Potential Impacts of Share Bike-Transit Integration on Equity in Job Accessbility

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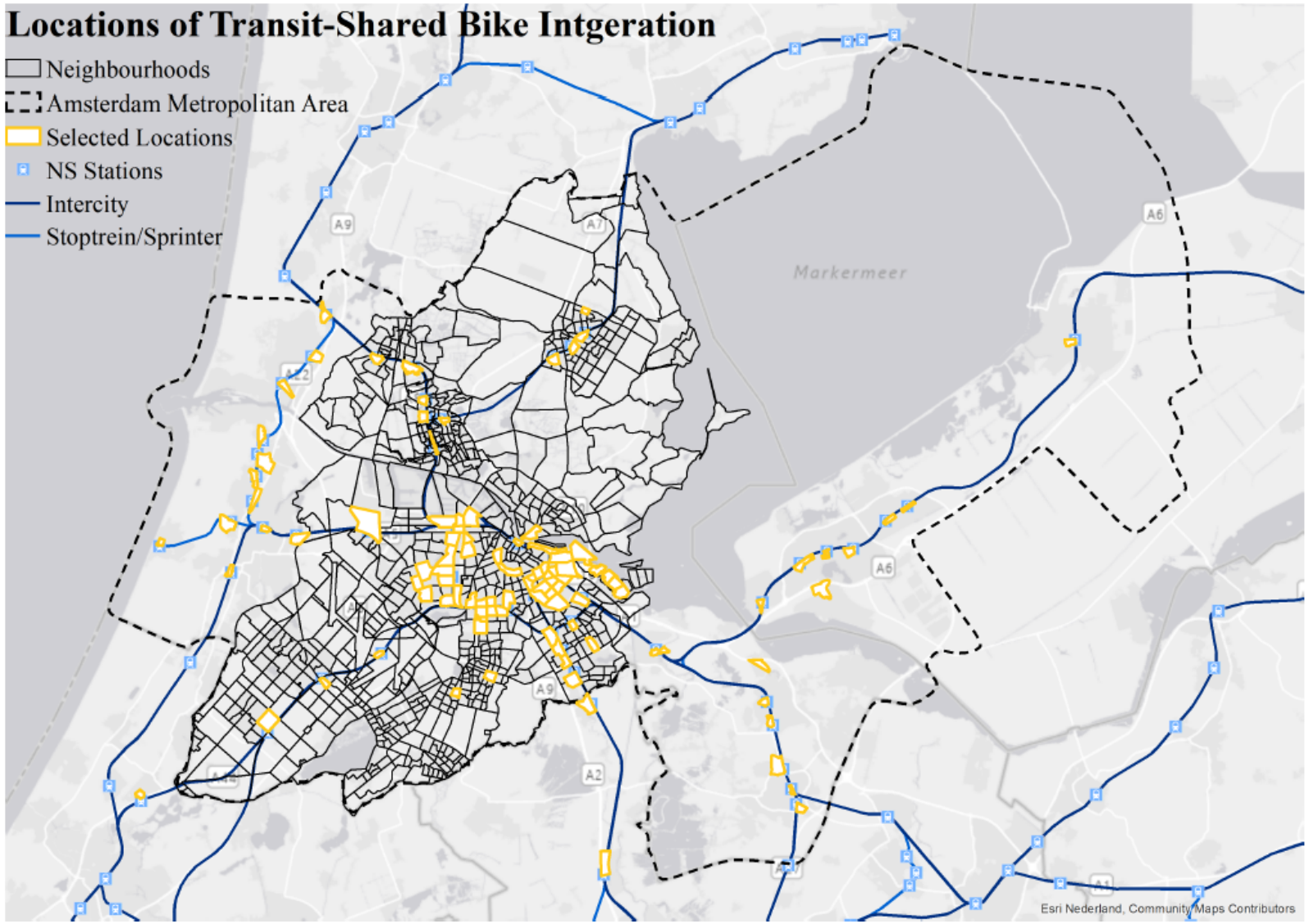


Lab
Smart Public Transport

TU Delft

Vervoerregio Amsterdam

https://nielsvanoort.weblog.tudelft.nl/inclusive-mobility/

Inclusive Mobility

Accessibility for all

TU Delft Lab Smart Public Transport

The 10 dimensions of exclusion[1]

- Time-based exclusion
- Discrimination-based exclusion
- Geographical exclusion
- Fear-based exclusion
- Space exclusion
- Informational exclusion
- Exclusion from facilities
- Economic exclusion
- Physical and cognitive exclusion
- Digital divide exclusion

How are the 10 dimensions addressed in public transport agreements (case: Amsterdam Region)[2]

Most of the 10 dimensions are addressed in some form:

- Topic has their own chapter:
- Mentioned in all documents: Physical
- Discussed indirectly: Cognitive
- Not addressed in selected documents:

Wider impacts of public transport.[3]

Transport inequality is based on:[4]

Accessibility
Resistance to activities (job, education, social).

Mobility
Quality and availability of modes of transport.

Affordability
Constraint on available financial resources.

Statistics of digital divide exclusion[7]

1 in 5 Dutch people aged 12 and above have low digital skills.

36%
36% of people with lower education levels have low digital skills.

43%
43% of people aged 65 and older have low digital skills.

9%
9% of Dutch car & public transport users find it difficult to plan a trip online.[9]

Three important topics for inclusive mobility.[5]

Key factors effecting transport inequality[4]

Car ownership · Age · Inhabitant density · Income · Job density

Travel distance inequality case: Amsterdam[6]

People with lower income often live further away from opportunities, and thus travel larger (Euclidean) distances. They also travel longer due to the fact that they make detours more often.

Inclusivity: from theory to reality[8]

A public transport network could fit one of the following principles, but may not be equitable according to another.

Proportionality
Public transport should be allocated based on the distribution of the total population and/or share of public transport.

Egalitarianism
All people should receive equal levels of public transport accessibility.

Sufficientarianism
Everyone should have some minimum threshold of public transport to reach their basic needs and important destinations.

Measures needed to tackle digital inequality in public transport[10]

- Use an accessible design.
- Keep an eye out for less digitally self-reliant users.
- Entice people to use digital products.
- Implement governance measures (planning, reflections, finance).
- Offer trainings to targeted groups.

References

1. Bruno & Van Oort (2023)
2. Bruno et al. (2023)
3. Van Oort et al. (2017)
4. Bon et al. (2023)
5. Durand et al. (2022)
6. Dixit et al. (2021)
7. Durand et al. (2023a)
8. Van Luven et al. (2023)
9. Durand et al. (2023b) (KiM)
10. Durand et al. (2023c)

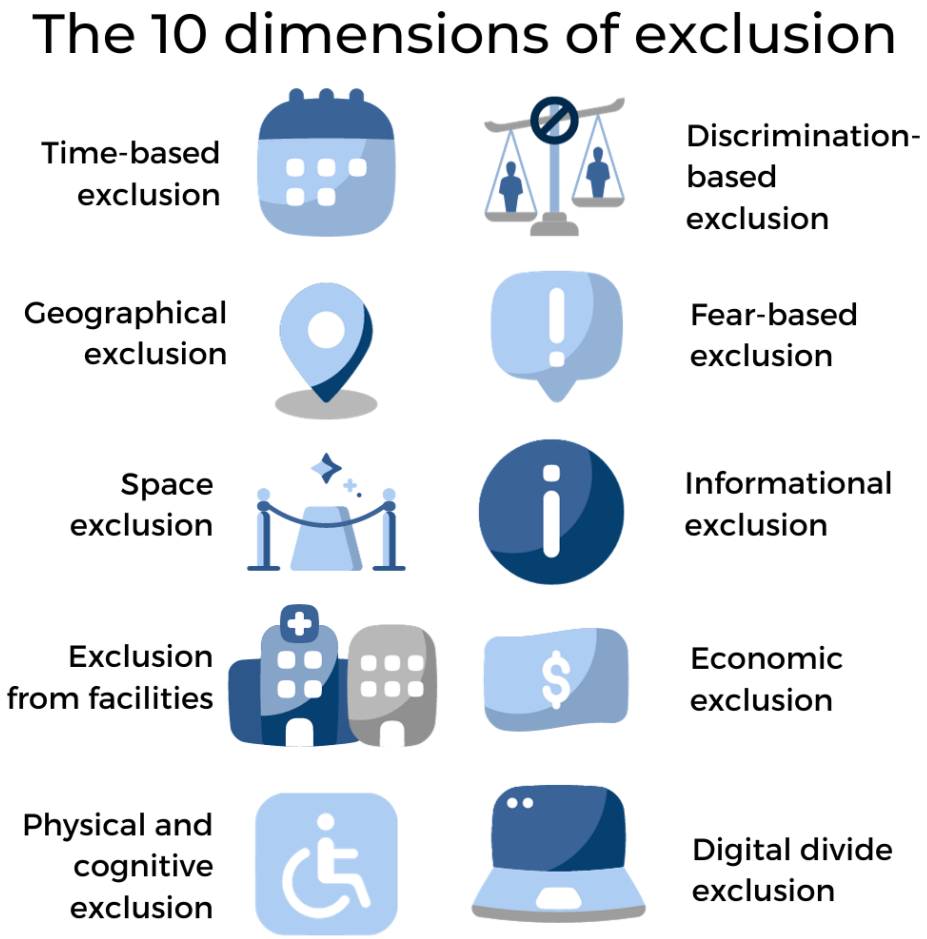
https://nielsvanoort.weblog.tudelft.nl/inclusive-mobility/

Postdoc: Naar een inclusief mobiliteitssysteem in de vervoerregio Amsterdam

Onderzoeksvraag:
Hoe evalueer je de mate van sociale inclusiviteit van een mobiliteitssysteem en hoe ziet dat eruit, toegepast op de vervoerregio Amsterdam?

Bron: https://www.stm.info/en/info/universal-accessibility/inclusive-mobility

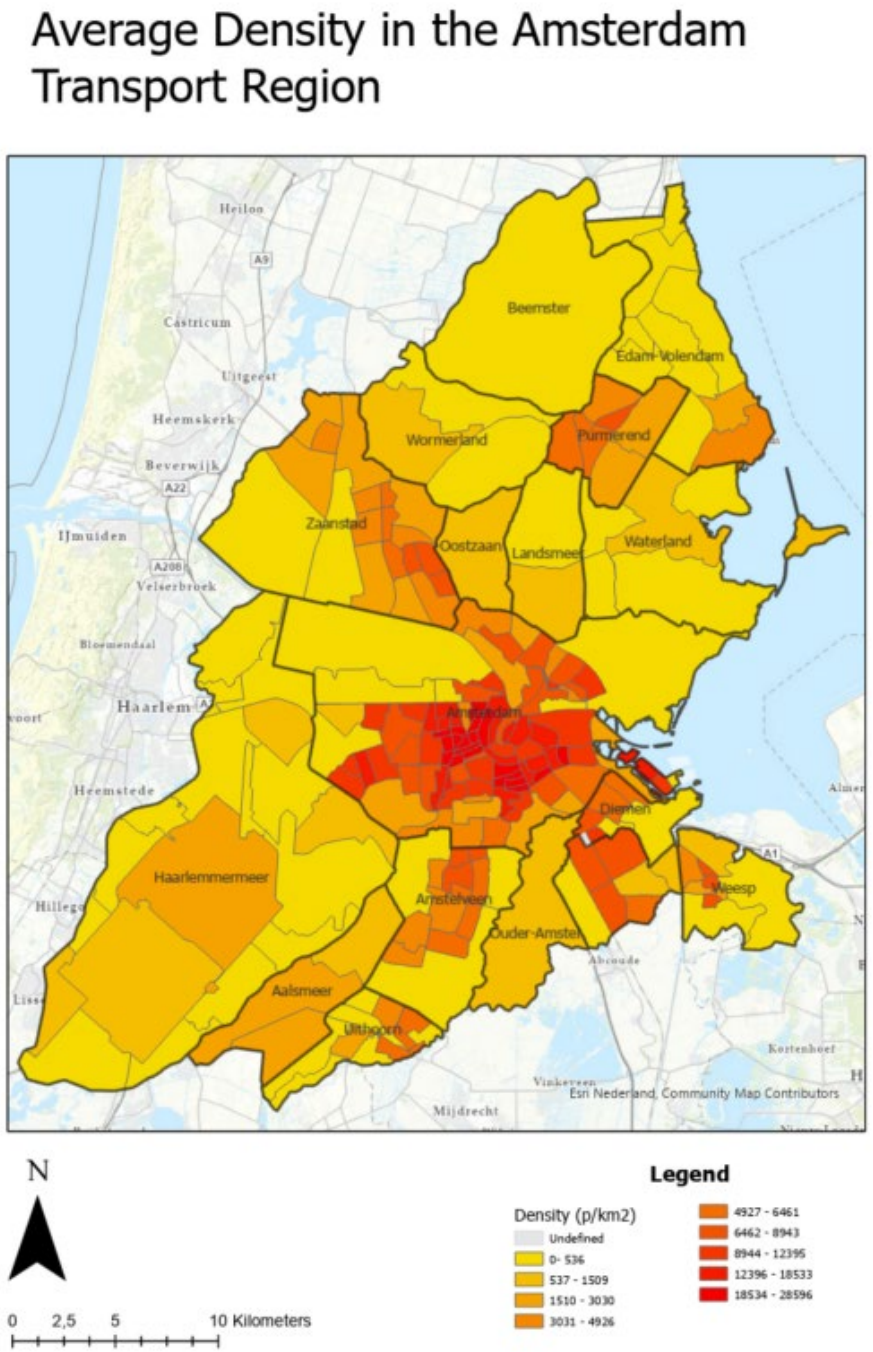
De 10 dimensies van vervoers-verbonden sociale uitsluiting [Transport Related Social Exclusion]



Adapted from Luz, G., & Portugal, L. (2021). Understanding transport-related social exclusion through the lens of capabilities approach. *Transport Reviews*. https://doi.org/10.1080/01441647.2021.2005183

Geografische uitsluiting/Geographical exclusion

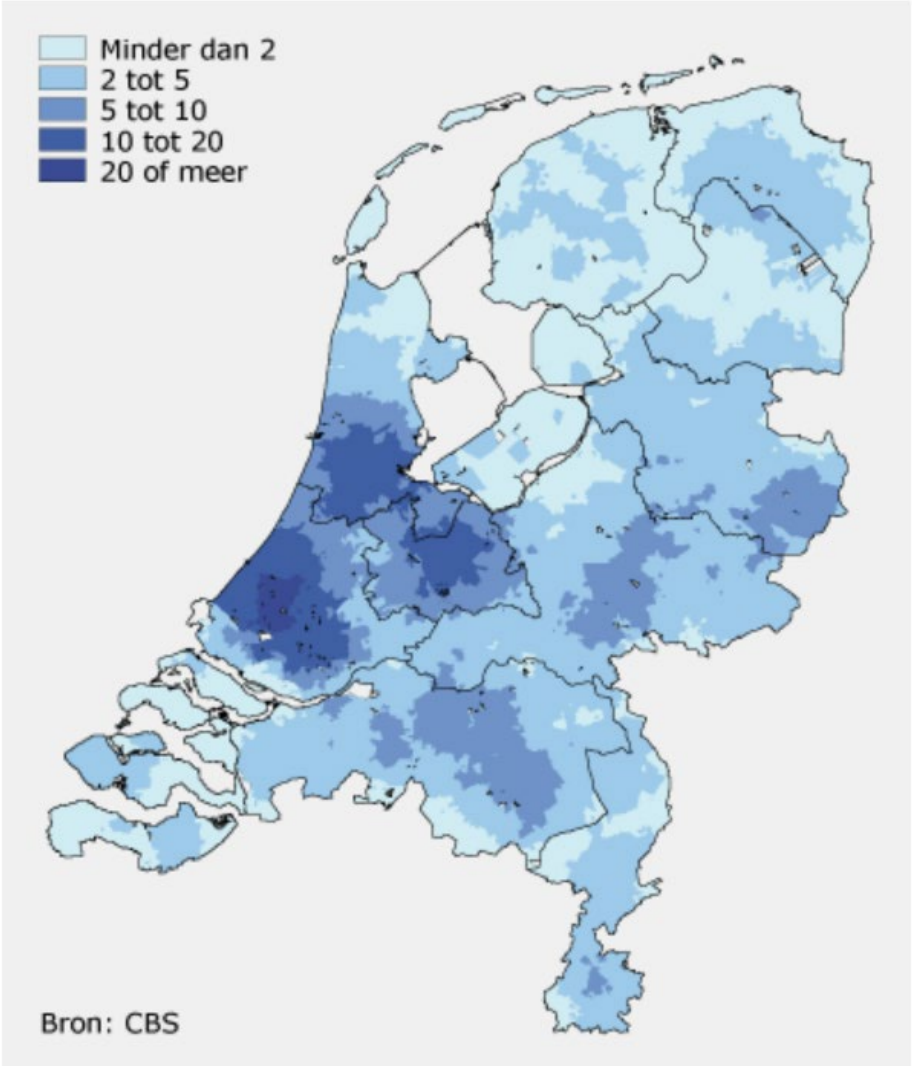
Er is spraak van geografische uitsluiting als een vervoerdienst niet voorhand is in de woonlocatie van iemand of als het vervoerssysteem geen verbinding heeft met de gewenst locatie.



Uitsluiting van faciliteiten/Exclusion from facilities

Er is spraak van uitsluiting van faciliteiten bij de afwezigheid of afstand van huis naar belangrijke bestemmingen zoals werk, school, zorg, winkel, of dienst. Het kan ook plaats hebben als de opportuniteiten die bereikbaar zijn door het openbaar vervoer evenwel niet geschikt zijn voor het individu.

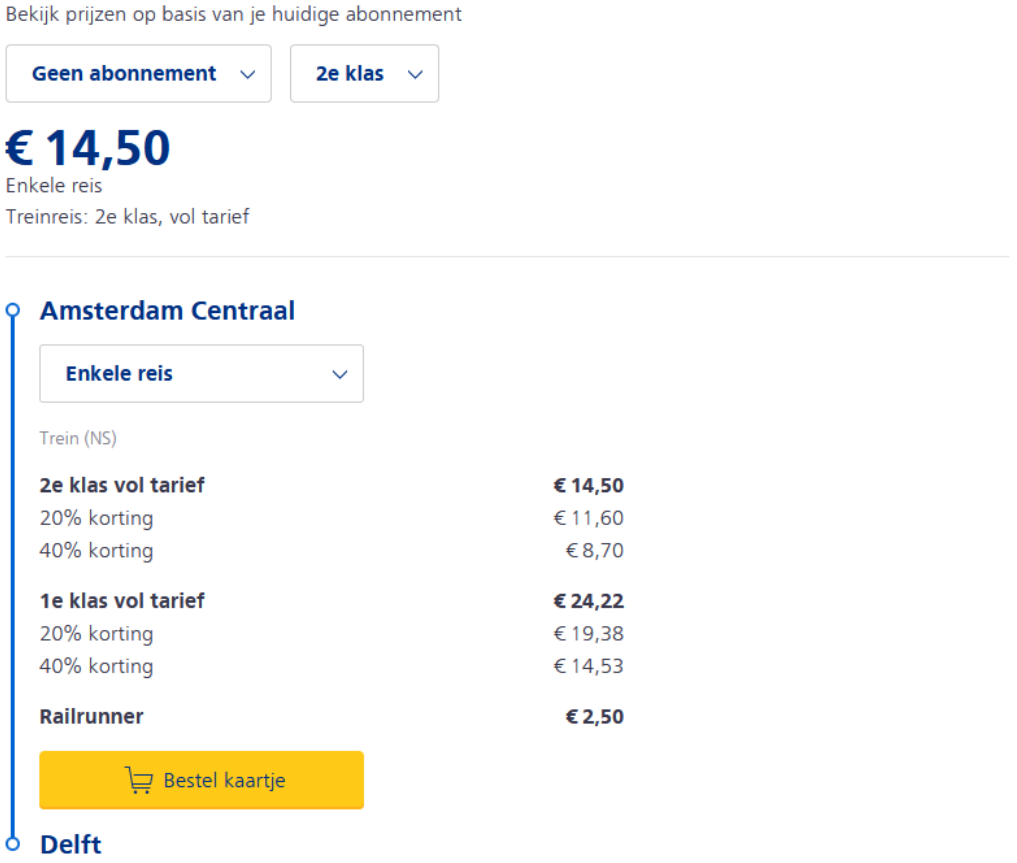
Aantal ziekenhuizen binnen een straal van 20 kilometer op buurtniveau, 2007

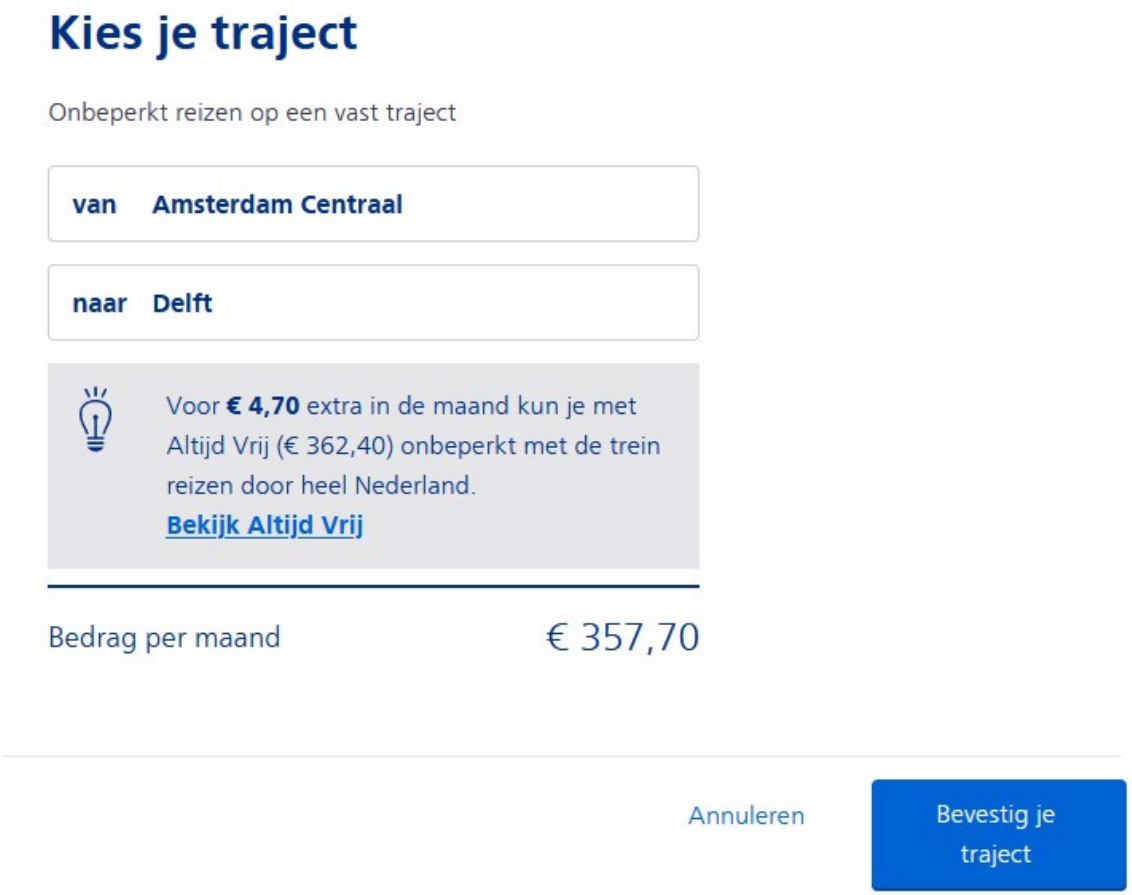


https://www.cbs.nl/nl-nl/nieuws/2009/33/meeste-nederlanders-wonen-binnen-5-kilometer-van-ziekenhuis

Economische uitsluiting/Economic Exclusion

Economische uitsluiting doet zich voor wanneer de monetaire kosten van reizen mensen verhinderen om te reizen of hun toegang beperken tot bestemmingen in de buurt van hun woonplaats of verplichte activiteiten. De meeste studies met betrekking tot TRSE hebben armoede, een laag inkomen en werkloosheid geïdentificeerd als factoren die individuen verhinderen of beperken om toegang te krijgen tot vervoer, waardoor hun deelname aan de maatschappij in het gedrang komt.





What makes this perspective differe

- Looks primarily at possibilities for deployment
- Takes the whole “Daily Urban System” or “Daily Regional System” into account
- Mobility and spatial planning together as well as proximity
- Assessing possibilities and interests of different groups

How to measure it?

- The method: Integrated Perspective On Accessibility
- Analysis of the current situation and autonomous developments
- Analysis of impact of measurements
- Choices in urban developments
- Impact on Dutch national policy

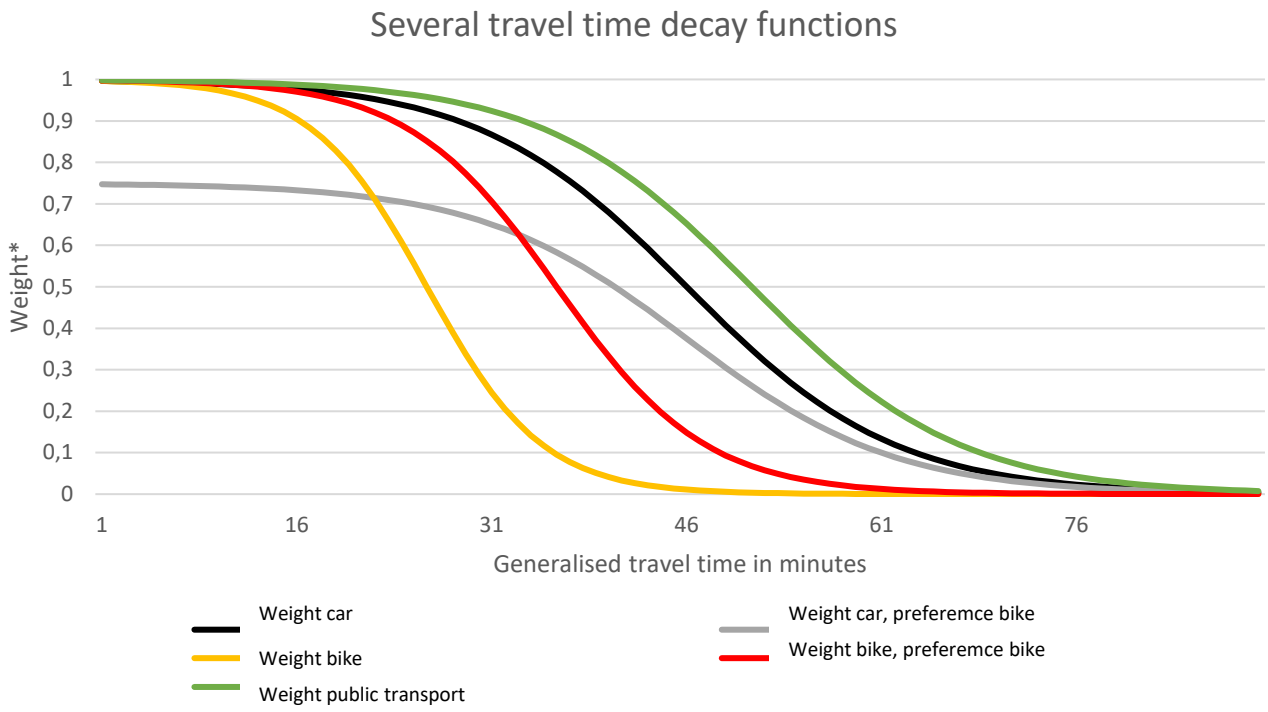
- Takes into account costs as well as travel time
- Car, pub;oc transport and car (and combinations)
- Destinations with a langer travel time gets a lower weight
- Division of groups according to
  - **Income level**
  - **Car possession** 1 Lease car; 2 Own car; 3 No car possess driving license; 4 No driving license
  - **Modality preference** (preference car, bike, public transport or neutral)

- Share of all these (52!) groups is known for all neighbourhoods.

- Only relevant jobs for education level are taken into account

Proximity: Weights of destinations according to generalised travel time

Traveltime decay functions



- Research Question:

What would be the impacts on **job accessibility** for commuters without car access and the **equity** of the whole transportation system in the **Amsterdam Transport Region** if **shared bikes** were provided at transit stations as an **egress mode**?

- Research Gaps:
  - Homogeneous assumptions among different individuals do not consider the influencing factors that shape individuals' perceptions of accessibility.
  - Transit-shared bike integration is often not given sufficient attention when evaluating accessibility and equity.
  - No literature uses the sufficientarianism principle to assess the impacts of transit-bike integration on equity in job accessibility.

- Methodologies (Perceived Accessibility Calculation: **IKOB Model**):

Factors incorporated in the IKOB model that affect individuals' **perception in job accessibility**

Individual component:

- Characteristics: Car ownership, mode preference, income levels
- Travel time decay curve

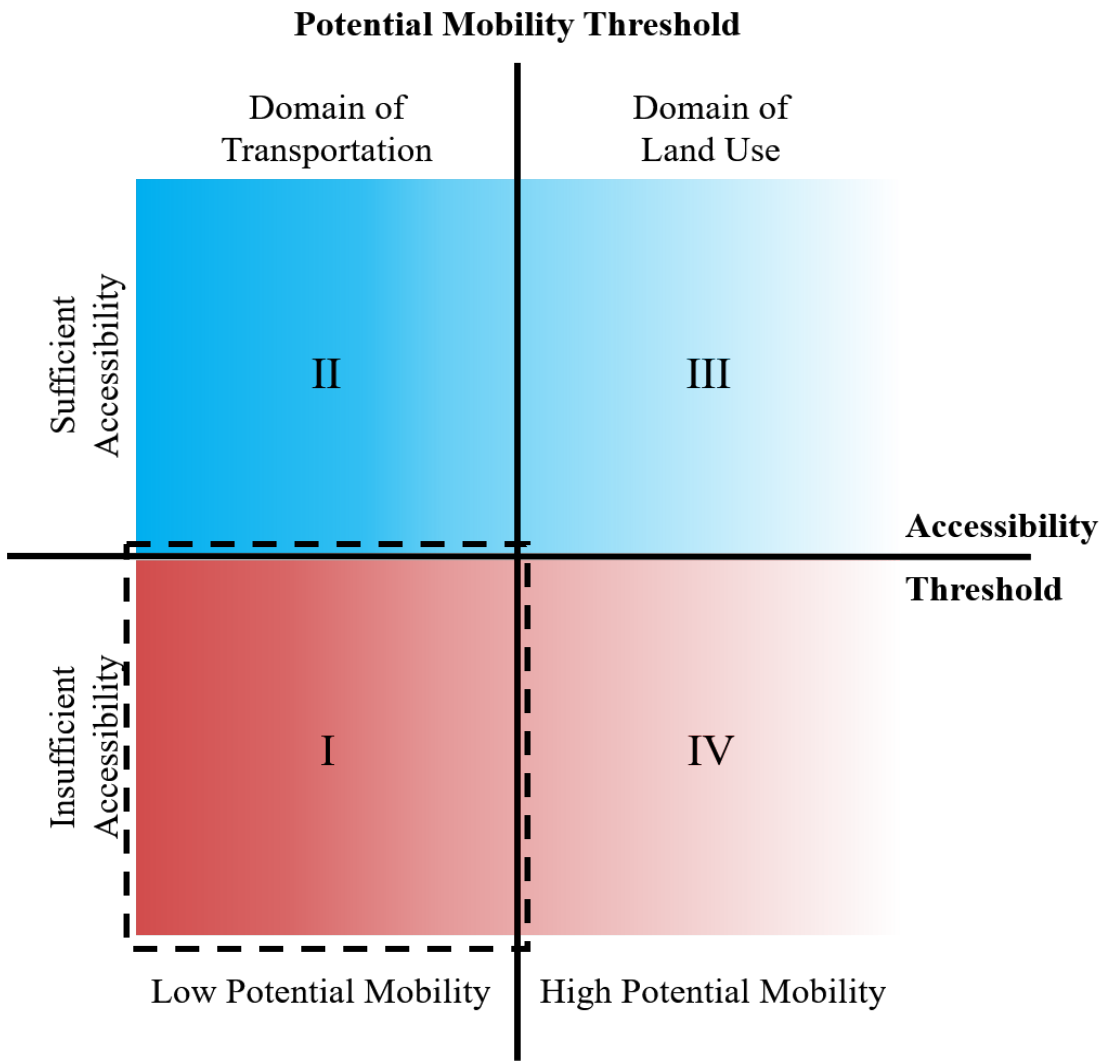
Transport component:

- Experienced Travel time = pure travel time + travel cost * time value of cost per income

Land use component:

- Low-income groups can only access low-income jobs
- Competition effects

- Methodologies (Equity Evaluation: **Sufficientarian Approach**):



- **Potential Mobility Index (PMI)**

$$PMI(im) = \frac{1}{n} \cdot \sum_{i=1}^{n} \frac{d_m(i, j...n)}{T_m(i, j...n)}$$

Euclidean distance

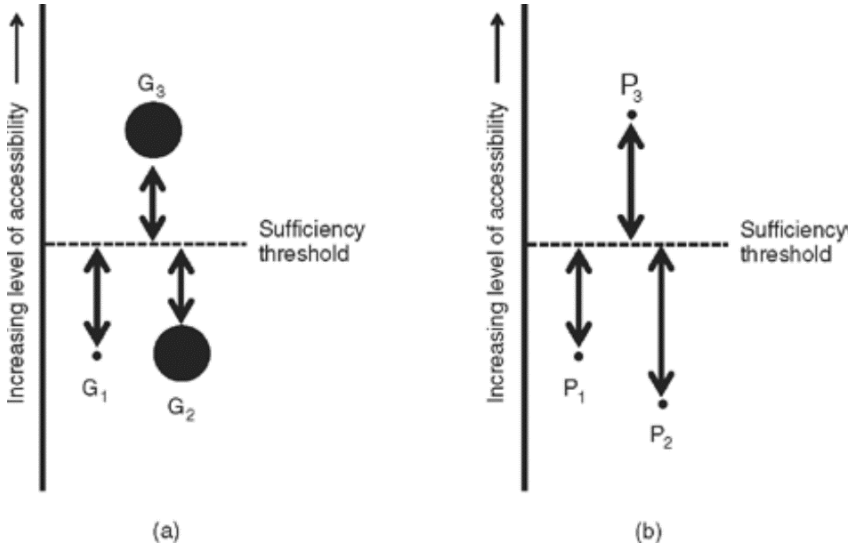
Pure travel time per mode

- **Accessibility Deficiency Index (ADI)**

$$AFI(r) = \frac{1}{N} \sum_{i=1}^{q} n_i \cdot \left(\frac{z - y_i}{z}\right)^2$$

Accessibility < Threshold

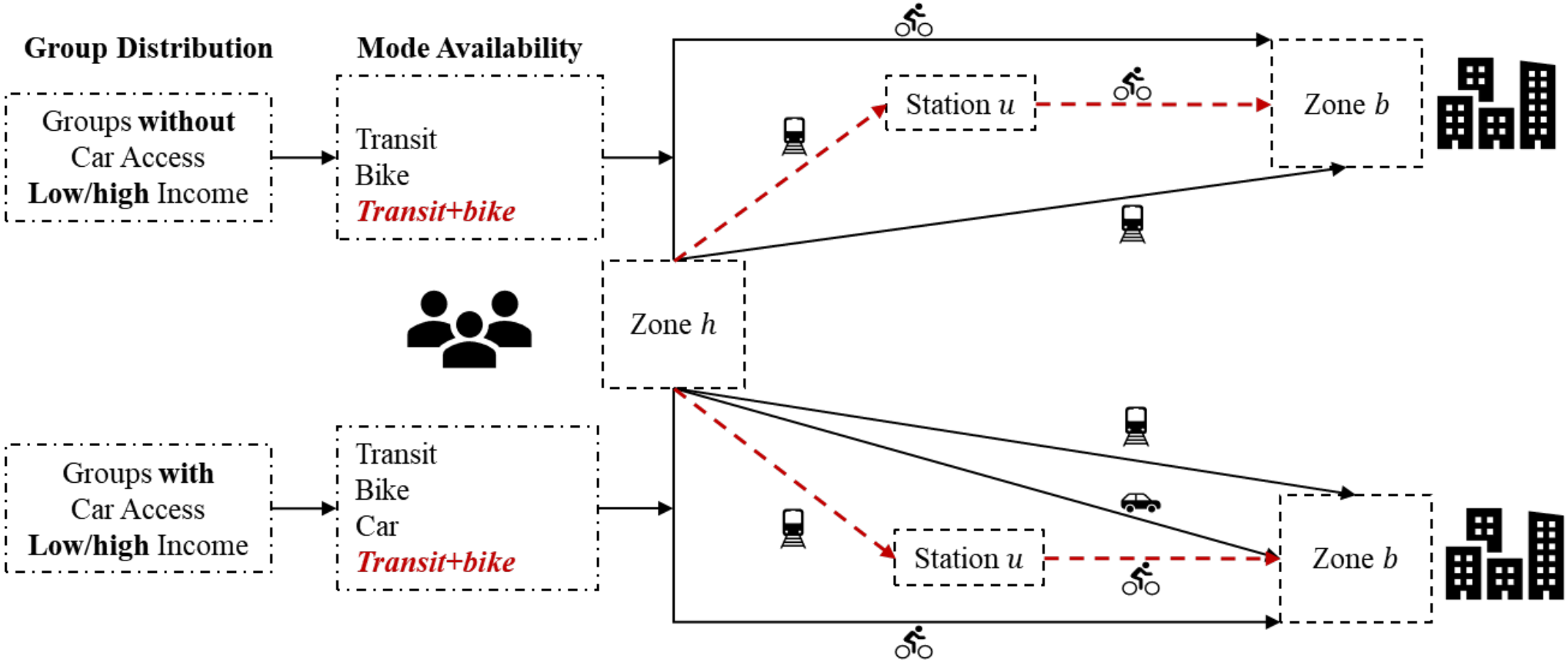
Threshold accessibility

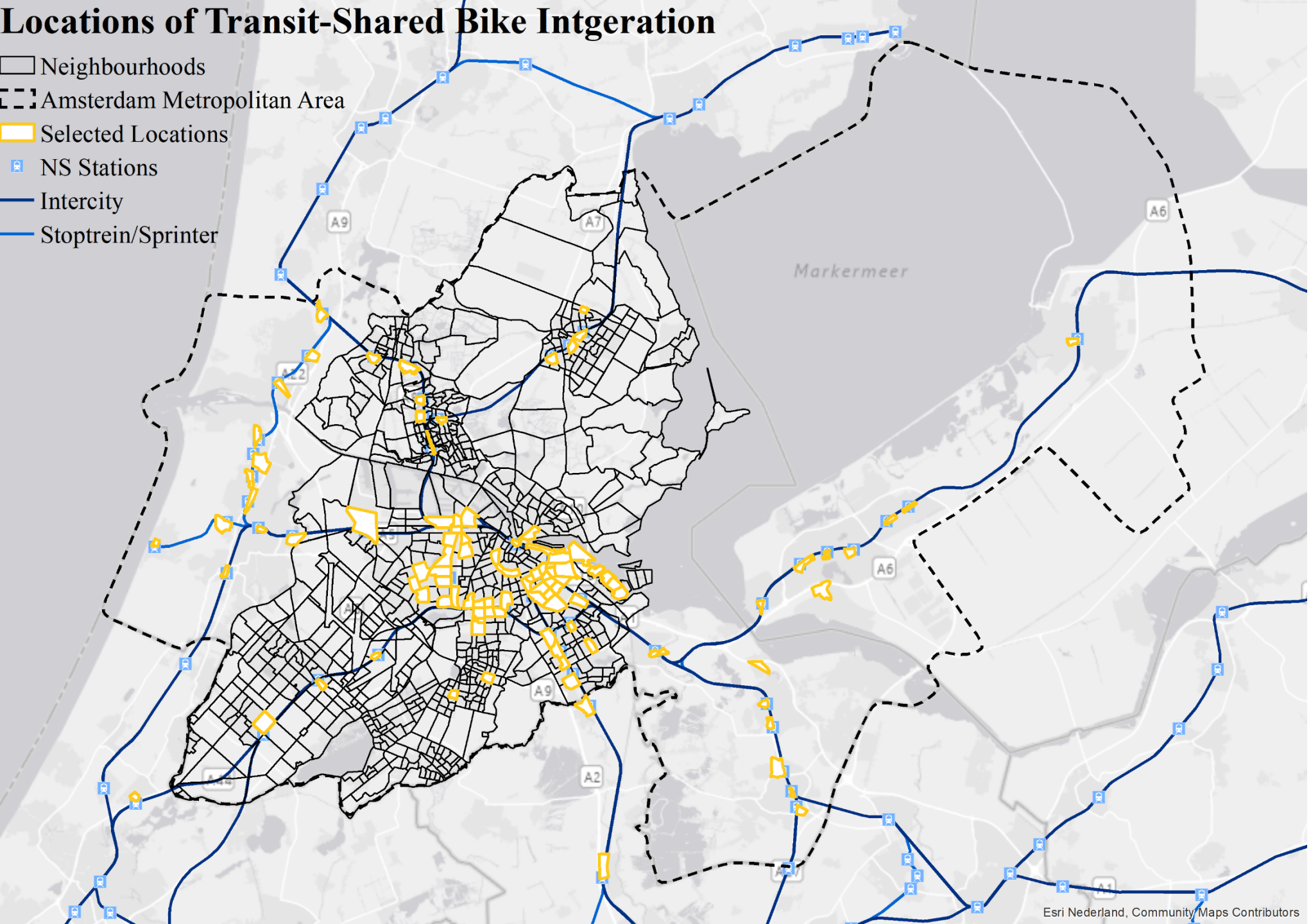


- Scenarios:

1 Base Scenario: Without Transit-shared bike Integration

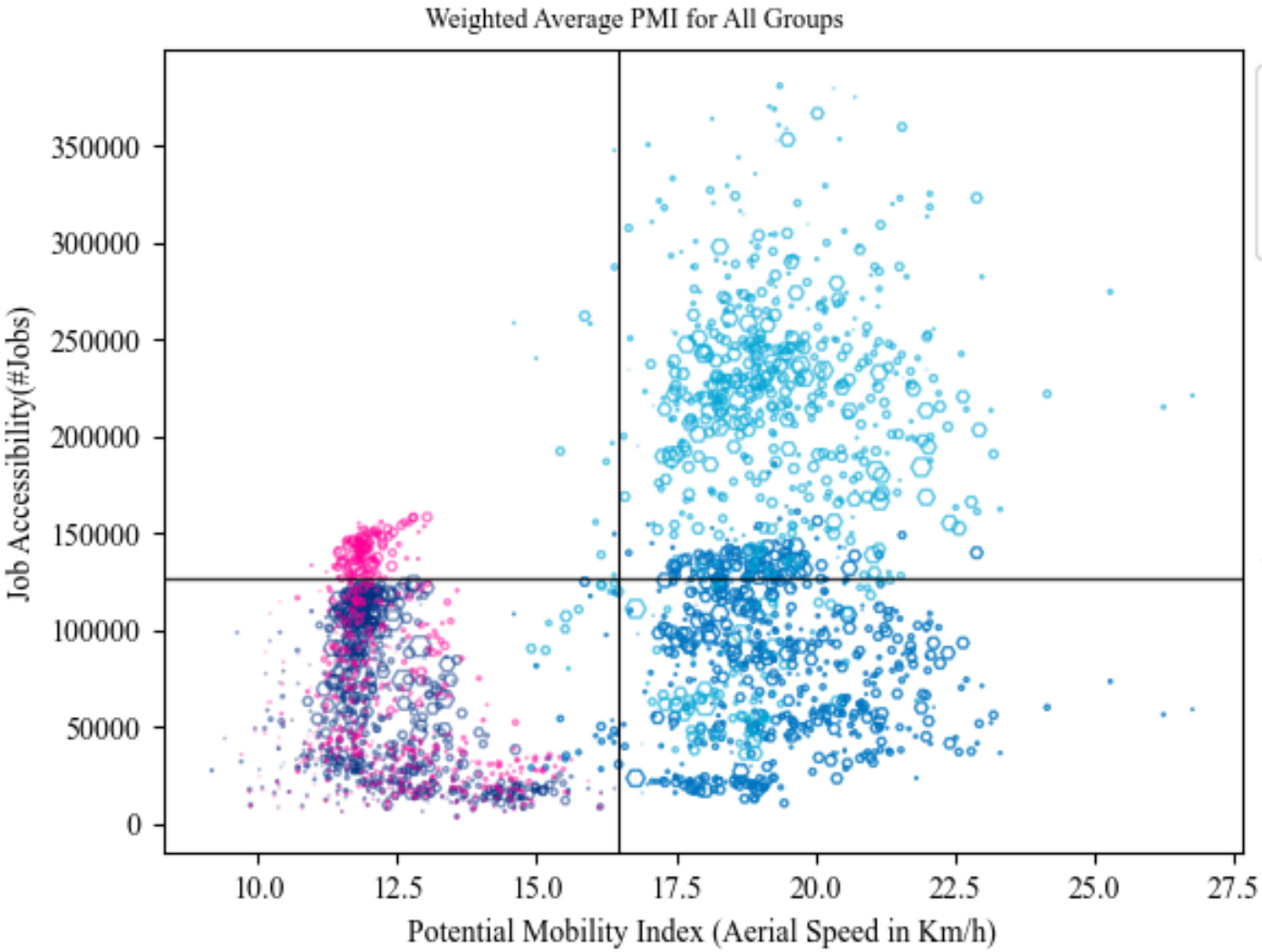
3 Intervention Scenarios: With Transit-shared bike Integration (Renting Price = 0, 1 and 2 €)

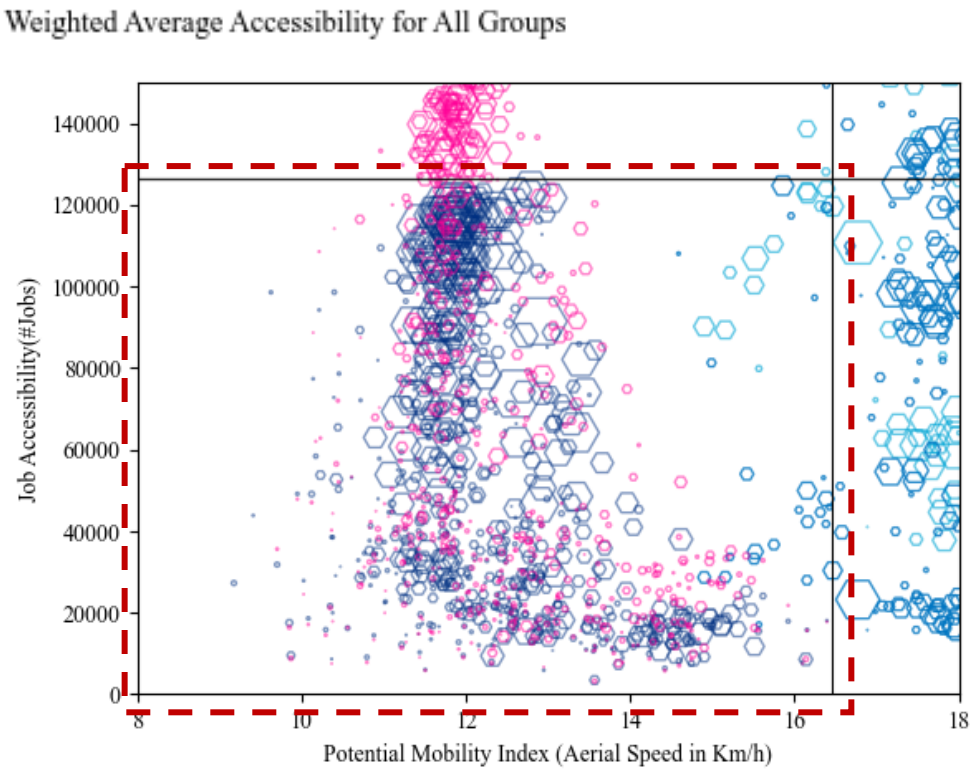




Source:

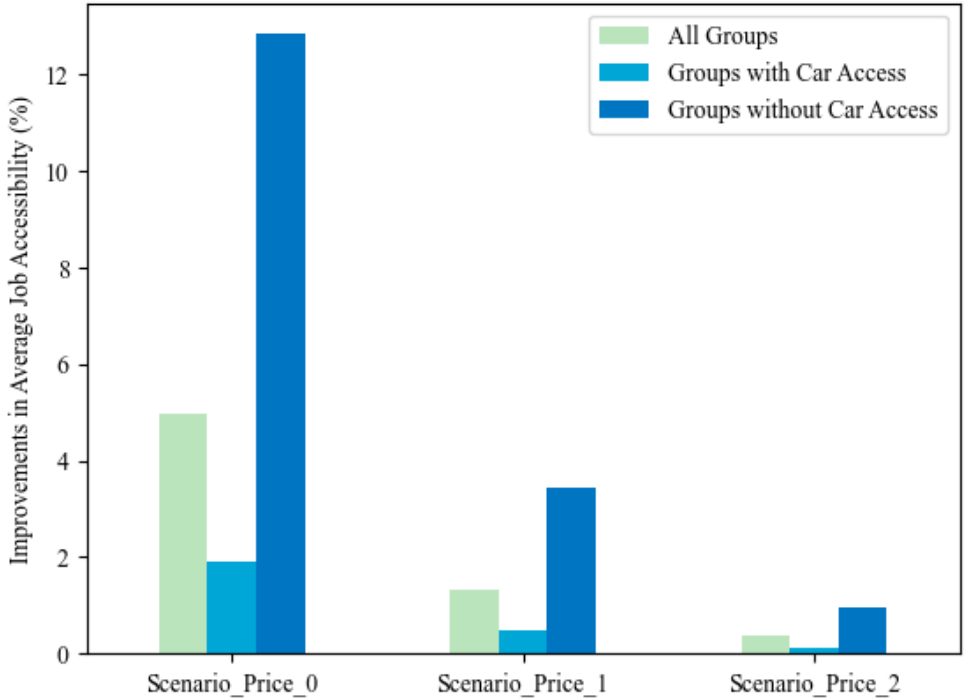
- **NS train stations in ATR**
- **P+R facilities in MRA**
- **Service points of shared bikes in Amsterdam**





Coordinate System: PMI and Job accessibility

- Results: Improvements in Job Accessibility



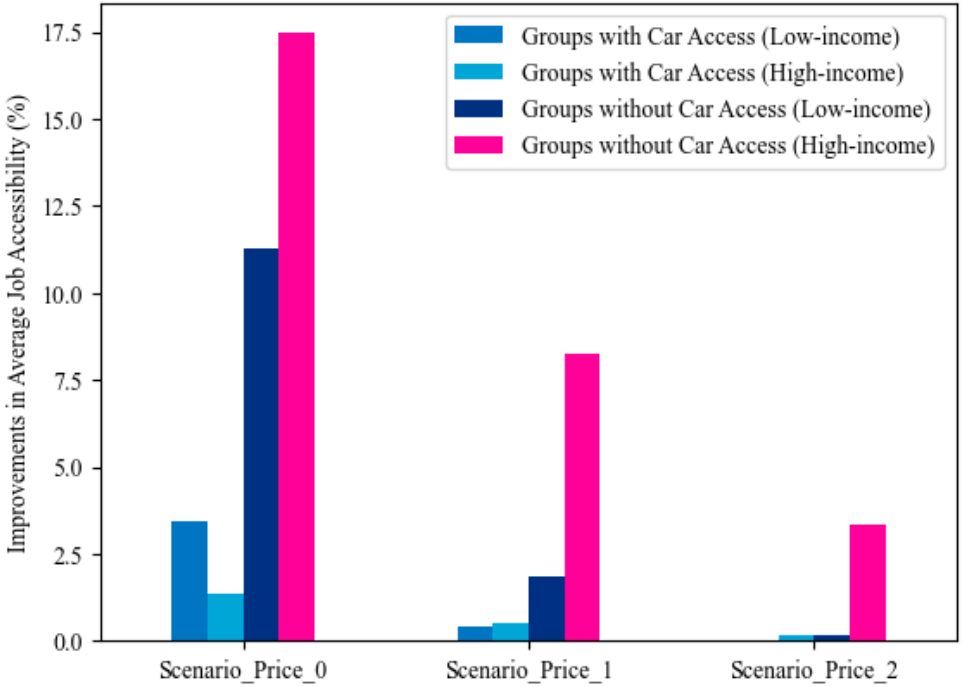
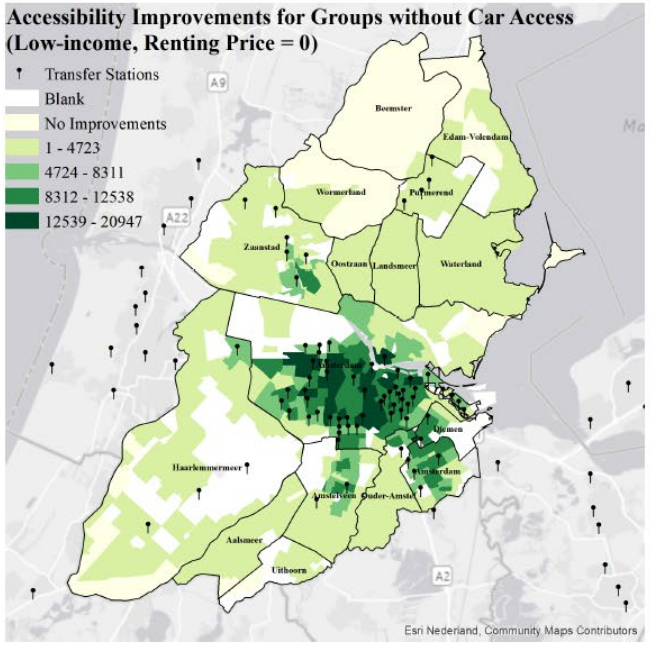


Table 5.3: Population Share of Transit-Shared Bike Benefits

Scenarios	Scneario_price_0	Scenario_price_1	Scenario_price_2
Group_1 ($With\_car\_low$)	90.62%	81.78%	44.91%
Group_2 ($With\_car\_high$)	86.93%	81.56%	70.42%
Group_3 ($Without\_car\_low$)	99.68%	97.79%	89.86%
Group_4 ($With\_car\_high$)	99.97%	99.75%	99.35%

Improvements in Job Accessibility



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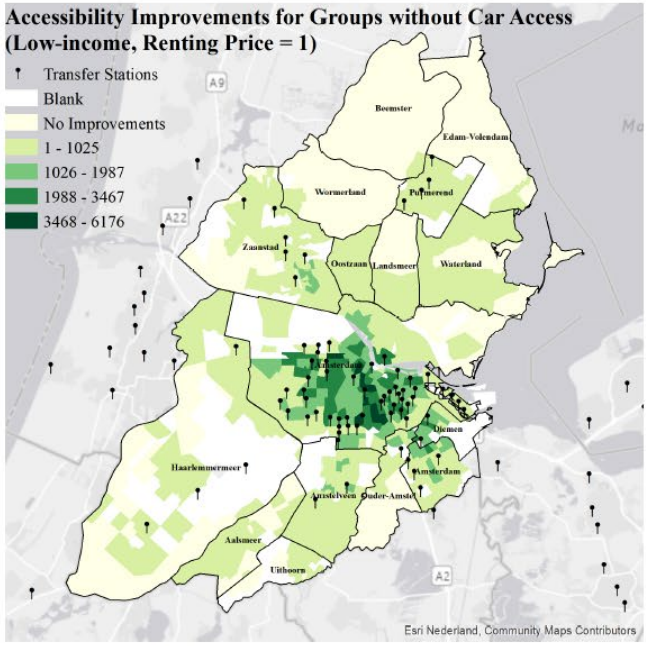

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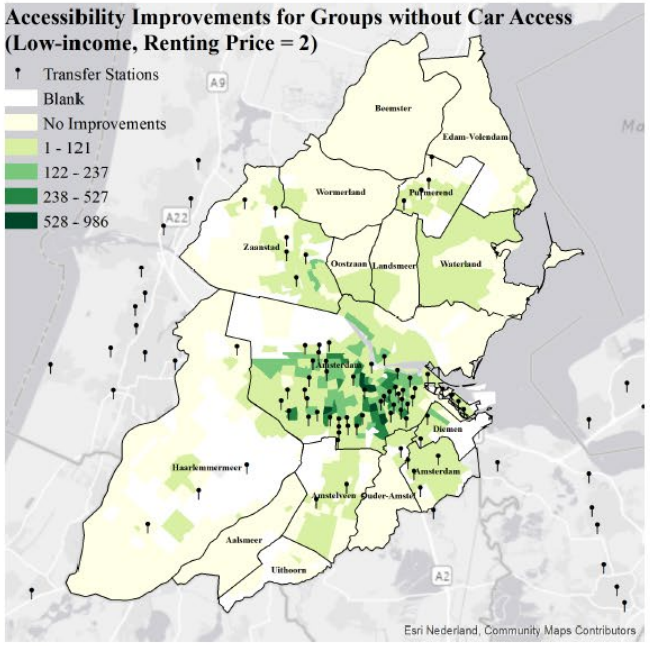

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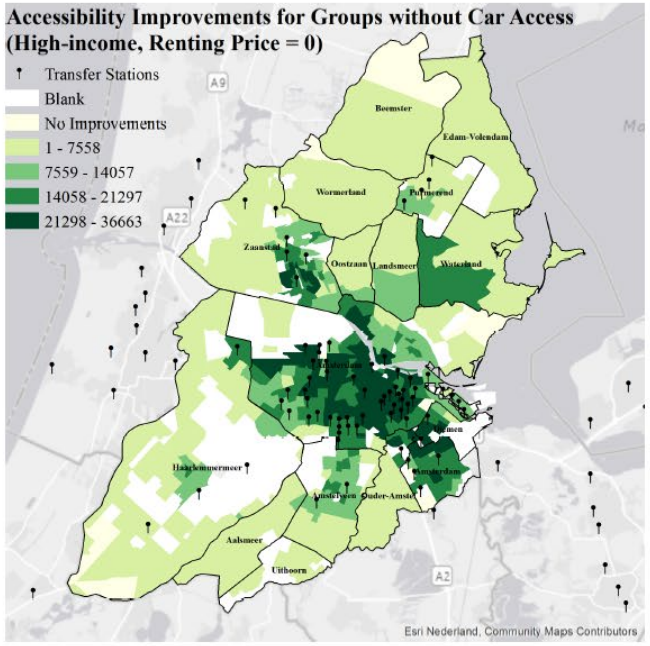

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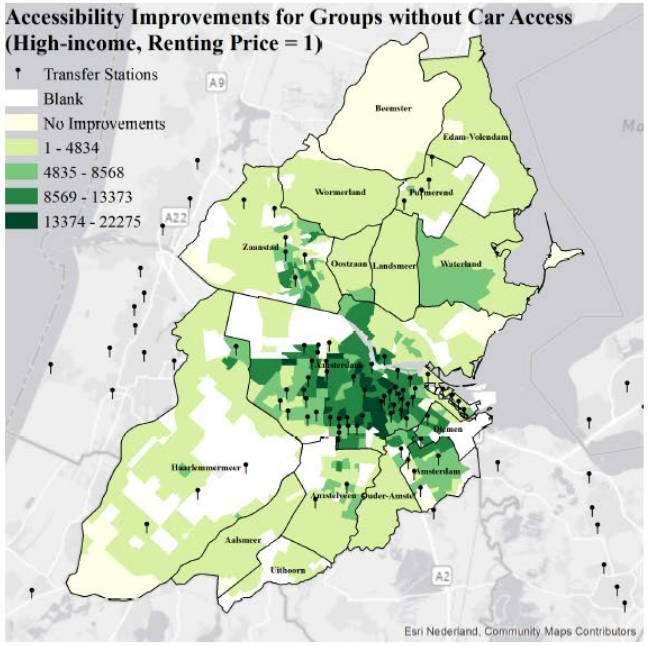

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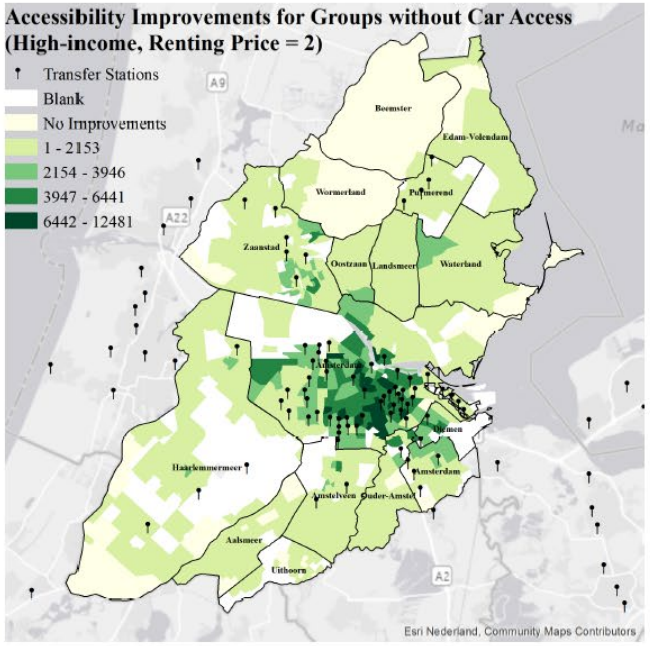

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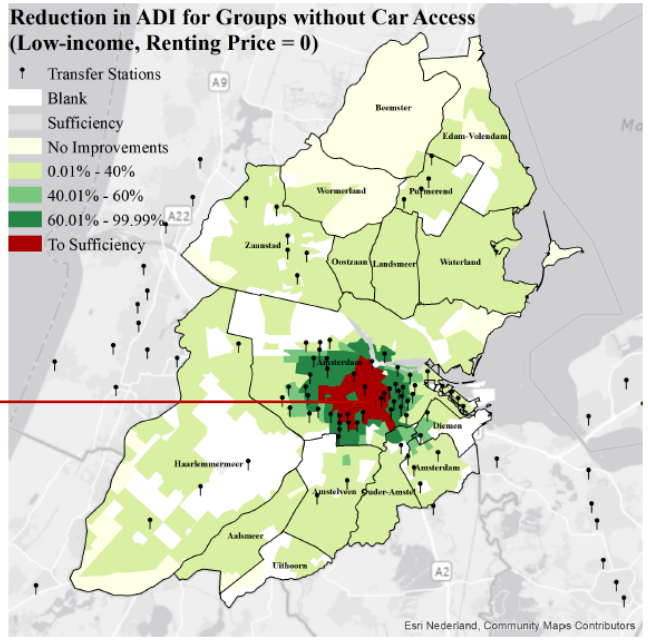
Improvements in Equity



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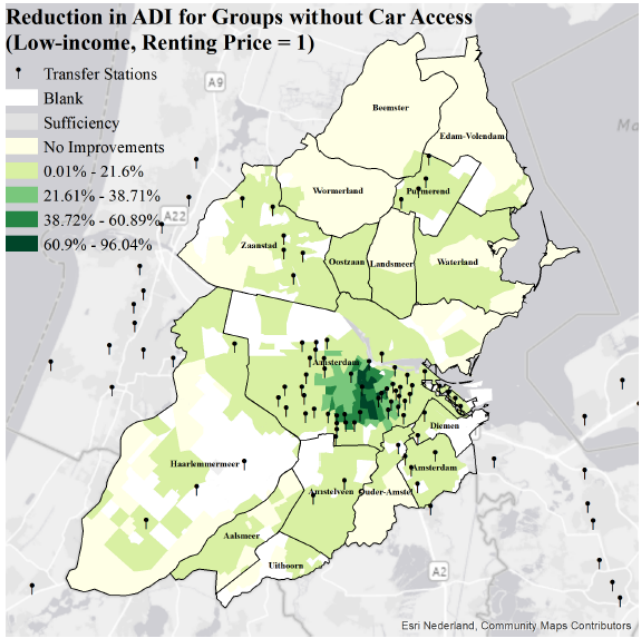

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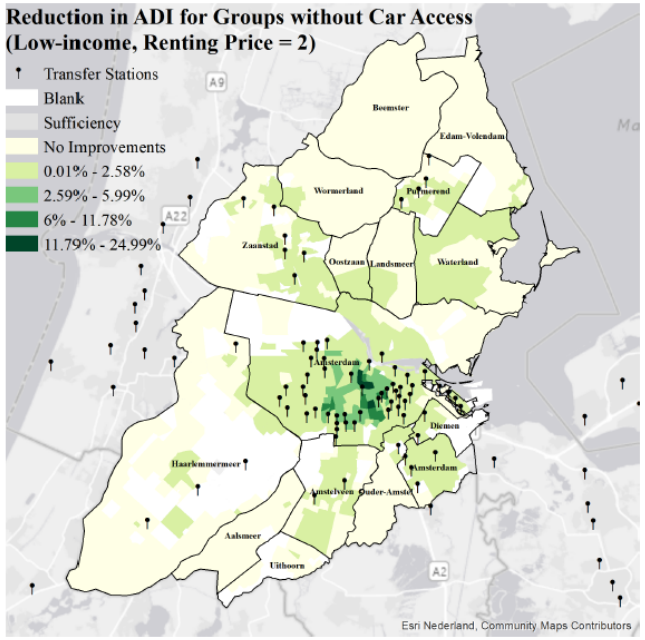

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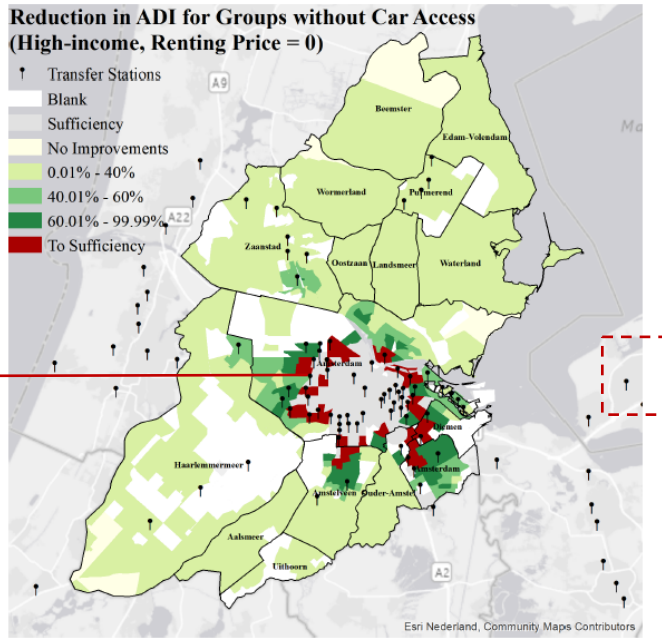

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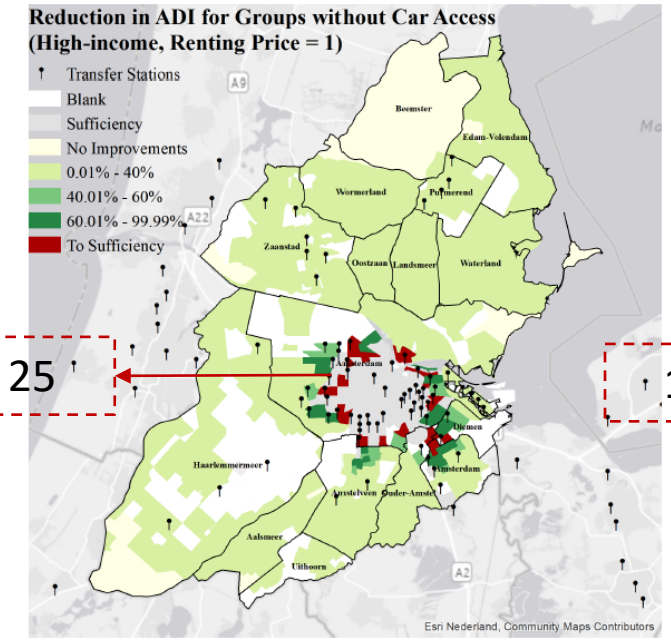

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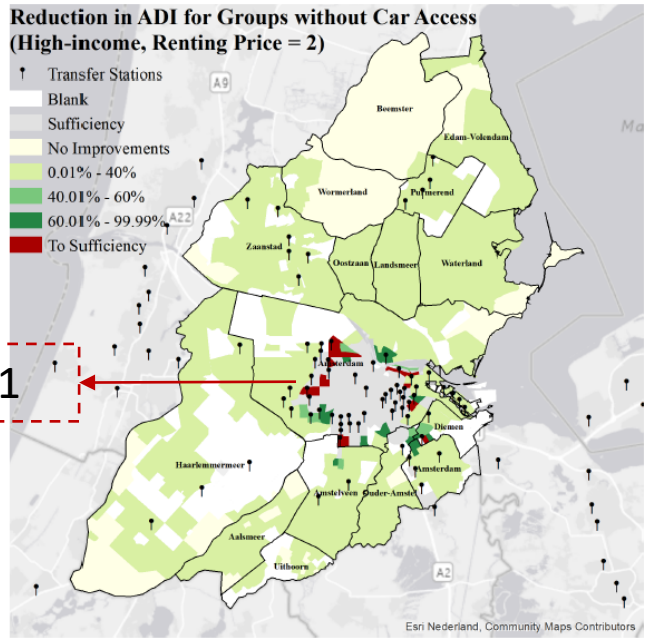

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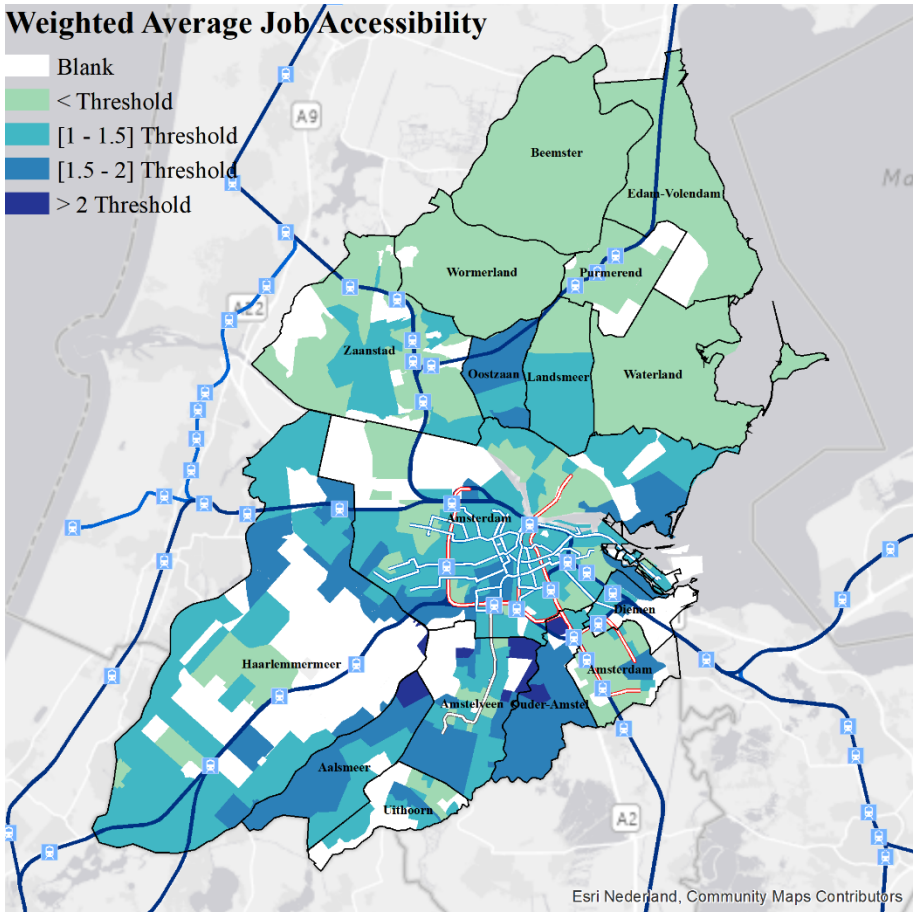
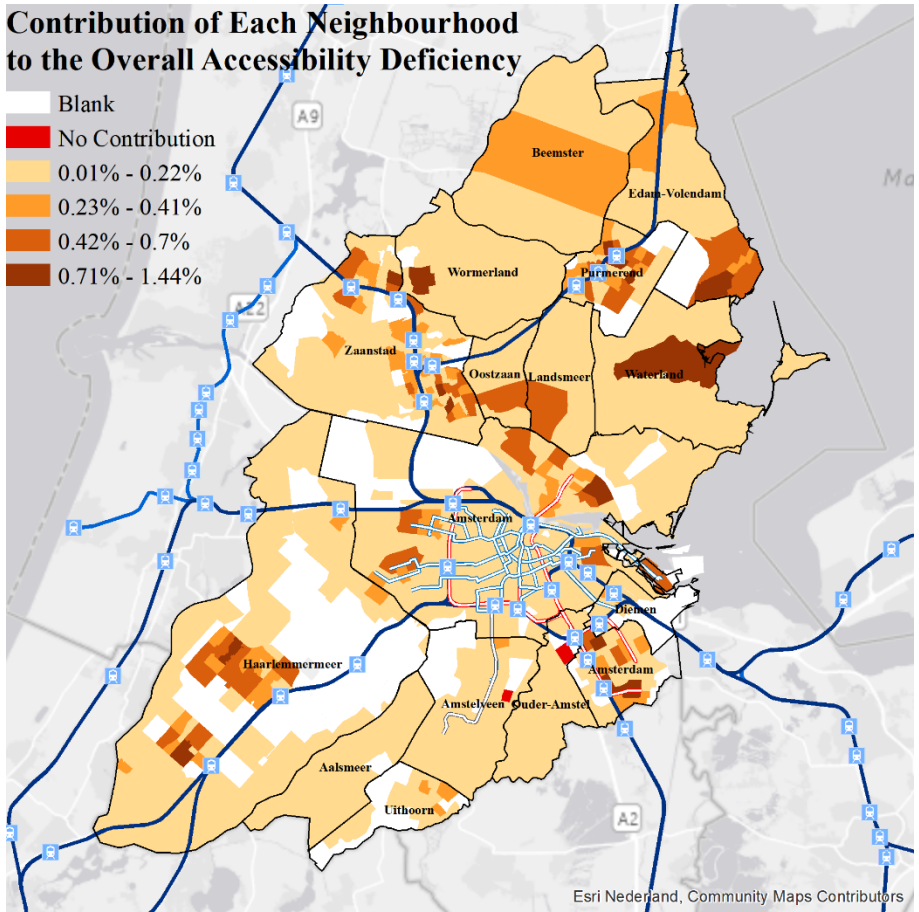
- Key Findings:
  - Groups without car access can benefit more than groups with car access.
  - The benefits tend to favour high-income groups.
  - People living in the Municipality of Amsterdam obtain the most benefits.
  - Transit-shared bike integration might benefit more for shorter transit trips than longer transit trips when the price increases.

- Key Findings:
  - Groups without car access, low-income groups concentrated in Amsterdam and neighbourhoods near train stations, but lower share of low-income jobs that they can competent.
  - Their first-mile is no problem. However, they still have low job accessibility.

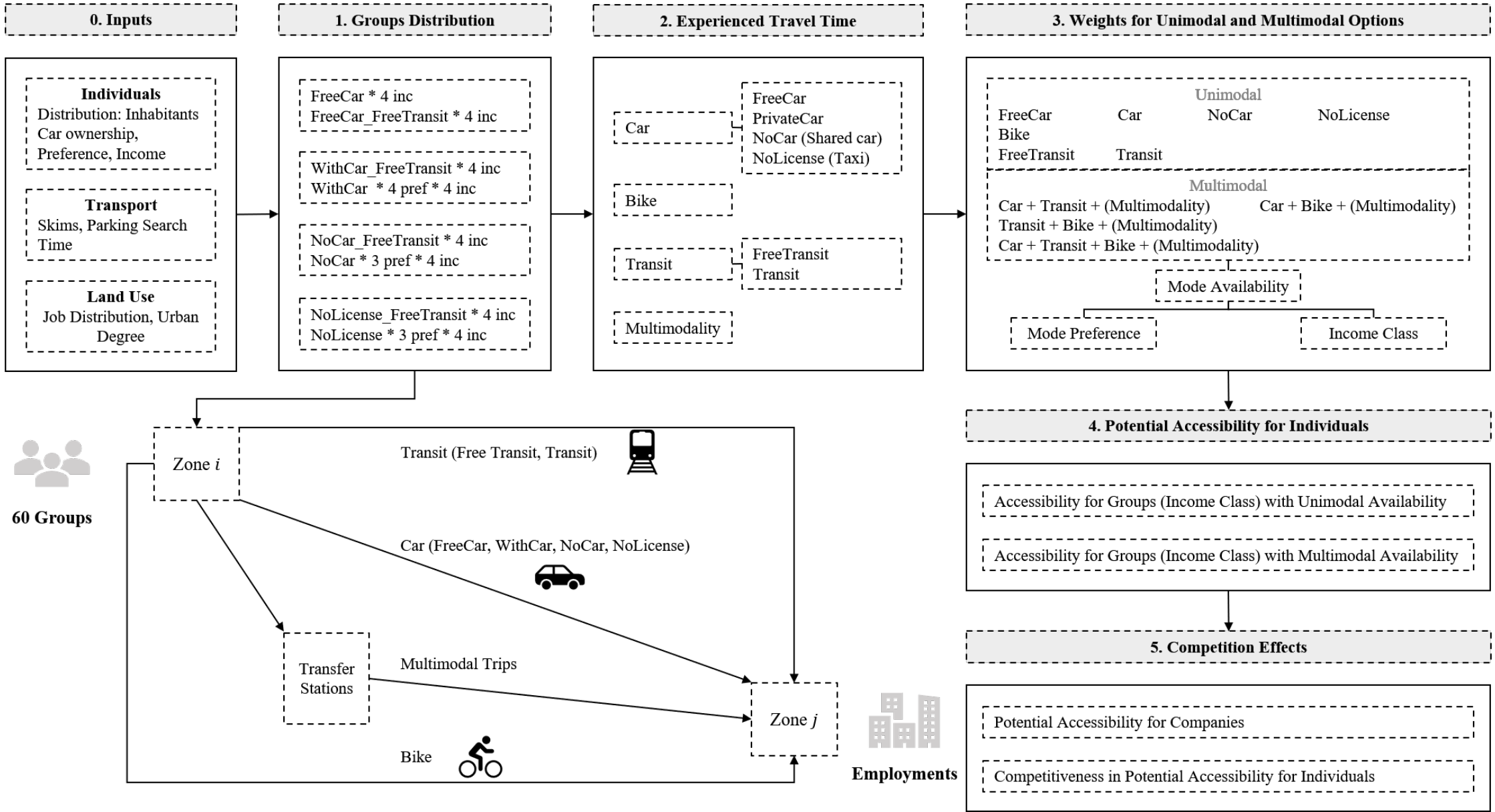




- Future Research:

  - Improve the representation of actual travel behaviour.
  - Incorporate the competition effects.
  - Investigate the impacts of multimodal hubs, including electric mobilities.

- Research Methodologies (Accessibility Calculation: **IKOB Model**):



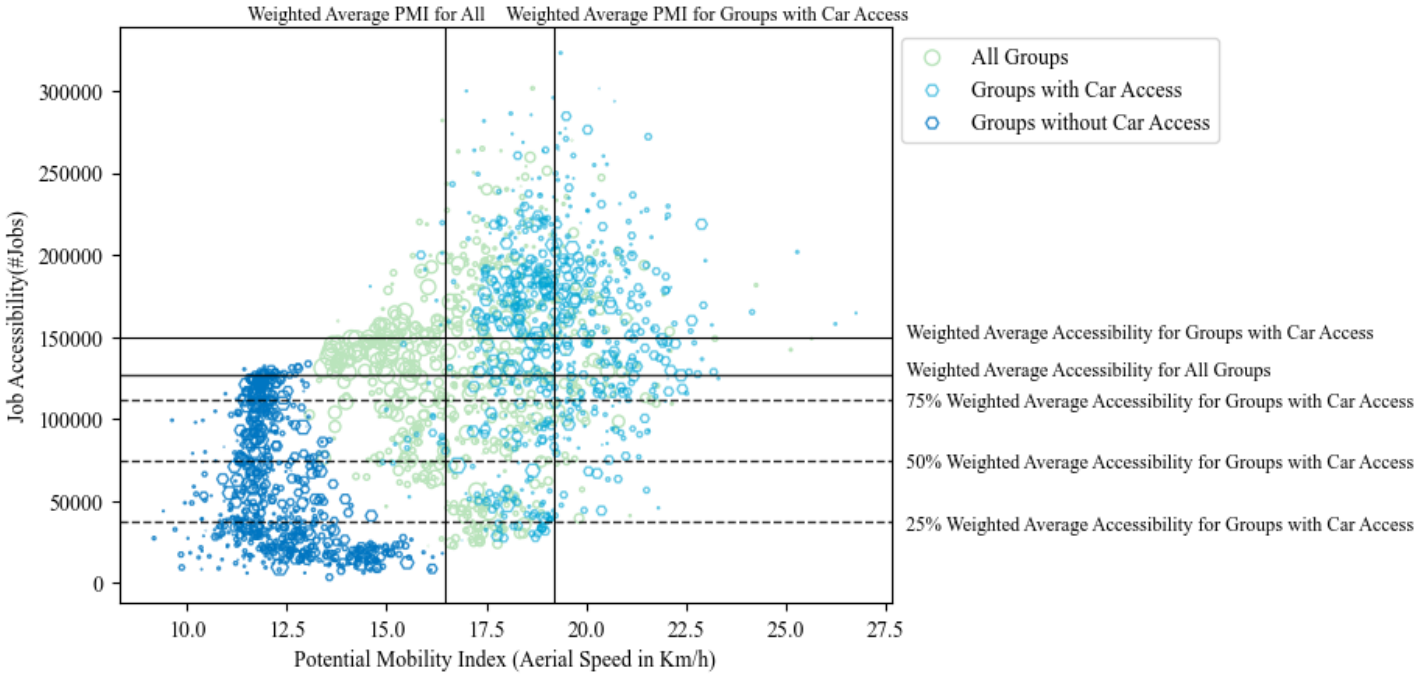
- Results: Reduction in Accessibility Deficiency Index

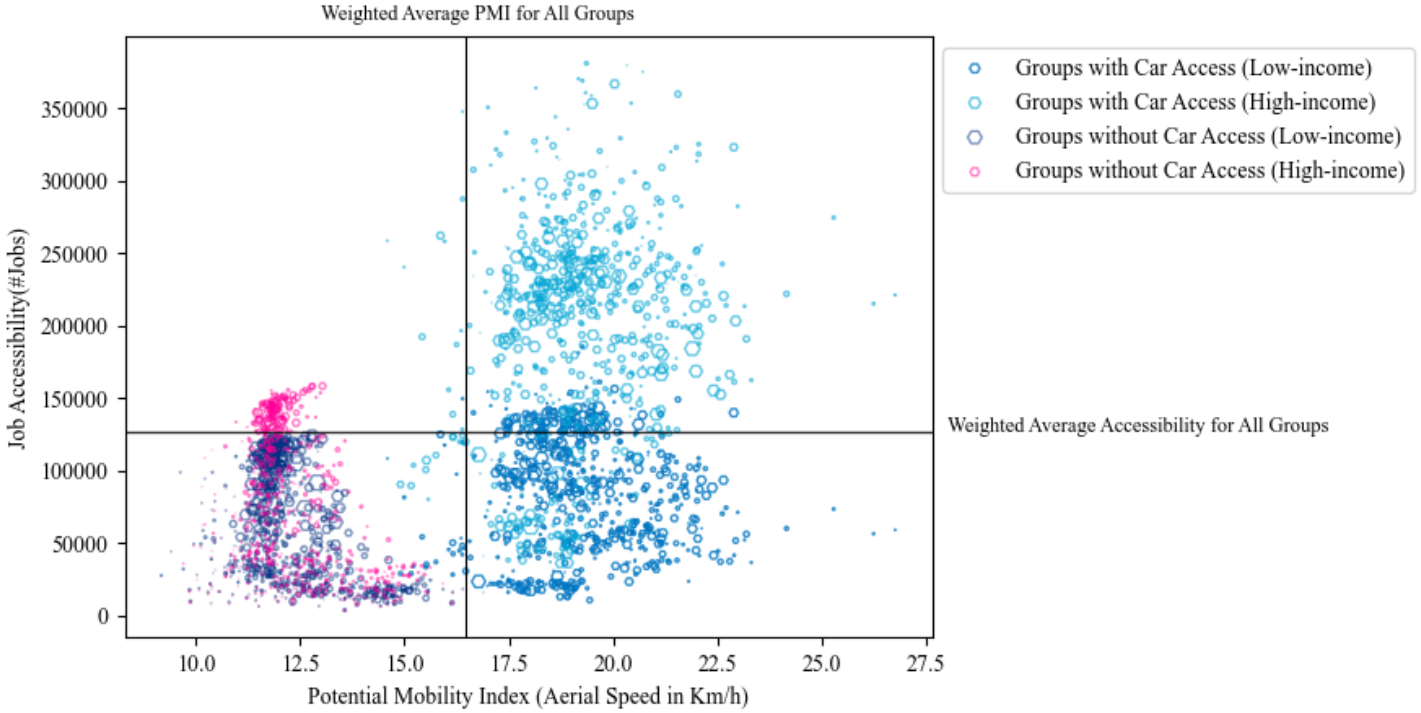
Table 5.4: Number of neighbourhoods for Groups from Accessibility Deficiency to Sufficiency

Disaggregate Level	Scenario_Price_0	Scenario_Price_1	Scenario_Price_2
Group_1 ($With\_car\_low$)	0	0	0
Group_2 ($With\_car\_high$)	3	0	0
Group_3 ($Without\_car\_low$)	47	0	0
Group_4 ($Without\_car\_high$)	45	25	11

- Key Findings:

- The “disadvantaged groups” will be overlooked if we do not analysis in a more disaggregate way. For example, one neighbourhood will be regarded as sufficiency, but some subgroups inside cannot have sufficient accessibility.





- Limitation:
  - Assumptions of travel behaviour (mode choice, route choice) in the IKOB model might not capture the actual behaviour of travellers.
  - Assumptions of travel time decay curve for transit-shared bike integration (same as transit)
  - Assumption of Potential Mobility Index for Groups with multimodal options.
  - When the difference between accessibility and the defined threshold is minimal, it is still considered to suffer from accessibility deficiency.
  - Location of transit-shared bike integration is represented by neighbourhood, not precise geographical coordinates.
  - Competition effects in job market are not taken into account