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Bicycle Traffic Model for Sustainable Urban Mobility Planning

Jacek Oskarbski

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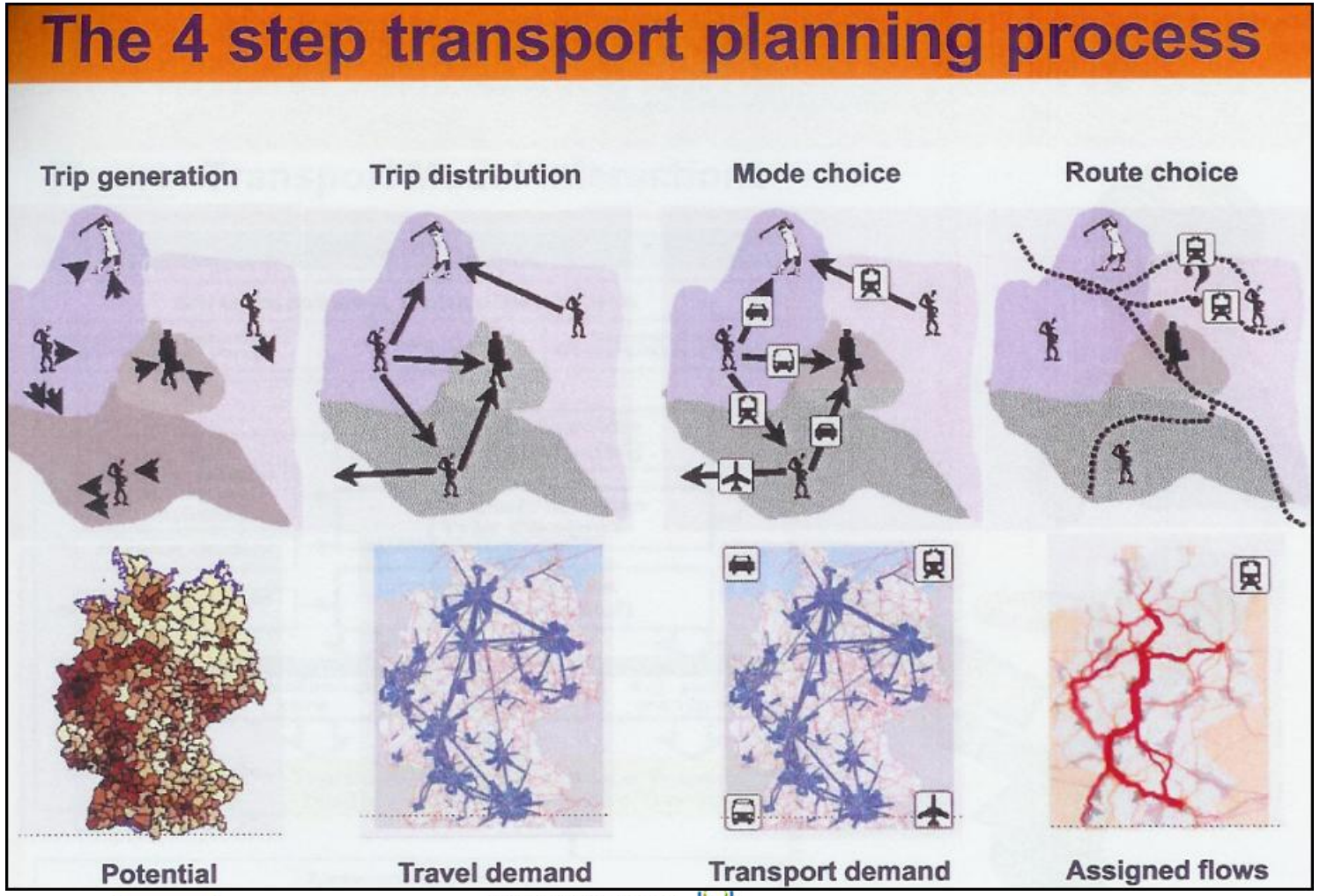
Modelling process



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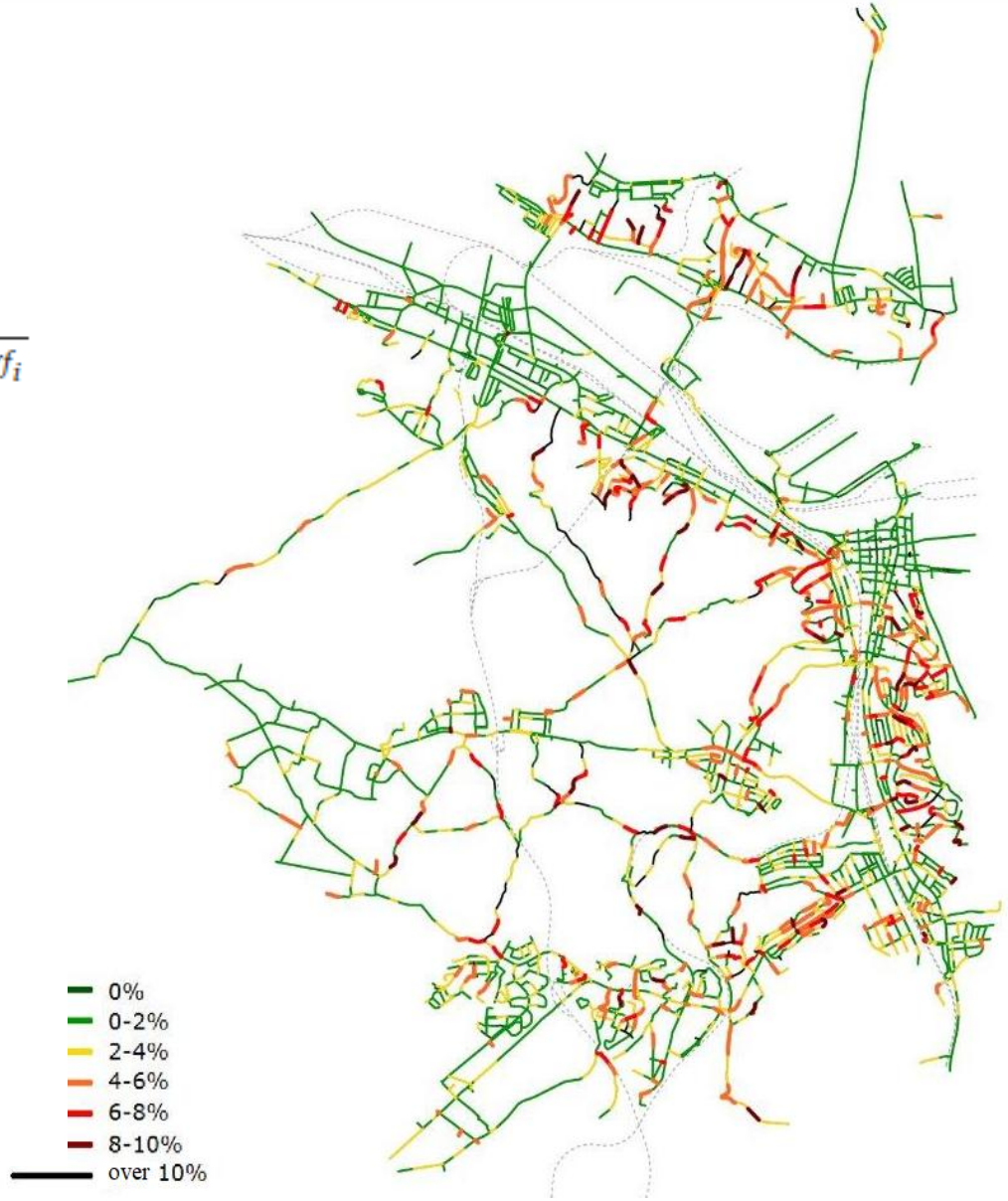
Bicycle network

$$Vel_i = 31 - \frac{25.5}{1 + e^{0.22 - 0.4 \cdot Slope_i - 0.07 \cdot Type_i - 0.077 \cdot Surf_i}}$$

Vel_i—average speed of link i;
$Slope_i$—slope of link i;
$Type_i$—type of road of link i;
$Surf_i$—type of surface of link i.

$$TT0r = \sum_{i=1}^{n} \frac{L_i}{Vel_i}$$

$TT0r$—travel time on bicycle routes between transport zones;
L_i—length of bicycle route link i;
Vel_i—average speed at link i.



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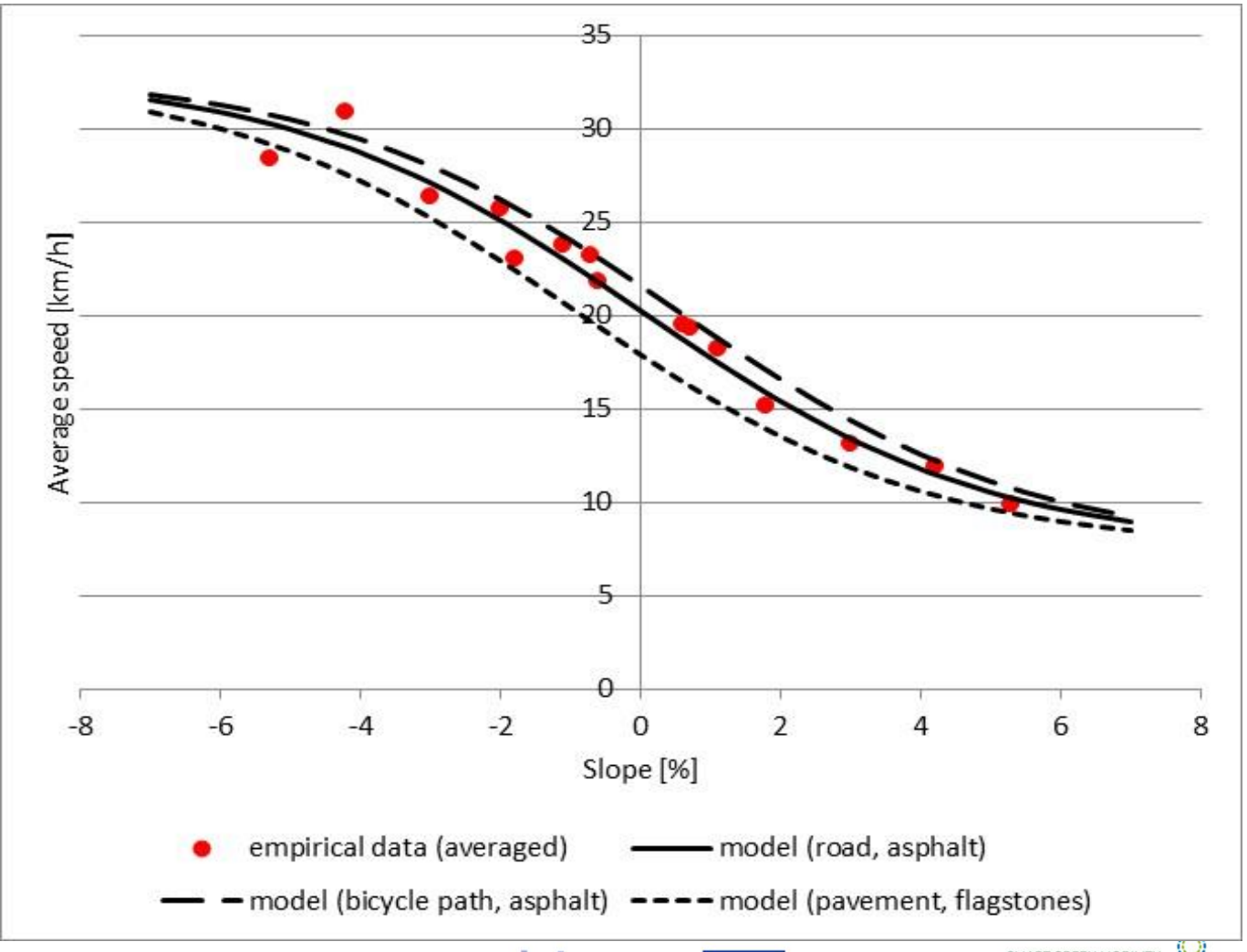
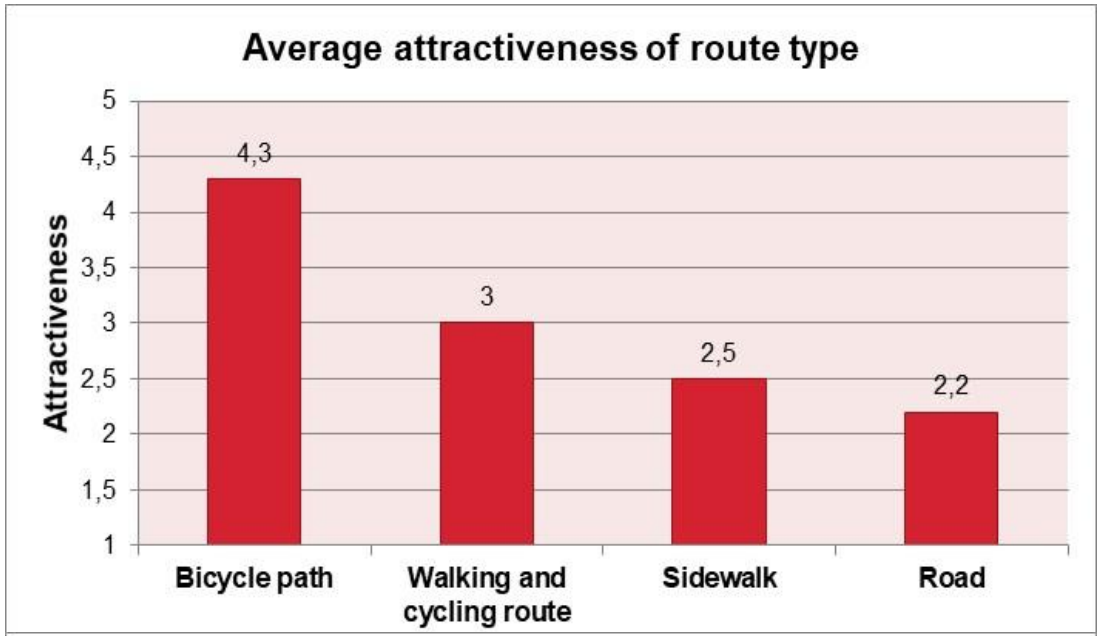
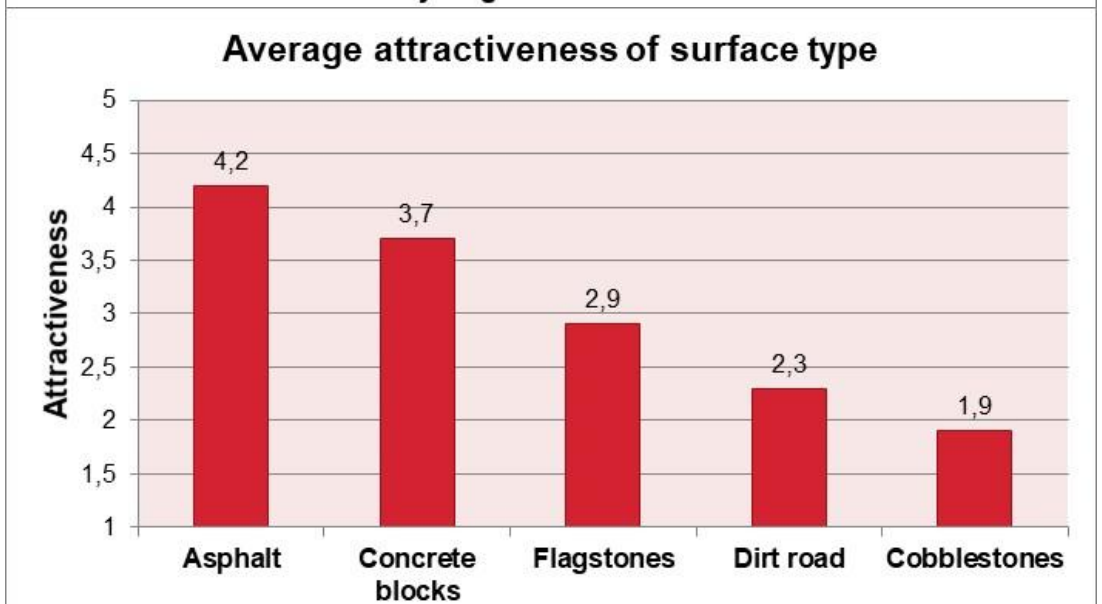
The relation between the average speed $Veli$ of cycling on the longitudinal slope and the characteristics of the route







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Modelling of modal split

$$P_{gn} = \frac{e^{\mu_n U_{gn}}}{\sum_{g \in n} e^{\mu_n U_{gn}}} \cdot \frac{e^{\mu_g \left[\frac{1}{\mu_n} log\left(\sum_{g \in n} e^{\mu_n U_{gn}} \right) \right]}}{\sum_{n=1}^{m} e^{\mu_g \left[\frac{1}{\mu_n} log\left(\sum_{g \in n} e^{\mu_n U_{gn}} \right) \right]}} \quad (3)$$

P_{gn}—the probability of choosing the nth mode of transport belonging to the gth group of transport modes;
U_{gn}—utility of the nth mode of transport belonging to the gth group of transport modes;
μ_n, μ_g—model scaling coefficients.

$$U_{ij} = V_{ij} + \varepsilon_{ij} \quad (4)$$

$V^m{}_{ij}$—measurable utility of transport modes m;
$\varepsilon^m{}_{ij}$ —random variable with a logistical distribution reflecting values not included in the utility $V^m{}_{ij}$.

For each mode of transport (p—walk trip; R—bicycle trip; TI—private transport trip; TZ—public transport trip), the authors of this paper developed a nested logit model with the following utility functions:

$$\begin{aligned} V_P &= \beta_{10} + \beta_{11} \cdot DIS \\ V_R &= \beta_{20} + \beta_{21} \cdot TT0r \\ V_{TI} &= \beta_{30} + \beta_{32} \cdot \frac{TTC}{PJT} \\ V_{TZ} &= 0 \end{aligned} \quad (5)$$

DIS—travel distance (km);
$TT0r$—calculated time of cycling trip (min);
TTC—calculated travel time by private transport (min);
PJT—perceived travel time by public transport (min);
β_l—equation coefficients.

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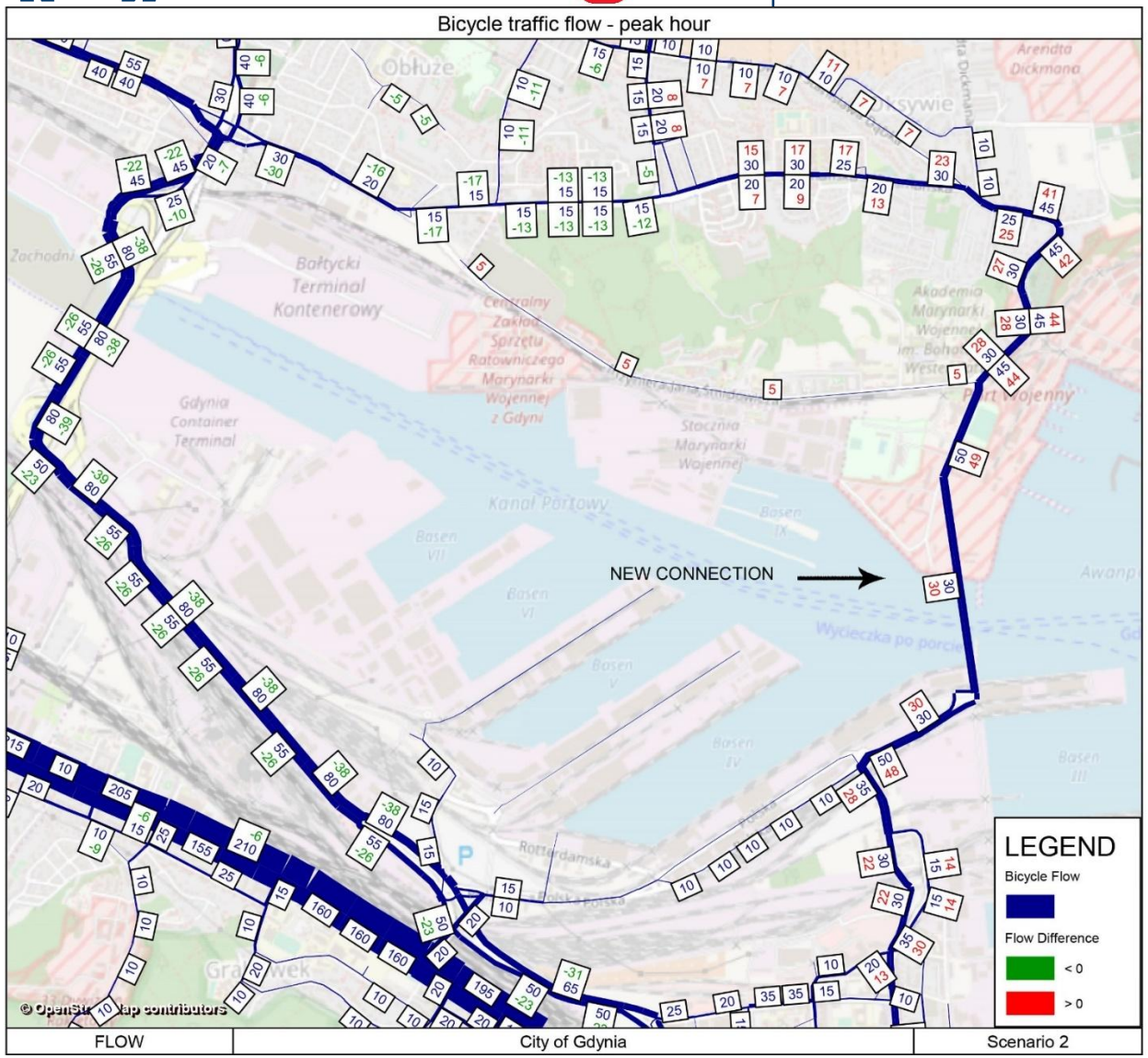
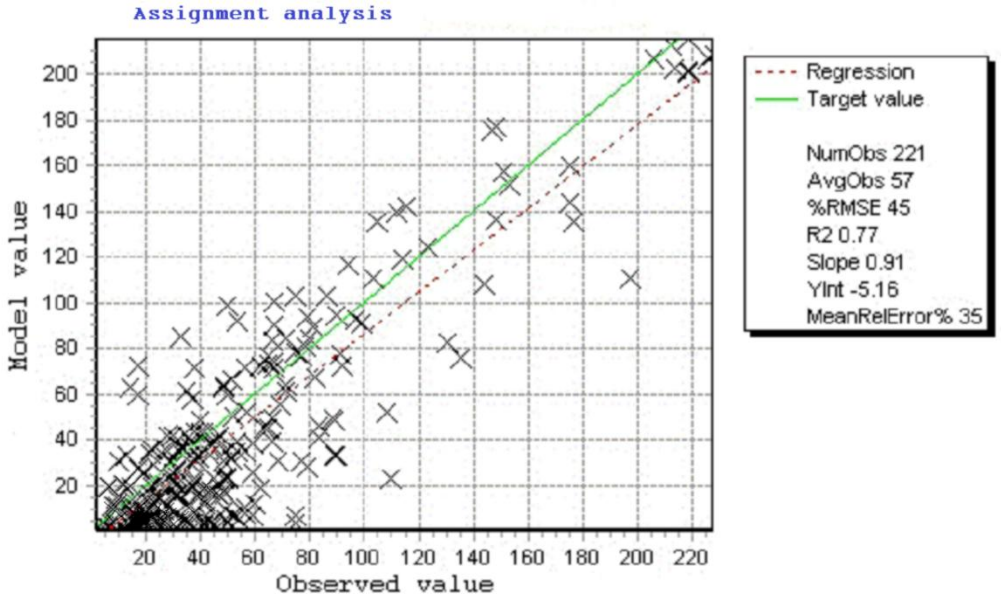
Results





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