UNIVERSITY OF TWENTE.

ACCESSIBILITY AND TRANSPORT APPRAISAL: APPROACHES AND LIMITATIONS

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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
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.

# COMPONENTS AND PERSPECTIVES

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INTRODUCTION

ACCESSIBILITY ASSESSMENT AND VALUATION: AN OVERVIEW

LIMITATIONS OF THE CURRENT PRACTICE

CONCLUSIONS AND DISCUSSION
DIFFERENT PERSPECTIVES, DIFFERENT ACCESSIBILITY BENEFIT MEASURES

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- Travel time savings, rule of half measure
- Gravity and Spatial Interaction Models
- Hybrid utility-activity based models
- Logsum MNL model
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

\[
\Delta E(CS_{Roh}) = -0.5 \sum_{z=1}^{Z} \sum_{j=1}^{J} (GC_{qj} - GC_{qj}^0)(A_{qj}^1 + A_{qj}^0)
\]
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
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)
DOUBLY CONSTRAINED SIM

\[ T_{ij} = A_i O_i B_j D_j \exp(-\beta c_{ij}) \]

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

and

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

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

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

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

• But applications of consistent benefit measures are rare!

• Martinez and Araya paper: 12 citations ….
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

• 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

\[ P_{nj} = \frac{e^{V_{nj}}}{\sum_j e^{V_{nj}}} \]

\[ E(CS_n) = (1/\alpha_n) \ln \left( \sum_{j=1}^{J} e^{V_{nj}} \right) + C \]
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?
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
LIMITATIONS TO THE APPRAISAL PRACTICE

• The treatment of the 4 components of accessibility
• Accessibility and digitalization
• Equity and distributive justice
• Appraisal frameworks (CBA, MCA)
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
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).
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?
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
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)
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.
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.
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
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
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
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