UNIVERSITY OF TWENTE.

ACCESSIBILITY AND TRANSPORT APPRAISAL: APPROACHES AND LIMITATIONS

PROF DR KARST T. GEURS

INTRODUCTION

ACCESSIBILITY
ASSESSMENT AND
VALUATION: AN
OVERVIEW

LIMITATIONS OF THE
CURRENT PRACTICE

CONCLUSIONS AND
DISCUSSION

UNIVERSITY
OF TWENTE.

INTRODUCTION

- Accessibility research has been flourishing in the past 10 years, but economic valuation of accessibility has received relatively little attention

- Available comprehensive accessibility modelling tools do not find their way into the transport project appraisal practice

UNIVERSITY
OF TWENTE.

WHY FOCUS ON ACCESSIBILITY

Accessibility should relate to the role of transport in society; *to provide individuals the opportunity to participate in activities in different locations*.

(Geurs, K.T., van Wee, B., 2004. Accessibility evaluation of land-use and transport strategies: review and research directions. Journal of Transport geography 12, 127-140)

UNIVERSITY OF TWENTE.

COMPONENTS AND PERSPECTIVES

Components / Perspectives	Transport component	Land use component	Temporal component	Individual component
Infrastructure-based perspective	Transport engineering and planning			
Location-based perspective		Urban planning Geography		
Person-based perspective			Time geography	
Utility-based perspective	Economic geography Spatial economics			

UNIVERSITY OF TWENTE.
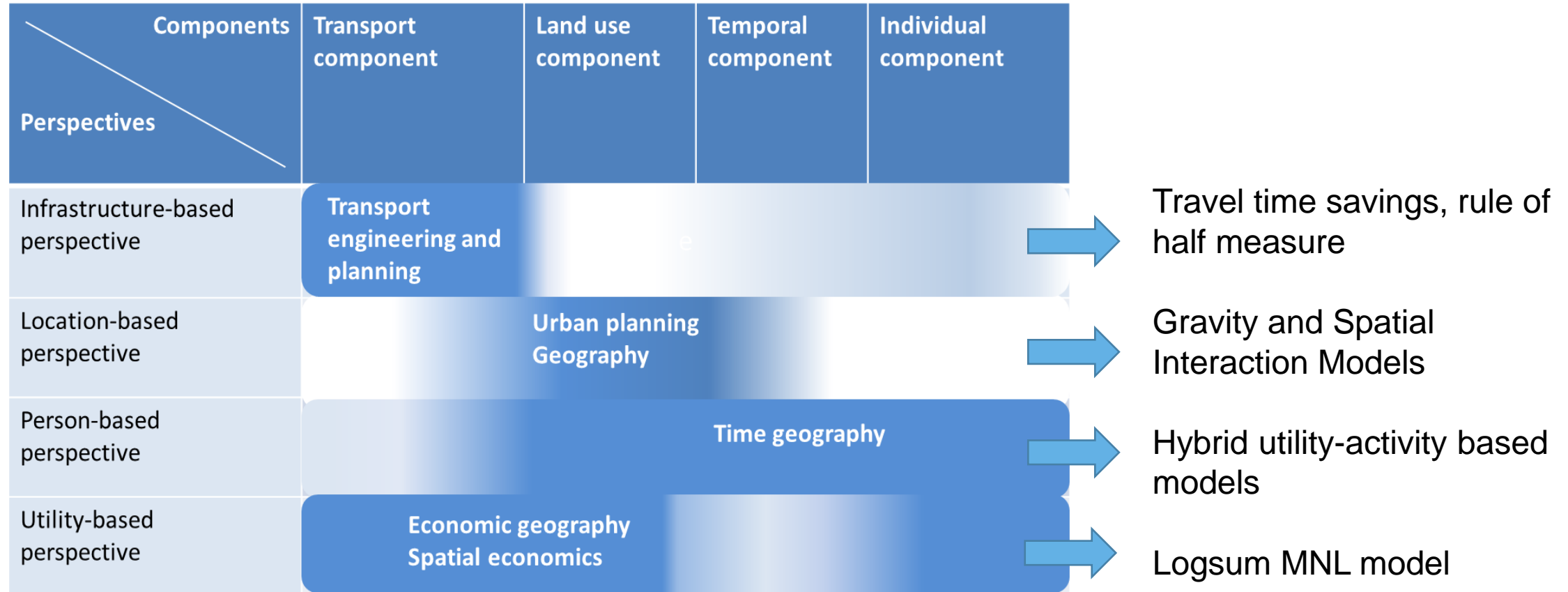
INTRODUCTION

ACCESSIBILITY
ASSESSMENT AND
VALUATION: AN
OVERVIEW

LIMITATIONS OF THE
CURRENT PRACTICE

CONCLUSIONS AND
DISCUSSION

UNIVERSITY
OF TWENTE.

DIFFERENT PERSPECTIVES, DIFFERENT ACCESSIBILITY BENEFIT MEASURES

Components / Perspectives	Transport component	Land use component	Temporal component	Individual component	
Infrastructure-based perspective	Transport engineering and planning				Travel time savings, rule of half measure
Location-based perspective		Urban planning Geography			Gravity and Spatial Interaction Models
Person-based perspective			Time geography		Hybrid utility-activity based models
Utility-based perspective	Economic geography Spatial economics				Logsum MNL model

UNIVERSITY OF TWENTE.

ACCESSIBILITY BENEFITS - INFRASTRUCTURE BASED PERSPECTIVE

- transport demand model simulates changes in travel costs and travel behaviour

- Rule-of-half (ROH) measure of user benefits (consumer surplus) applied, using outputs of transport demand model

- Assumption: all accessibility benefits are attributable to (marginal) generalized cost changes within the transport network
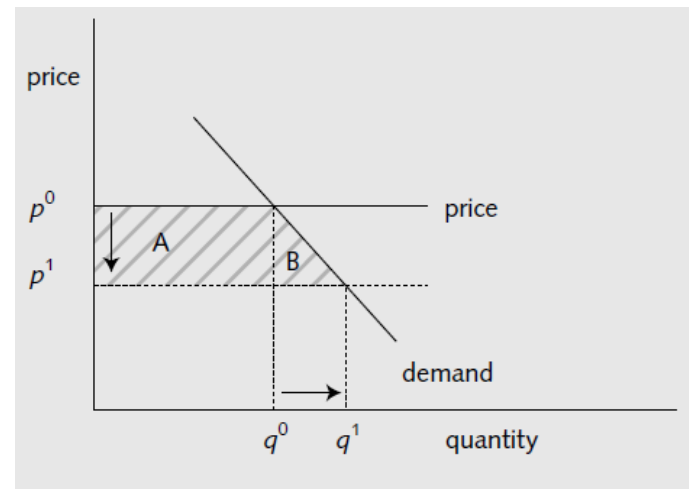
$$\Delta E\left(CS_n^{RoH}\right) = -0.5 \sum_{z=1}^{Z} \sum_{j=1}^{J} (GC_{zj}^1 - GC_{zj}^0)(A_{zj}^1 + A_{zj}^0)$$

UNIVERSITY OF TWENTE.

ACCESSIBILITY BENEFITS - LOCATION BASED PERSPECTIVE

- Established links between gravity-based models, entropy-maximizing spatial interaction models and random utility models

- Benefit measures based on (unconstrained) gravity model

- Benefit measures based on doubly constrained spatial interaction model

UNIVERSITY OF TWENTE.

POTENTIAL "HANSEN-BASED" ACCESSIBILITY
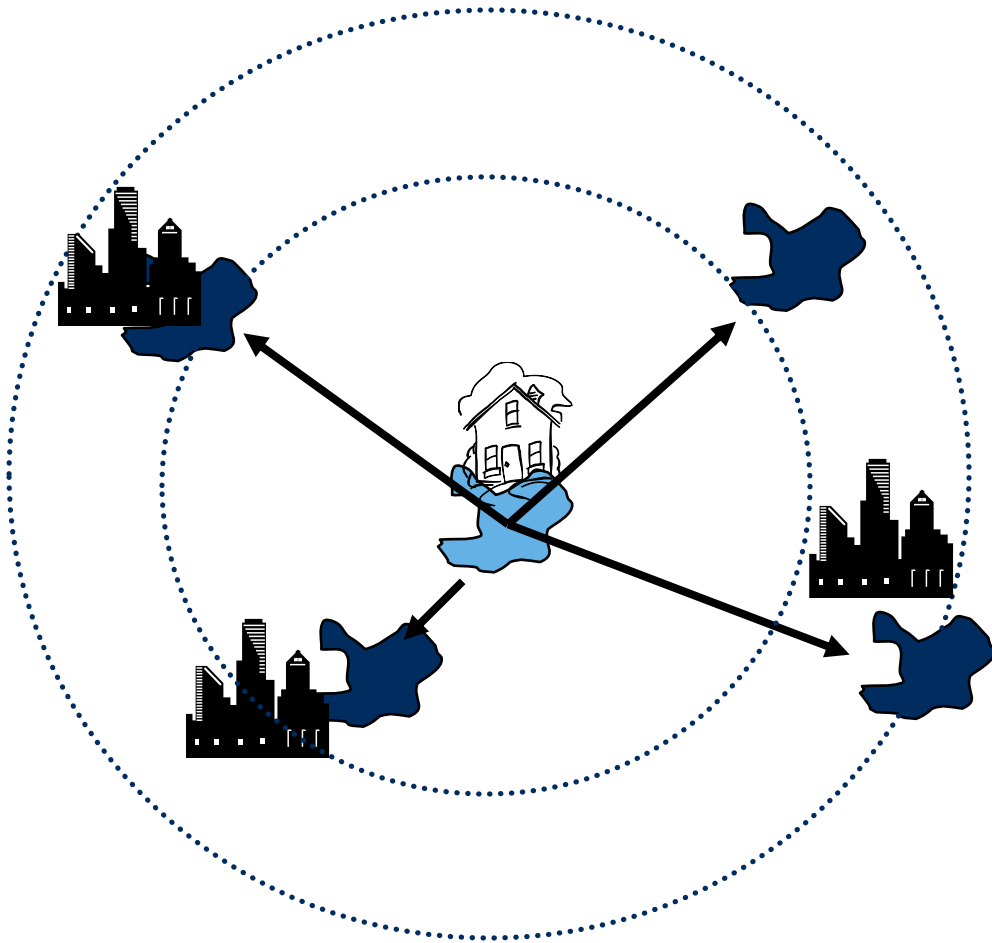
$$A_i = \sum_{j=1}^{n} D_j e^{-\beta c_{ij}}$$

Neuburger (1971) measure of consumer surplus, assuming trip distribution is correctly described by an (unconstrained) gravity model with a negative exponential distribution function.

$$S = \frac{1}{\beta} O_i \ln \sum_{j=1}^{n} D_j e^{-\beta c_{ij}}$$

Surprisingly few applications (e.g., Raux, 2008)

UNIVERSITY OF TWENTE.
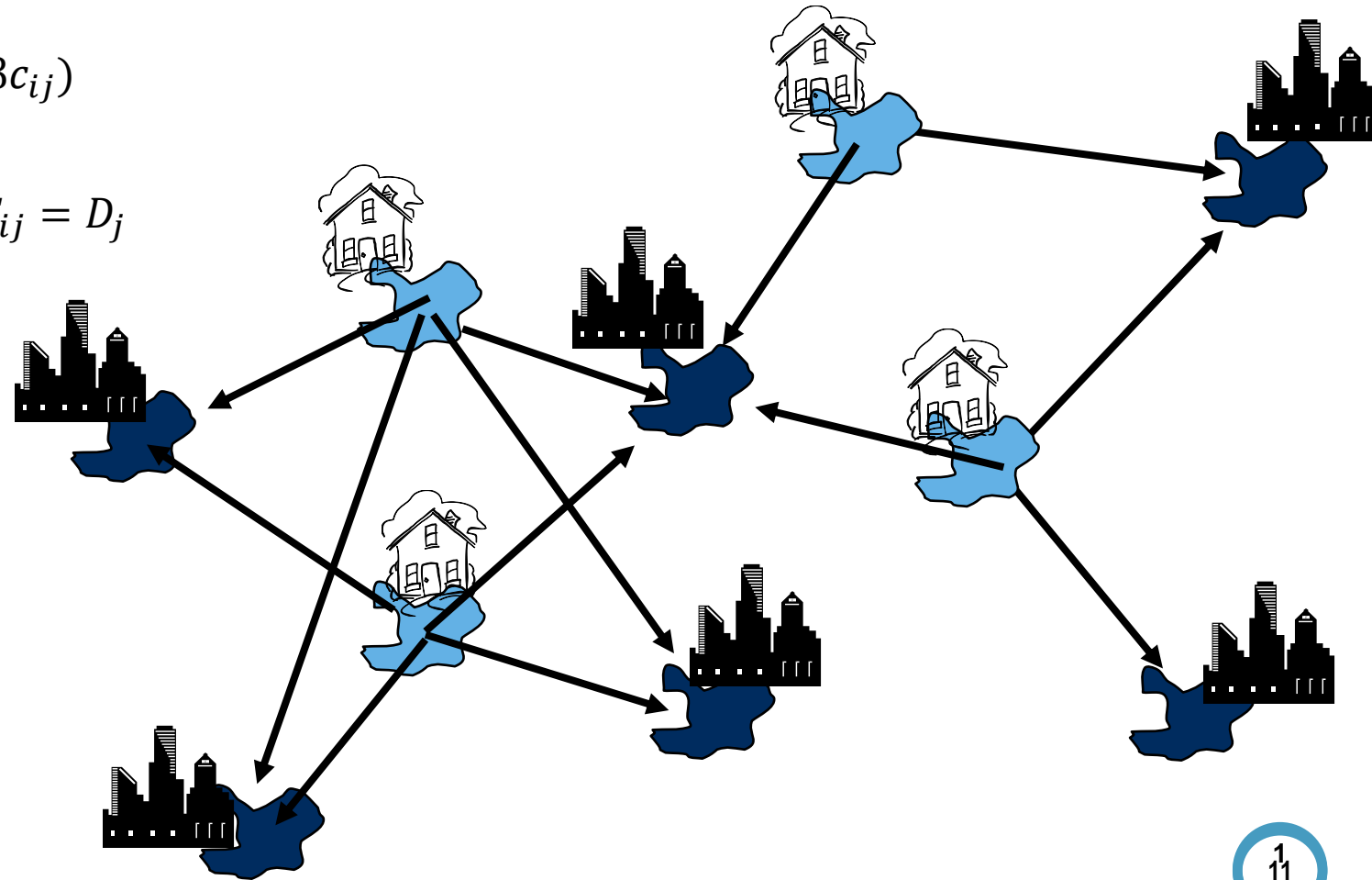
DOUBLY CONSTRAINED SIM

$$\text{T}_{ij} = A_i O_i B_j \text{D}_j \exp(-\beta c_{ij})$$

with $\sum_j T_{ij} = O_i$ and $\sum_i T_{ij} = D_j$

and

$$A_i = \frac{1}{\sum_j B_j D_j \exp(-\beta c_{ij})}$$

$$B_j = \frac{1}{\sum_i A_i O_i \exp(-\beta c_{ij})}$$

Martínez, F.J., C. Araya (2000). A note on trip benefits in spatial interaction models. *Journal of Regional Science*, 40(4), 789-796.

$$Tub_{ijm} = \frac{-1}{\beta} \ln(a_{im} b_{jm})$$

a unit of absolute benefit, perceived by a user travelling between i and j, subject to trips complying with total trip origins and destinations from the entropy model

$$\Delta CS_{ab} = \sum_i \sum_j \sum_m \left(T^*_{ijm} \Delta Tub_{ijm} - \frac{1}{\beta} \Delta T_{ijm} \right)$$

a pseudo-rule-of-half and a macro-level correction. The latter relaxes the overall constraint in the entropy framework, allowing locations activities to change in the long run. Correctly measures long run benefits within LUTI framework

UNIVERSITY OF TWENTE.

- Doubly constrained SIM is still often used in transport planning.

- But applications of consistent benefit measures are rare !

- Martinez and Araya paper: 12 citations ….

UNIVERSITY
OF TWENTE.

ACCESSIBILITY BENEFITS – UTILITY-BASED APPROACH

- The *log* of the denominator of the multinomial logit model

- Logsum considers the utilities of all alternatives in the choice set of each traveller

$$P_{nj} = \frac{e^{V_{nj}}}{\sum_j e^{V_{nj}}}$$

- Exact measure of user benefits. Computed in monetary terms as the difference in conditions before and after a change, assuming utility is linear in income

$$E(CS_n) = (1/\alpha_n) \ln \left(\sum_{j=1}^{J} e^{V_{nj}} \right) + C$$

LOGSUM MEASURE

- MNL mode/destination choice models are commonly used around the globe, stand alone or within LUTI framework

- Theoretical advantages of the logsum are well known

- Still, applications of the logsum as accessibility or welfare measure are rare. Probably less than 20 studies most published after the year 2000. Application in CBA?

UNIVERSITY
OF TWENTE.

ACCESSIBILITY BENEFITS - PERSON-BASED APPROACH

- Hybrid utility-/person-based accessibility: representing an individual's benefit to perform an activity in space and time (Miller, 1991; Dong et al., 2006; Neutens et al., 2010)

- Comprehensive accessibility benefit estimations, going beyond trip-based approaches.

- Few applications

UNIVERSITY
OF TWENTE.

INTRODUCTION

ACCESSIBILITY ASSESSMENT AND VALUATION: AN OVERVIEW

LIMITATIONS OF THE CURRENT PRACTICE

CONCLUSIONS AND DISCUSSION

UNIVERSITY OF TWENTE.

LIMITATIONS TO THE APPRAISAL PRACTICE

- The treatment of the 4 components of accessibility

- Accessibility and digitalization

- Equity and distributive justice

- Appraisal frameworks (CBA, MCA)

UNIVERSITY
OF TWENTE.

TREATMENT OF THE LAND USE COMPONENT – LAND USE/TRANSPORT INTERACTIONS

- Common practice: ignore

- Result: appraisal not account for decreasing marginal returns of transport investment due to land use changes

- modest changes in location choices (LUTI model) can have significant effects on (logsum) accessibility benefits

- Logsum accessibility benefits from land-use policy strategies can be quite large compared to investment programmes

UNIVERSITY OF TWENTE.

TREATMENT OF THE LAND USE COMPONENT – VALUATION OF TRAVEL OPTIONS

- the valuation of accessibility in entropy and random utility frameworks is derived from actual travel demand.

- the only reason to include more options in the logsum than the alternative with the best utility performance is the stochastic element (reflecting imperfect knowledge of the analyst).

UNIVERSITY
OF TWENTE.

OPTION VALUE

- literature on the *option value* concept explains that people might value transport *options* over and above the use value. An "insurance premium" for future use

- Applications relate to public transport availability, but the option value concept can be applied to accessibility.

- A need for more research; e.g., decreasing marginal utility when number of shops, services, jobs etc. increase?

UNIVERSITY
OF TWENTE.

MOTILITY (KAUFMAN) – MOBILITY AND ACCESSIBILITY

- The *capacity of humans to be mobile* in social and geographic space, defined by access (modes, activities), competences (skills, abilities) and appropriation

- The access dimension of motility has been related to travel satisfaction and well-being: more options; higher travel satisfaction (de Vos et al., 2013; Abou-Zeid et al, 2012)

- How to valuate motility, travel satisfaction, well-being?

- Links between land use, transport and individual components of accessibility

THE TRANSPORT COMPONENT OF ACCESSIBILITY- VALUE OF TIME AND COMFORT

- Not all travel time is a disutility or cost

- Mobile working in a society on the move; comfort enhancement reduces VoT for train users

- The including of 'soft'(latent) and 'hard' variables in choice models is a rapidly growing field of study

- But few applications related to accessibility modelling

UNIVERSITY
OF TWENTE.

INDIVIDUAL COMPONENT OF ACCESSIBILITY

- Capabilities, needs and opportunities influence accessibility

- Links between travel and (subjective) well-being, life satisfaction, satisfaction with travel

- Longer commuting associated with lower job/leisure time satisfaction and poorer mental health, but depends on the mode

- A longer commute by foot or bike can increase of travel satisfaction and happiness (Lancée et al., 2017)

UNIVERSITY OF TWENTE.

THE TEMPORAL COMPONENT OF ACCESSIBILITY

- A growing field of accessibility modelling is related to temporal dynamics in accessibility (e.g., using navigation; GTFS data)

- Little attention in transport appraisal for temporal dynamics

- A need for more research on the interactions between the temporal component, transport, individual and land use components of accessibility.

UNIVERSITY
OF TWENTE.

ACCESSIBILITY AND DIGITALISATION

- Digitalisation and technological advances are rapidly changing the way people move, communicate, socialize, work, or shop

- growing landscape of transport options (e.g., shared modes)

- ICT potentially impacts all four components of the concept of accessibility

- The inclusion of digitalisation in accessibility research is still in its infancy.

UNIVERSITY
OF TWENTE.

ACCESSIBILITY, EQUITY AND JUSTICE

- Equity analysis is not straightforward. Results are heavily influenced by the accessibility and equity indicator and operationalisation

- Valuating accessibility is problematic; WTP for additional travel is low for low-income groups; reduces monetary gains for low-income groups

- If equity, not efficiency is the goal: different theories of justice (egalitarian, sufficientarian, ..) need to be explored and provide real challenges. The identification of minimum thresholds of accessibility is an unsolved challenge

UNIVERSITY
OF TWENTE.

ACCESSIBILITY IN APPRAISAL FRAMEWORKS

- Transport appraisal should cater for a multidisciplinary perspective on the transport system based on insights and theories from economics AND psychology, sociology and geography.

- CBA as part of a broader and more flexible MCA.

- Accessibility and equity measures (e.g., Gini, Palma ratio) and can easily be included as indicators.

- Can include actors or actor categories - Multi Actor Multi Criteria Analyses (MAMCA) developed by Macharis

UNIVERSITY OF TWENTE.

INTRODUCTION

ACCESSIBILITY ASSESSMENT AND VALUATION: AN OVERVIEW

LIMITATIONS OF THE CURRENT PRACTICE

CONCLUSIONS AND DISCUSSION

UNIVERSITY OF TWENTE.

CONCLUSIONS (1/2)

- Accessibility research has been flourishing, but economic valuation of accessibility has received relatively little attention.

- Existing tools hardly used in appraisal practice
  - location/utility-based accessibility benefit measures
  - dynamic relationships between land-use and transport

- Overcoming institutional, organisational and technical barriers

UNIVERSITY OF TWENTE.

CONCLUSIONS (2/2)

- Also a need for more theoretical and empirical research - benefit of having increased choices, related to travel satisfaction and wellbeing

- Research on digitalisation and accessibility is still in its infancy

- Transport and accessibility appraisal should reflect the multidisciplinary nature of transport; integrate CBA in a broader (MA)MCA

UNIVERSITY OF TWENTE.