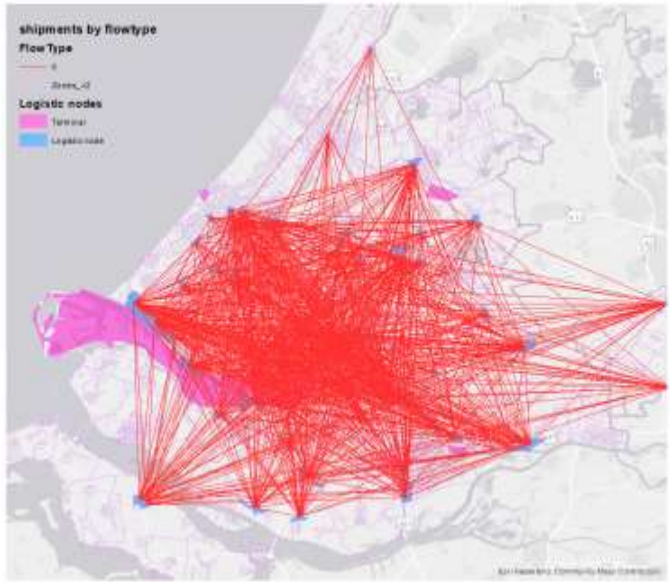
Conceptual Model - TFS

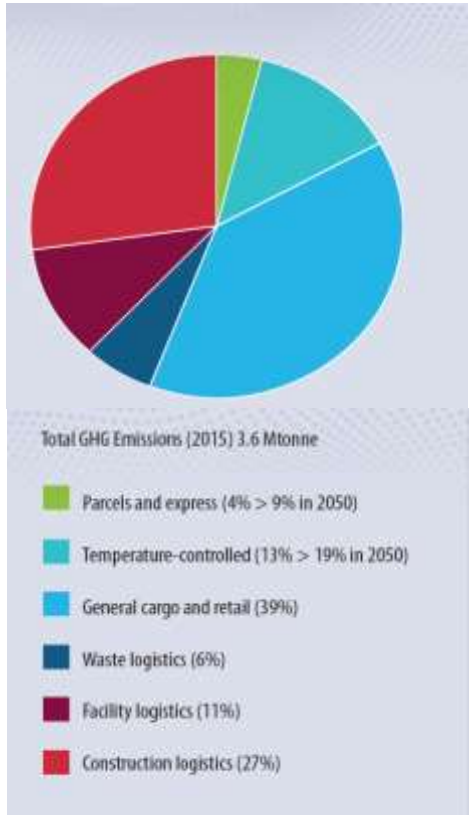


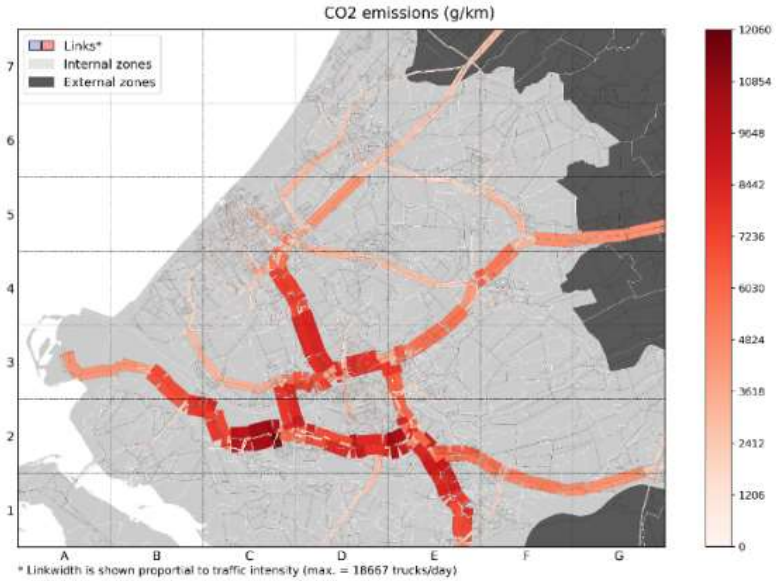
HARMONY

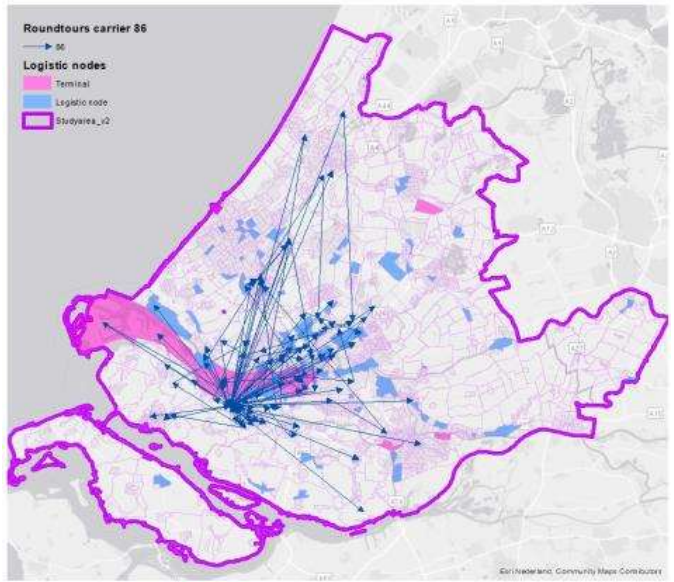
HARMONY TFS (MASS-GT v3) in 5 figures











HARMONY

Main structure

MASS-GT prototype v3

Shipment module: simulates long-term decisions:

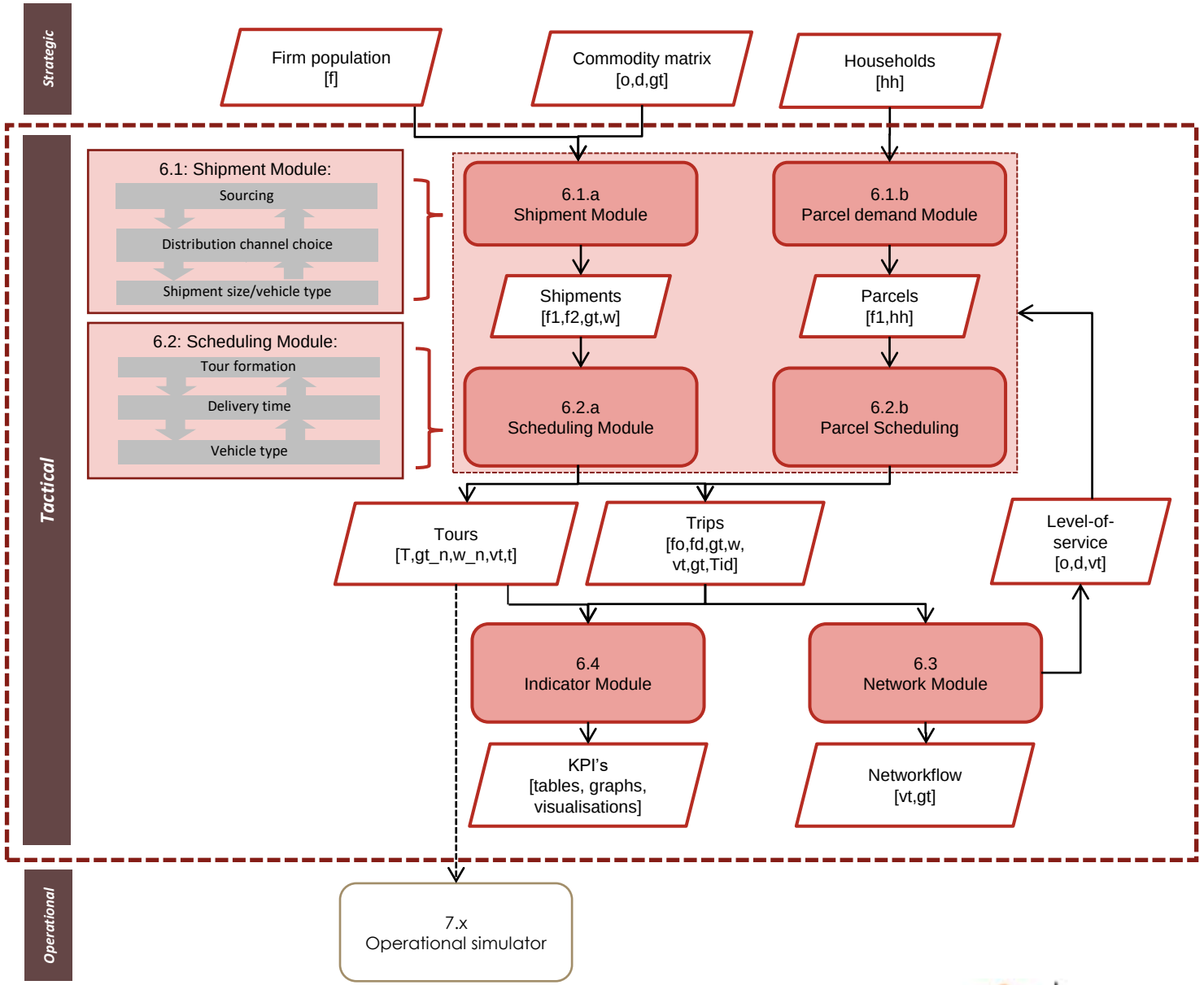
- ❑ Sourcing/Producer choice
- ❑ Distribution channel choice
- ❑ Shipment size & vehicle type (simultaneous)

Scheduling module: simulates daily decisions:

- ❑ Tourformation
- ❑ Time-of-day

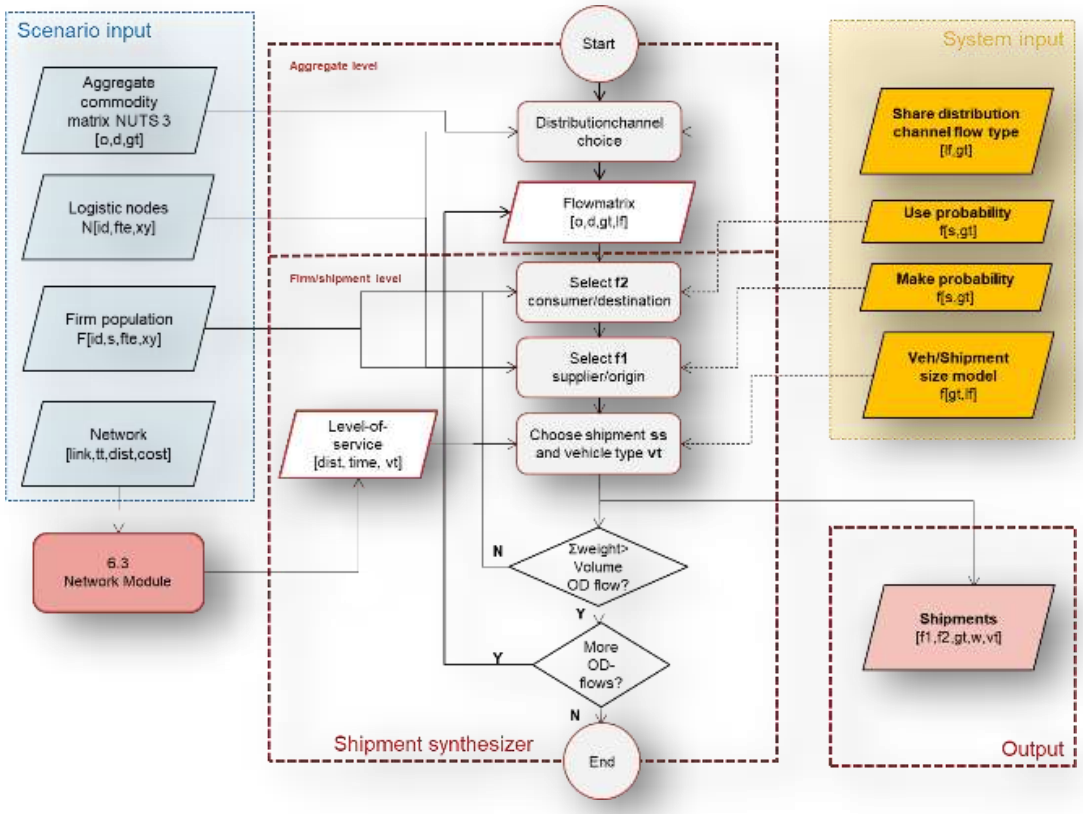
Two auxiliary modules:

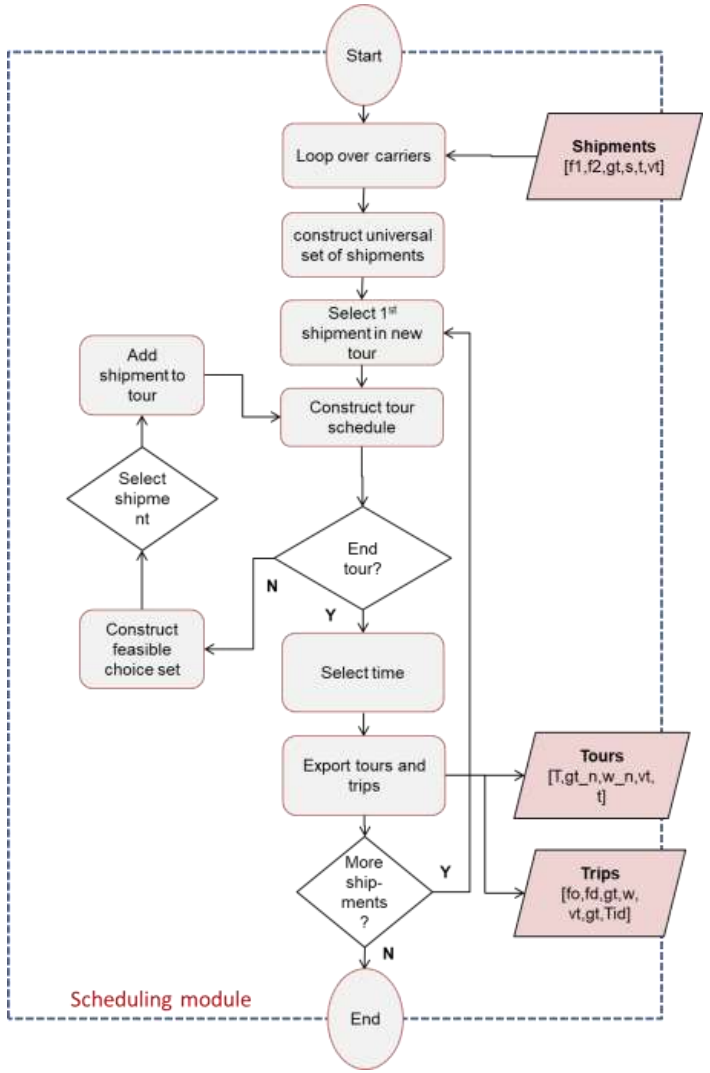
- ❑ Network Module (skim & routechoice)
- ❑ Indicator Module



HARMONY

Shipment modules





HARMONY

Shipment module

Objective of the shipment synthesizer:

To build a set of all shipments that are transported to/from/within the study area.

Top-down simulation of mid-term tactical decisions:

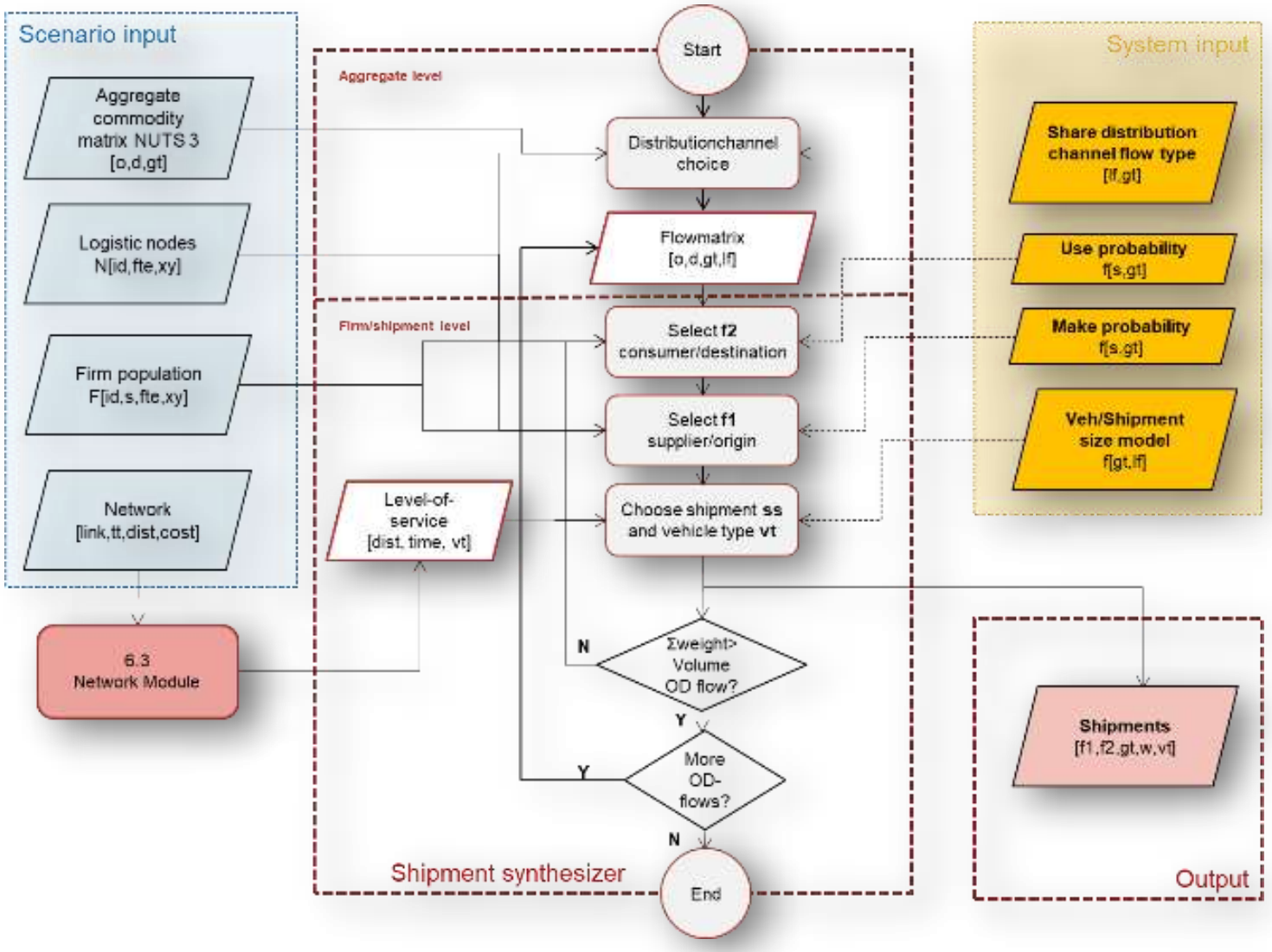
1. Allocation to distribution channel
2. Vehicle and shipment size choice
3. Selection of consumer
4. Selection of producer

Output:

All shipments in the study area

Use already available data:

- ❑ Statistics Netherlands (XML microdata)
- ❑ Regional transport Model

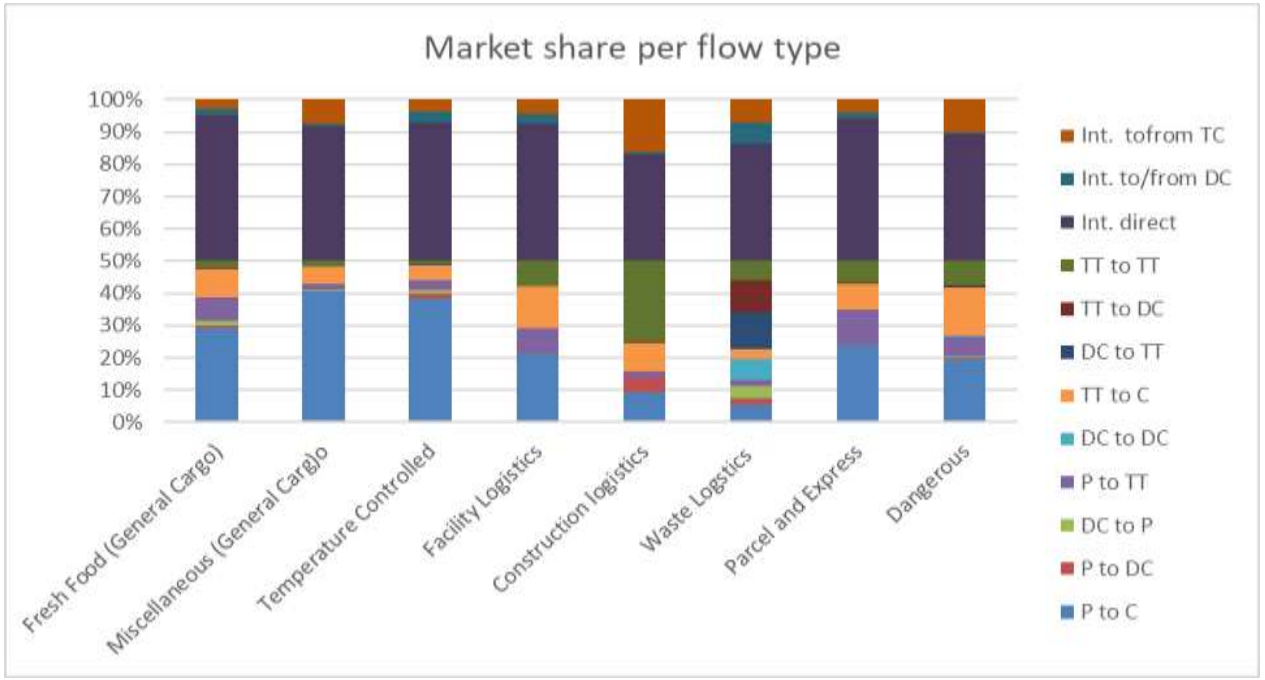


HARMONY

Distribution channel choice

Distribution channel choice is done based on observed market shares

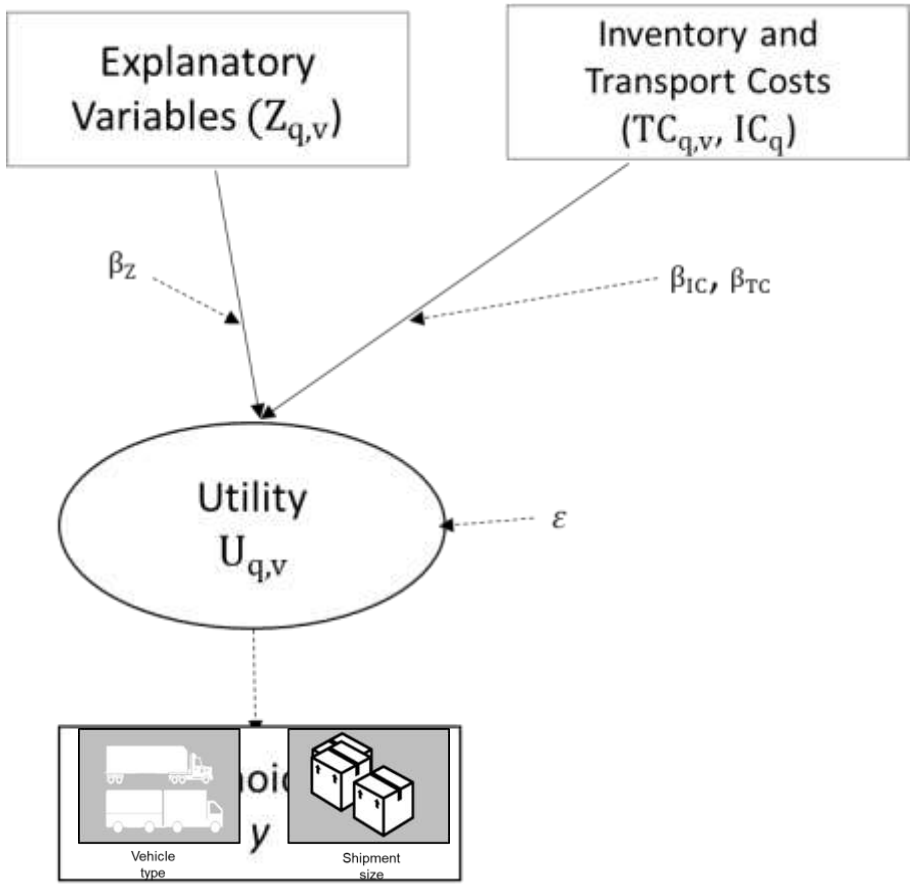
Observed market shares by logistics segments from the XML data:



Vehicle and shipment size choice model

- The shipment module includes a **logistic choice model** for **vehicle type** and **shipment size**.
- Both logistic choice are explained by a logistic cost function that includes **transport costs** and **inventory holding cost**:

Cost =  + 



- We develop a **discrete-discrete MNL** for the simultaneous choice of shipment and vehicle size

HARMONY

Consumer and supplier selection

❖Consumer allocation:

Probability that a firm f belonging to sector *s*, being the **receiver** of a shipment belonging to the logistics segment *ls* depends on firm size, *E*, 'use' probability for the sector, $P_{s;ls}^{use}$, and other firms in destination zone

$$P_{f;ls}^{receiv} = \frac{E_{f;s} * P_{s;ls}^{use}}{\sum_{i \in dest}[E_{i;s} * P_{s;ls}^{use}]}$$

❖Producer selection:

Probability of firm f belonging to sector s, being the **producer/sender** of shipment from a logistics segment (ls) which depends on firm size, E, 'make' probability for the sector, $P_{s;ls}^{make}$, and other firms in origin zone:

$$P_{f;ls}^{receiv} = \frac{E_{f;s} * P_{s;ls}^{use}}{\sum_{i \in dest}[E_{i;s} * P_{s;ls}^{use}]}$$

HARMONY

Scheduling module

Objective of the Scheduling module:

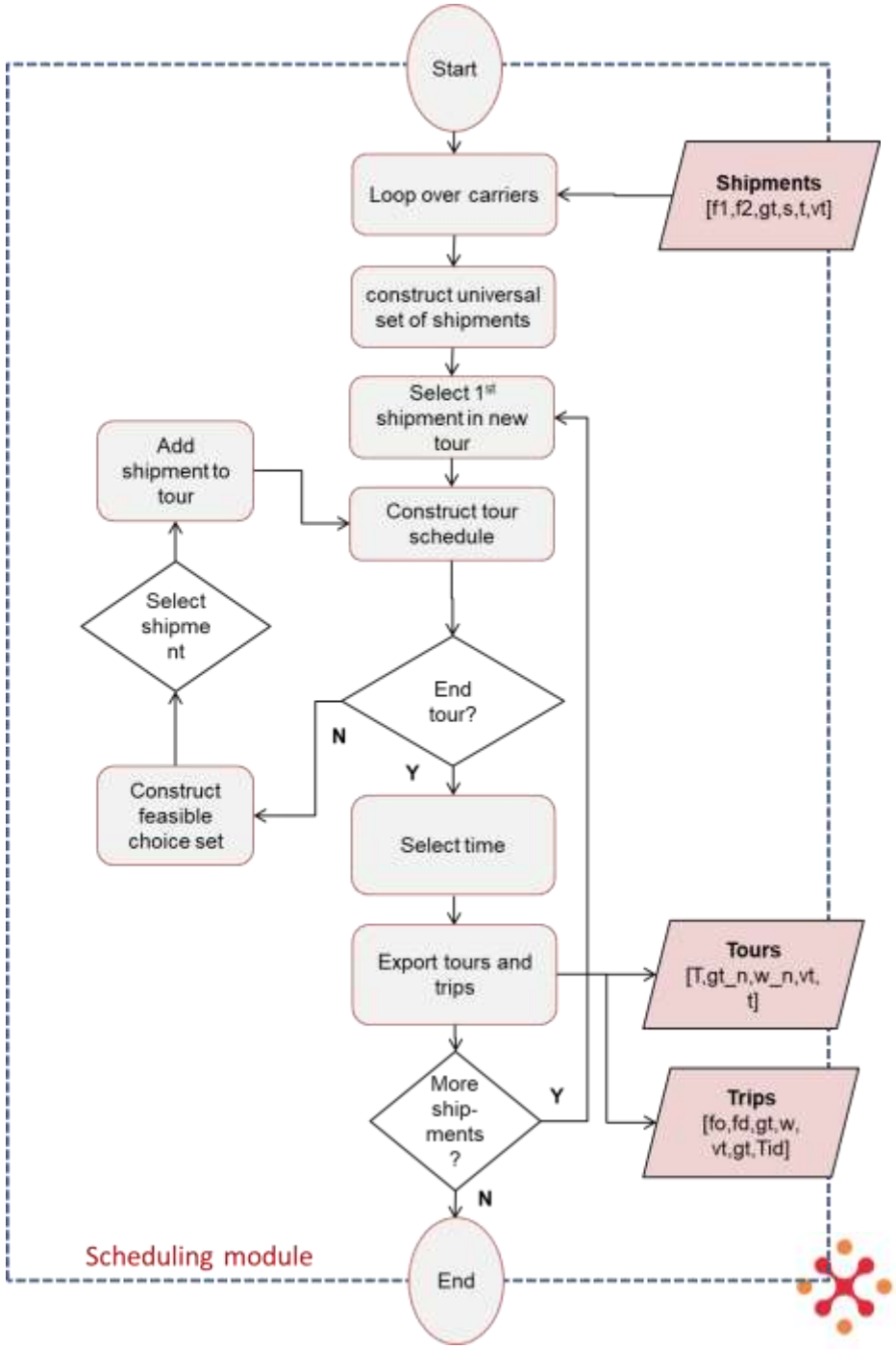
Simulate daily logistic decision making to schedule the delivery of all shipments that are transported to/from/within the study area.

Builds tour patterns, in a step-wise procedure, simulating the following logistic processes:

1. Tourformation
2. Delivery time

Output:

Truck round tours for the collection and delivery of all shipments in the study area



HARMONY

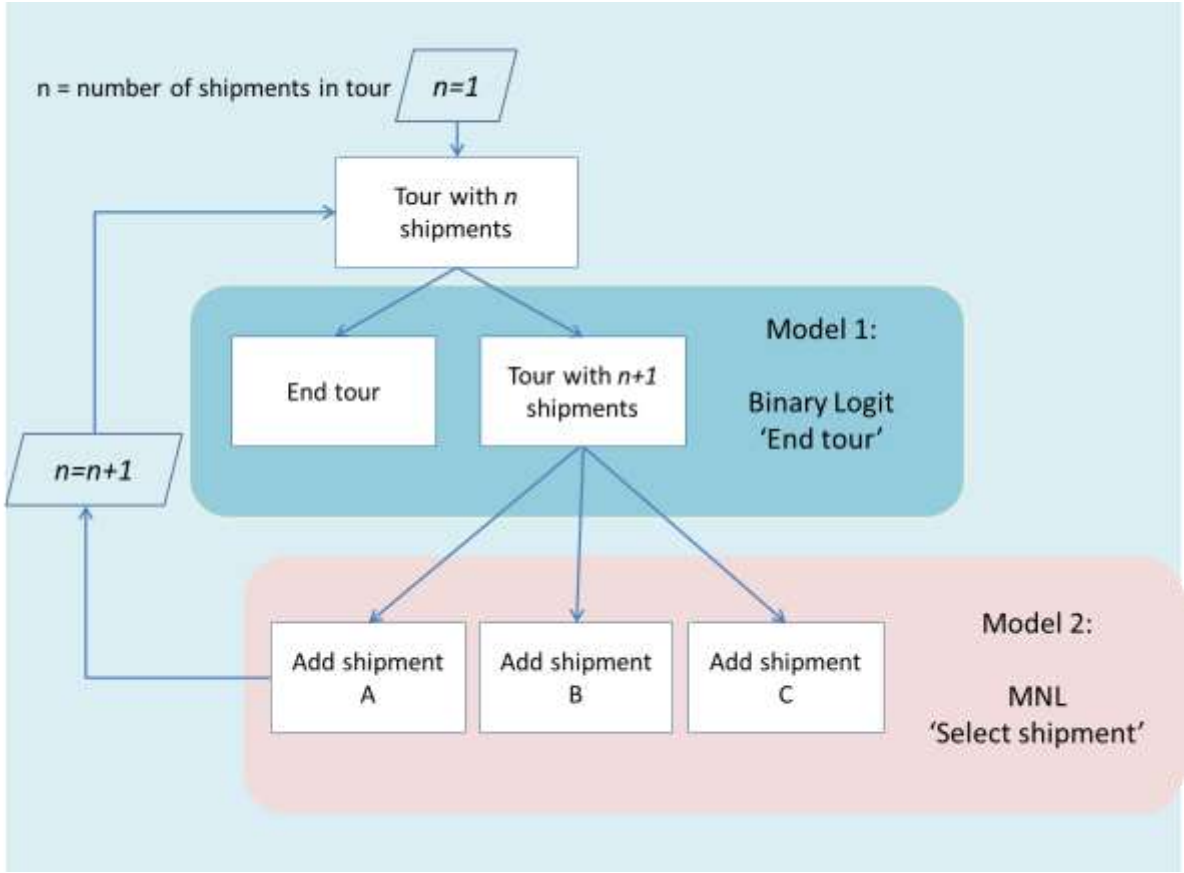
Tour formation choice model

Purpose:

Choice model for the formation of roundtours making one or multiple stops

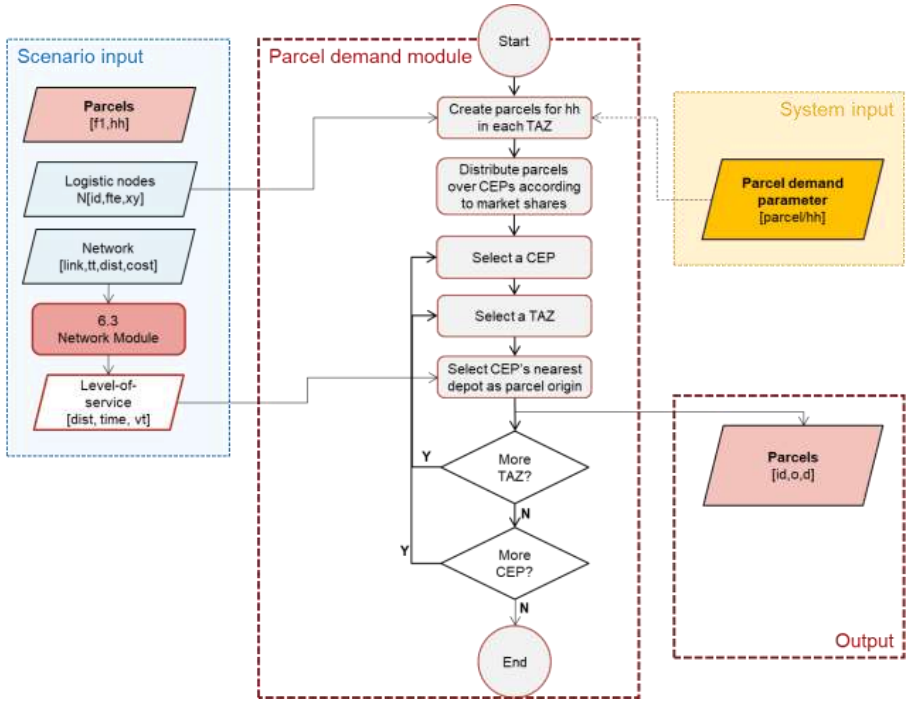
Approach:

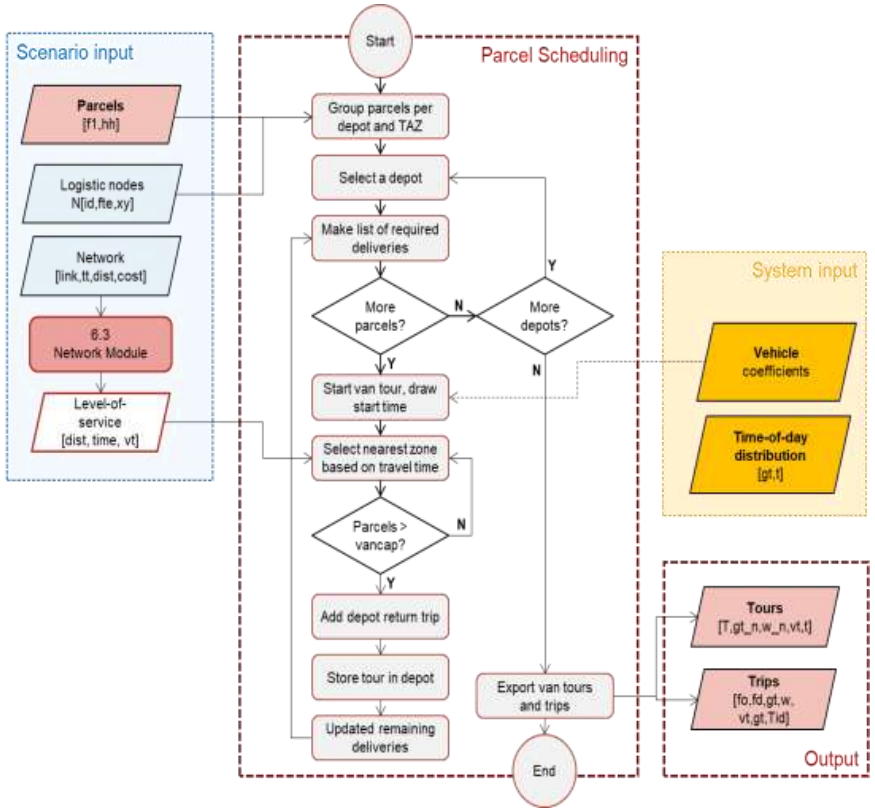
- Shipment based
- Step-wise discrete choice models
- Constraints: capacity, tour duration, distance
- Attributes in utility function: transport costs, commodity types, vehicle type, location type



HARMONY

Parcel modules





HARMONY

Parcel demand module

Objective of the parcel demand module:

To create a set of parcels with their origin and/or destinations in the study area.

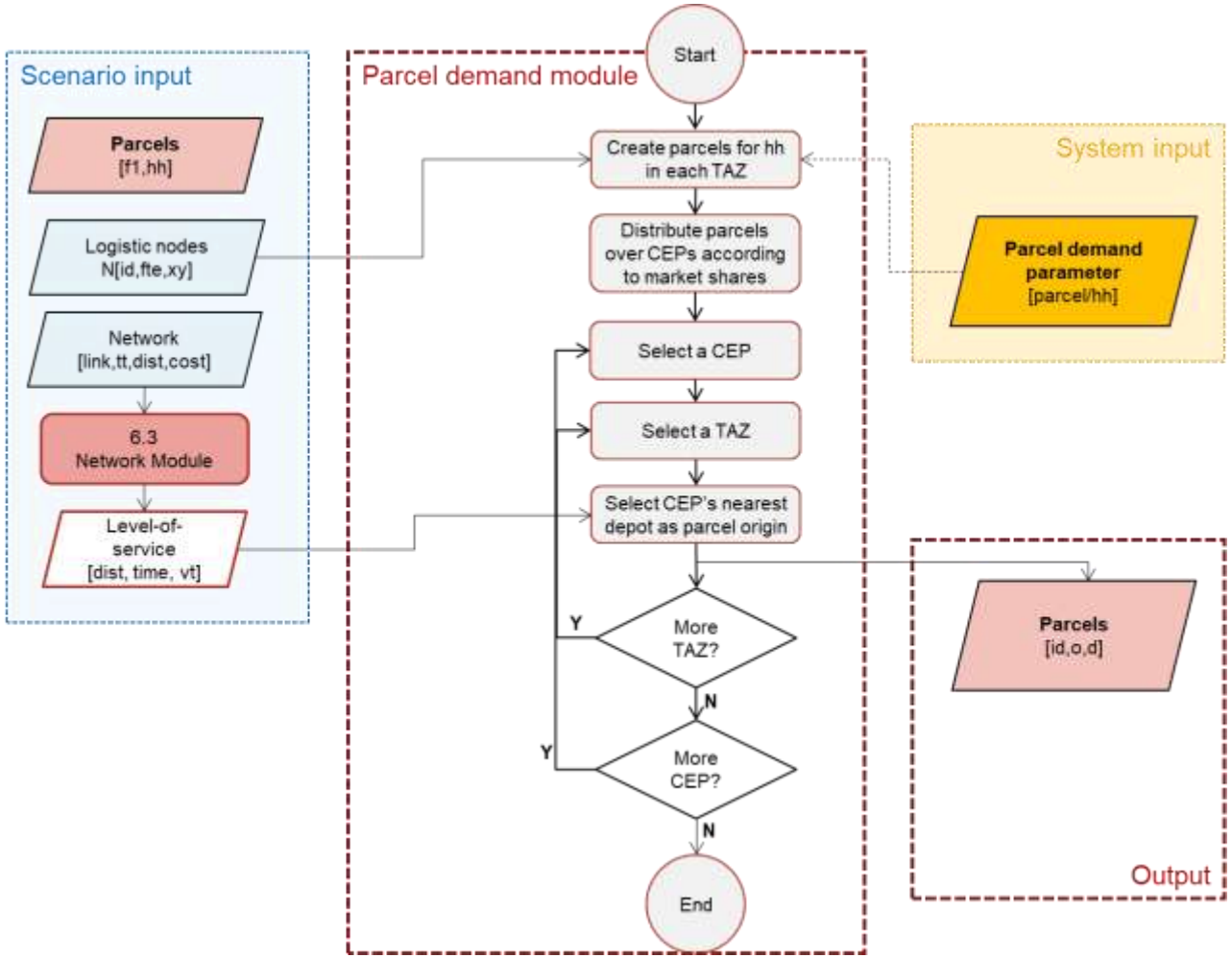
Parcels are assigned to companies based **on market shares** and to depots based on **proximity.**

Input:

Households and business in the study area

Output:

All parcels in the study area



Parcel scheduling module

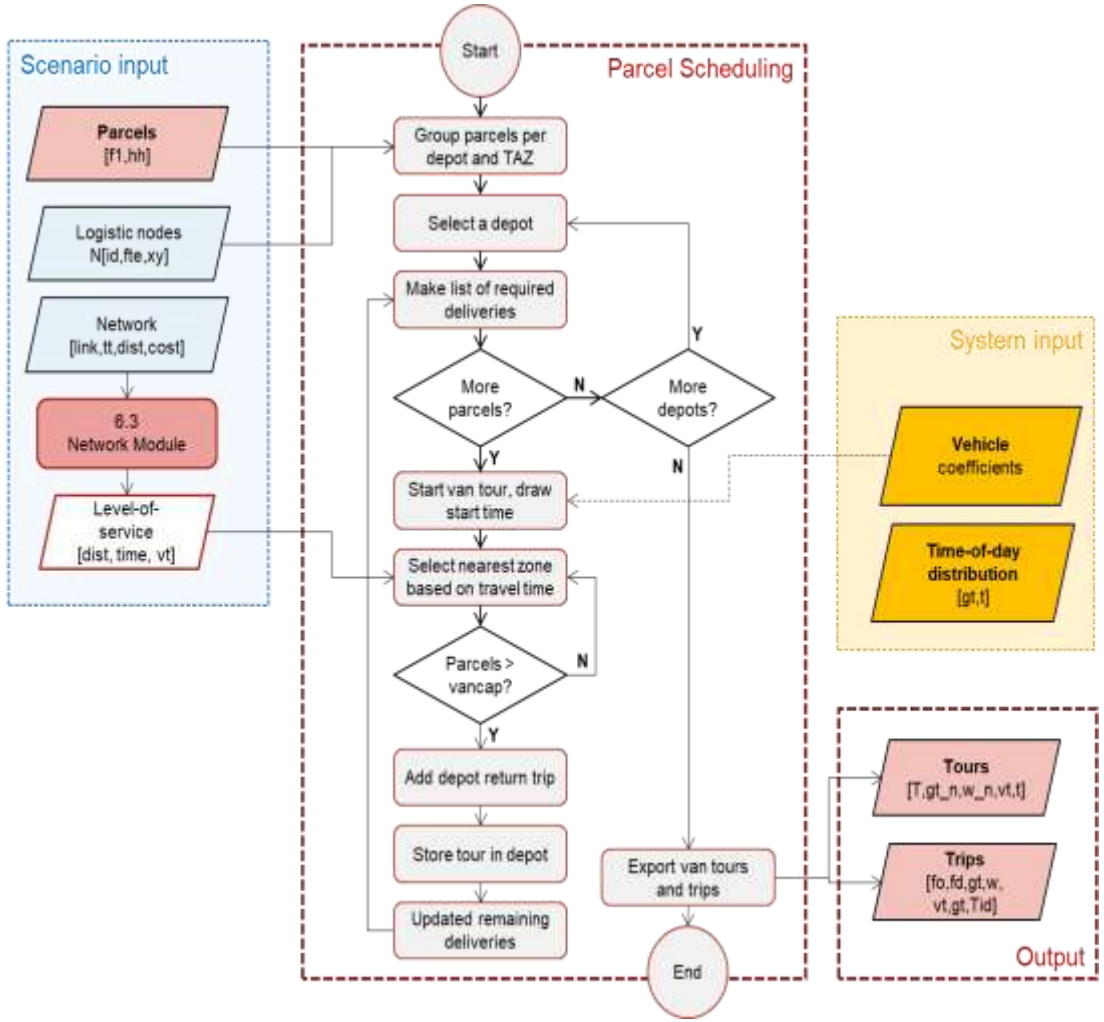
Objective of the parcel scheduling module:

Simulate the formation of distribution tours for the delivery of parcels.

Parcels are added to the tour od the van based on delivery location. Deliveries are done to the nearest zone is based on travel time.

Output:

Van trips and tours for the delivery of parcels.



Conclusions

- **First application** of the TFS showed that the model can be applied for the assessment of policies in the system.
- Emerging sources of '**big data**' allow the development of a new generation of empirical multi-agent simulation models for urban freight planning.
- **Multi-agent simulation** models allow a better representation of stakeholders (e.g. logistic segments), and implementation of scenarios for city logistics.
- **Next iterations** of the TFS are expected to improve the validity of models.

HARMONY

Thank you for your interest

Thank you for your interest!

e-mail: I.Kourounioti-1@tudelft.nl