DemAnd And/OR Equity (DARE) method for implementing bike sharing systems (BSS)

A structural equation modelling approach

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14.09.2020
Fair?
Who uses BSS?  

Who has access to BSS?  

Fair?
“What is fair for one person, however, might not be fair for others.”

Distribution based on:  
- **ALL THE SAME**  
- **NEEDS**  
- **CONTRIBUTION**
Resources are limited so equality is hard to reach

But can we balance equity and efficiency?
Objectives

• To develop a fairness-based method to implement BSS depending on a justice focus desired:
  ✓ deprivation (spatial equity)
  ✓ potential demand (spatial efficiency)
  ✓ a mix of both.

• To apply the method in the hybrid BSS system in Munich

• To use and validate a theoretical structure for potential demand prediction merging three theoretical models:
  a) land-use and transport interactions (Wegener, 1999; Wulfhorst, 2003)
  b) urban mobility cultures (Deffner et al 2006)
  c) spatial fairness assessment (Duran-Rodas et al 2020)
DARE: DemAnd And/Or Equity

Variables' theoretical Structure

1. Zones of analysis

2. Potential demand models

2.A Potential demand models

2.B Deprivation index

3. Allocate stations and boundaries of the service area for HBSS
1. Zones of analysis: Network based delimitation

Dist = 300m

n = 1234
2. Potential demand + Deprivation
2.A SEM Potential Demand

- Department stores
- Food services
- Tourist attraction
- Cinema and theatre
- Car sharing usage: < monthly
- Car usage: 1-3 months
- Transit stations
- Cycle ways
- Population density
- Walkability Density
- Cosmopolitan and performers

Model Parameters:
- R2 (train) = 0.60
- R2 (test) = 0.59
- RMSEA: 0.09 < 0.1
- CFI: 0.91 > 0.9
2.B. Deprivation index

\[ EI_j = \frac{\text{Millieu}_{\text{low status}}}{\frac{1}{n} \sum_{i=1}^{n} \alpha_1 * e^{-\alpha_2 * D_i}} \]

n=Basic POIs classes
D= distance to basic opportunities from Area centroid
Millieu\_low status= % low social status in Area
\(\alpha_{1,2}\)= parameters

Low -> Privileged Area
High-> Deprived area

3.1. Rank index

\[ \text{RankIndex}_j = \text{nor}(EI_j) \times \text{Equity}_{\text{weight}} + (\text{nor}(Bookings_j) \times \text{Demand}_{\text{weight}}) \]

0 < Equity_weight < 1
0 < Demand_weight < 1
Equity_weight + Demand_weight = 1

\text{nor}() \text{-> max value = 1, min value = 0}
## 3.2. Allocation algorithms

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### Island-weighted

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Stations = 6

Islands = 3

\[ \frac{n - x_i}{n^2 - \sum_{i=1}^{n} x_i} \]

1st -> 0.66 * 3 = 2
2nd -> 0.33 * 3 = 1
3rd -> 0 * 3 = 0
Stations = 100, Islands = 10
Conclusions

• DARE is an alternative so that benefits do not only go to the most privileged.

• Fairness is part of the input on the planning process for BSS.

• Direct association of BSS usage in areas with
  - low car usage
  - leisure, touristic and shopping activities

• Further applications:
  - implementation of other BSS and shared systems or public transport
  - include an environmental and public participation weight in the rank index
Thank you for your attention

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Do you Dare?
Thank you for your attention

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