© 2002 WIT Press, Ashurst Lodge, Southampton, SO40 7AA, UK. All rights reserved. Web: <u>www.witpress.com</u> Email <u>witpress@witpress.com</u> Paper from: *Urban Transport VIII*, LJ Sucharov and CA Brebbia (Editors). ISBN 1-85312-905-4

# Accessibility indices and planning theory

M.-C. Brodde Makri

Department of Technology and Society, Lund University, Sweden

# Abstract

Accessibility is an important factor in land-use planning and several methods have been developed to calculate and to predict it. Nevertheless, it is seldom applied in planning situations, maybe because many land-use planners and elected officials lack the knowledge and resources needed to use traffic models. Consequently, accessibility is often used as a concept and a goal in daily planning, but is seldom translated into operational forms. One way to bridge this gap is the introduction of accessibility indices for planning situations as an alternative. In this paper, a theoretical analysis is conducted in order to place accessibility in the theoretical context of urban and land-use planning. Main theories of urban and regional planning are analysed with focus on their explicit and implicit relations to accessibility. The aspects of planning theory that are dealt with are urban design, planning procedures, planning legislation and societal goals (i.e. equity and sustainability). The indices discussed here are mainly integral place accessibility measures, containing a range of available opportunities with respect to their attractiveness and travel impedance. The applicability of the chosen indices has been evaluated quantitatively and qualitatively. The goal, by means of introducing accessibility indicators addressed to planners, architects, and elected officials, is to contribute to bridging the gap between the general discussions about accessibility in the planning context and the use of quantitative measures in accessibility models.

# 1. Introduction

This paper contains a general discussion of the issues touched on by accessibility indices (AI) as well as a theoretical discussion on the role of accessibility in the planning process. The aim is to investigate is included explicitly or implicitly in

© 2002 WIT Press, Ashurst Lodge, Southampton, SO40 7AA, UK. All rights reserved. Web: <u>www.witpress.com</u> Email <u>witpress@witpress.com</u> Paper from: *Urban Transport VIII*, LJ Sucharov and CA Brebbia (Editors). ISBN 1-85312-905-4

**38** Urban Transport in the 21st Century

the town planning ideals that has affected the design of our towns, whether it has a place in the most common planning paradigms, and to discuss the use of AI as a tool in the planning process.

The indices used and discussed in this project are mainly integral place accessibility measures (PAI), containing a range of available opportunities with respect to how they measure attractiveness and travel impedance. The reason for this is that the aim of the overall project and, not just this paper, is to develop and evaluate tools suitable for qualified and continuing discussions in planning. This kind of discussion is by necessity more one of areas than of individuals living there. Though the research is carried out on a geographically aggregated level, the accessibility discussion in this paper is valid for all types of AI.

# 2. Why accessibility

One of the ongoing discussions among politicians, planners and researchers is how to find ways of limiting the negative effects of traffic without diminishing its positive effects. Ways are being sought to increase accessibility (i.e. the ease of reaching activities) keeping mobility (produced vehicle kilometres) invariable. In the EU Commission's report of 1999, "European Sustainable Cities", this is given particular emphasis through the concept of "sustainable accessibility". In Sweden, the 1998 transport political decision based on the government bill 1997/98:56, "Transport Policy for Sustainable Development", stipulates accessibility as one of five traffic policy goals.

The mobility achieved in an extended transport network is no longer a goal in itself. Today we know that building new and/or expanding existing roads lead to increased amounts of traffic (e.g. Goodwin 1997, Naess 2000). Moreover, high road standards attract businesses and enterprises, which move from central locations accessible to all, to remote areas accessible only by car which in turn leads to increased amounts of car traffic. Today the aim is rather to achieve good accessibility to satisfy our needs of interaction. The basic assumption is that people travel for a purpose in order to reach certain activities, not just for the fun of it. Even though this it may seem contradictory to the fact that roads generate traffic, it is assumed to be consistent in broad outline and is the starting point for several researchers who deal with peoples travelling patterns (e.g. Bertil Vilhelmson and Lars-Göran Kranz). This perception is called the "activity axiom".

On the other hand, high accessibility levels do not necessarily imply a reorientation towards sustainability. By means of choices, individuals optimise their own utility and not the society's. For the individual, higher accessibility signifies an increased quality of life in the form of greater freedom to choose activities and the amount of time to devote to them. In such a society attention is paid to a social sustainability, since all the social groups, regardless of age, income and state of health, can avail themselves of certain facilities.

Another motive for raising accessibility goals during the planning process is that it provides an opportunity to build in an environmental sustainability potential gradually in the urban environment. The accessible society acquires an © 2002 WIT Press, Ashurst Lodge, Southampton, SO40 7AA, UK. All rights reserved. Web: <u>www.witpress.com</u> Email <u>witpress@witpress.com</u> Paper from: *Urban Transport VIII*, LJ Sucharov and CA Brebbia (Editors). ISBN 1-85312-905-4

Urban Transport in the 21st Century 39

environmental sustainability potential in that it does not have an in-built structural compulsion for motorised transport. Bertil Vilhelmson illustrates this in his report Tidsanvändning och resor (1997). He carries out a hypothetical experiment in which we wake up one day and have no access to cars. For many of us this means that normal daily activities are inaccessible within the available time budget. This naturally leads to new travelling patterns and to new routines (for example change of workplace). In the long run this has an inevitable impact on the location of housing and activities.

### 3. Why accessibility indices

Accessibility as a term has long been used by politicians and planners in descriptions of concepts and planning goals. Nevertheless, it has seldom been an integral part of performance measures used to evaluate policies, and has seldom been applied in planning situations. The introduction of AI for planning situations as an alternative is one way to bridge this gap. Even though simplification of PAI is a possible drawback, this is outweighed by the fact that they are relatively plain, easy to understand and simple to apply. In the last few years we have witnessed an increased interest in translating the concept of accessibility into this type of operational form. The field of application for PAI is wide. For the uninitiated, indices presented as digital maps are the easiest to understand. This provides a communication platform for the planner, from which he can spread information as well as facilitate a dialogue between all the parties concerned. Naturally, the indices are also useful in their numeric format. Socioeconomic evaluations are an example of their applicability. Accessibility is not usually regarded as measurable and therefore excluded from calculations and only included in verbal descriptions.

One prerequisite for PAI to be accorded legitimacy, is that they should concern issues that are relevant to urban development and the planning process. The latter is discussed in the present paper. Another prerequisite is the existence of independent connections between PAI and travel patterns. This has been analysed in a field study where the effect of accessibility on people's travelling was estimated. Data on the traffic network was combined with available data on population and potential destinations into a series of AI and added as layers on a digital map. A study focusing on the land-use impact on travelling patterns was then carried out in order to obtain a quantitative evaluation (Brodde Makri forthcoming 2002). Home- and work- based PAI with different modes were compared to actual travel behaviour (i.e. number of trips, distances, travel time and trip-linking) obtained from travel diary data in RES, Statistic Sweden. The study was carried out on a regional level with the county of Scania, in the south of Sweden, as a case study.

# 4. Definition of accessibility

Accessibility can be regarded as an indicator of the built-up environment's potential for sustainability, as well as a dimension of people's quality of life and

© 2002 WIT Press, Ashurst Lodge, Southampton, SO40 7AA, UK. All rights reserved. Web: www.witpress.com Email witpress@witpress.com

Paper from: Urban Transport VIII, LJ Sucharov and CA Brebbia (Editors).

40<sup>ISBN 1-85312-905-4</sup> Crban Transport in the 21st Century

is therefore a notion of importance. A general definition for it is "the ease with which various activities, including the needs of citizens, trade and industry and public services, can be reached" (Swedish National Road Administration, 1998) and can be considered to summarise the characteristics of the built-up environment and of the traffic system.

The concept of accessibility may be regarded as including many different aspects (Davidsson, forthcoming) such as 1) *physical accessibility*. being able to reach a point in spite of any physical hindrances, 2) *mental accessibility* - understanding and being able to use a given area and its facilities, 3) *social accessibility* - having friends and a job; being able to get to and from work, meet friends and participate in social activities, 4) *organisational accessibility* - having access to travel opportunities, information and service regarding a journey and 5) *financial accessibility* - being able to afford available public or private means of transport. A different aspect connected to the modern lifestyle, mentioned by Gudmundsson (2000) in "Driving Forces of Mobility" is 6) *virtual accessibility* -being able to access information and people without moving from a certain place, by using electronic facilities.

In consequence, accessibility can be ascribed either to people or places. Today, the tendency is towards a concentration on individual aspects of accessibility, both in qualitative analyses, e.g. Ståhl (fothcomming 2002) and in traffic models, e.g. Miller (1999). This approach of relating individuals travel patterns with their physical, socio-economic, and accessibility prerequisites is suitable for a deeper understanding of the underlying mechanisms of movement.

Notwithstanding, this paper departs from the general practice in that it deals with measures suitable for geographically aggregated levels and there are several reasons for that. The first is that the project aims to develop tools for qualified and continuing planning discussions, which by necessity deal with areas and not with individuals living in it. The second is that we have chosen to develop measures, which are relatively plain and easy to work and communicate with. We believe that, in spite of the simplifications, the measures will provide a general understanding of the accessibility situation in the studied areas and provide planners with a usable tool.

#### 4.1 Definition of place accessibility measures

Place accessibility (PA) is derived from patterns of land-use and from the transportation system. Measures of PA normally consist of two elements: a transportation (or resistance or impedance) element and an activity (or motivation or attraction or utility) element (Handy and Niemeier, 1997; Kwan, 1998). The transportation element comprises the travel distance, time, or cost for one or more modes of transport, while the activity element comprises the amount and location of various activities.

Ingram (1971) was first to subdivide the concept into relative and integral accessibility. Relative place accessibility was defined as the degree of interconnection between two points on the same surface, and integral place accessibility as the degree of interconnection between one point and all other points on the same surface.

© 2002 WIT Press, Ashurst Lodge, Southampton, SO40 7AA, UK. All rights reserved. Web: www.witpress.com Email witpress@witpress.com Paper from: Urban Transport VIII, LJ Sucharov and CA Brebbia (Editors). ISBN 1-85312-905-4 Urban Transport in the 21st Century 41

PA are operationalised in several ways depending on the issue at hand, the area of the application, and means and limitations concerning resources and feasible data (Handy and Niemeier, 1997, Ingram, 1971). They range from the very simple, e.g. distance measures, to the more complex, e.g. utility measures. Depending on the complexity, various degrees of accuracy are obtained.

Distance measures are the simplest accessibility measures, counting the distance from one location to different opportunities. They can be measured as average distances, weighted area distances or distances to the closest opportunity. The estimation of these distances can be performed in several ways, from simple straight-line distances to more complicated impedance formulations.

Cumulative-opportunity measures are evaluations of accessibility with regard to the number or proportion of opportunities accessible within a certain travel distance or time from a given location. These measures provide an idea of the range of choices available to residents within an area and are attributable to the work of several researchers. All potential destinations within the cut-off area are usually weighted equally, but even cumulative indices, which take the spatial distribution of opportunities into consideration, may be used.

Gravity-based measures derive from the denominator of the gravity model for trip distribution (Geertman and van Eck, 1995; Sonesson, 1998). They are obtained by weighting opportunities in an area with a measure indicating their attraction and discounting them by an impedance measure (for example Geertman and van Eck, 1995; Kwan, 1998; Handy and Niemeier, 1997).

The definition of relative accessibility  $A_{ij}$  at location i is the attraction at destination j discounted by the distance decay function between these two points. The integral accessibility  $A_i$  for the residents of zone i is measured as: where

$$A_{i} = \frac{\sum_{j} a_{j} * f(d_{ij})}{A}$$

 $a_j$  is the attraction in zone j  $d_{ij}$  is the travel time, distance or cost from zone i to zone j  $f_{(dij)}$  is the impedance function A is a standardising factor

Utility-based measures are based on random utility theory, and consist of the denominator of the multinomial logit model, also known as logsum (Handy and Niemeier, 1997; Sonesson, 1998). Utility theory is based on the assumption that individuals maximise their utility. This means that the individual gives each destination a utility value, and that the likelihood of an individual choosing a particular destination depends on the utility of that choice compared to the utility of all the other choices. (Sonesson, 1998). The utility function contains variables representing the attributes of each choice, reflecting the attractiveness of the destination, travel impedance, and socio-economic characteristics of the individual or household. Accessibility  $A_n$  for individual n can, for example, be measured as (Handy and Niemeyer 1997):

© 2002 WIT Press, Ashurst Lodge, Southampton, SO40 7AA, UK. All rights reserved. Web: <u>www.witpress.com</u> Email <u>witpress@witpress.com</u> Paper from: *Urban Transport VIII*, LJ Sucharov and CA Brebbia (Editors).

**JSBN** 1-85312-905-4 **4**2 *Cribin Transport in the 21st Century* 

$$A_{n} = \ln \left( \sum_{\forall \in C_{n}} \exp(V_{n(c)}) \right)$$

where

 $V_{n\left(c\right)}$  is the observable temporal and spatial transportation components of indirect

utility of choice c for person n

 $C_n$  is the choice set for person n

### 4.2 Some general issues

As mentioned above, different situations and purposes demand different approaches to accessibility. Regardless of the chosen approach, according to Handy and Niemeier (1997), some interrelated issues such as a) the degree and type of disaggregation (spatial, socio-economic etc), b) the definition of origins and destinations, c) the measurement of travel impedance and d) the measurement of attractiveness, have to be resolved.

Consequently, the planner is confronted with imperative choices that make him reflect over the information he wishes to convey. In this way he obtains flexibility through the broad spectrum of measures, variables and issues he is able to choose from. He has the opportunity to balance accuracy, the size of the investigated area, the size of the zones, etc. against the requisite costs for acquiring data and make an optimal choice. Instead of working traditionally with a model that is a "black box" to him, the planner works with a transparent tool, which lets him decide what the measures reflect.

# 5. Accessibility and Planning Theory

Planning theory consists of two partly conflicting areas called scientific or descriptive and normative (Naess och Saglie 2000). Scientific planning theory attempts to describe what reality looks like. It operates on meta level and deals with scientific theory about the planning process, methods for the planning process and the need for planning tools and communication instruments. Normative planning theory assumes that planners are able to evaluate reality and work normatively on planning issues. Questions concerning the connection between localisation and transport often fall within the normative sphere. Indeed, almost all the available theory about traffic planning is normative elements of planning theory.

### 5.1 Accessibility in Descriptive Planning Theory

Planning theory has mainly been developed in an attempt to understand and explain the mechanisms behind planning. Irrespective of whether it concerns the physical environment or any other area, there are common features characteristic of the planning process, i.e. distribution of power between actors, interaction between decision-making levels, extent of long-term perceptions etc. © 2002 WIT Press, Ashurst Lodge, Southampton, SO40 7AA, UK. All rights reserved. Web: <u>www.witpress.com</u> Email <u>witpress@witpress.com</u> Paper from: *Urban Transport VIII*, LJ Sucharov and CA Brebbia (Editors). ISBN 1-85312-905-4 *Urban Transport in the 21st Century* 43

Prevailing political ideologies during the second half of the century gave rise to various planning traditions which have been analysed by several scientists. Some of these theories and doctrines are presented below.

Rationalism deserves to be dealt with separately, especially since rationalistic methodology dominated planning for long periods in the 1900s. In Sweden, there was a widespread belief in the welfare state and in social engineering. Society's planners had visions and the belief that rational planning could achieve the Good Society. This was questioned by the planners themselves in the 70s (Nylund 1995) and later on in the 80s and 90s by public opinion. Despite this, it has maintained a dominant position within planning because it is the starting point that other theories relate to.

Rationality implies that the decision-making planner always chooses the alternative that optimises his material interests and utility. (Nyström 1999). According to Andreas Faludi (1984), the rationale of planning theory is "that of planning promoting human growth by the use of rational procedures of thought and action". Human growth is enhanced by planning in two ways; it shows the best way of achieving particular goals and adds to existing knowledge, and thereby to future growth. When localisation is discussed in a national economic context it is assumed that individuals and companies make rational choices. In the case of physical planning it is presupposed that land use can be evaluated in terms of utility or financial gains that are quantifiable before the choice of localisation.

Planners held much of the power in the era of rationalism. The urban ideals of functionalism and "small house neighbourhoods", which differed considerably, were tried but neither gave satisfactory results. This was due to the fact that planners and politicians were far too powerful and quantitative in their working methods. They chose to optimise a few utilities such as accessibility to workplaces or local shops, but largely neglected the qualitative aspects. This resulted in unpleasant and unpopular neighbourhoods. The remnants of rationalism in the urban environment clearly illustrate the effects of one-sided methods. The implication here is that decision makers should be careful about relying only on experts intent on optimising one particular aspect to the detriment of others. An holistic approach to the planning process including as many of the aspects and actors as possible is to be preferred.

John Friedmann (1987) divides rationality into market and social rationality. The former was described above, while social rationality is based on the assumption that people belong to a social group whose interests are more important than the individual's. Planning is mainly motivated by social rationality. Planning in a capitalistic society falls somewhere between these two forms (ibid).

Rationalism gave way to several other new theories dealing with different planning aspects. This can be likened to a paradigm shift as described by Kuhn (1962) in "The Structure of Scientific Revolutions". Rationalism and the other theories were grouped together by Friedman (1987) as follows:

Social reform – the most dominant form within planning theory, has a social reforming perspective with both economic growth and welfare as the

© 2002 WIT Press, Ashurst Lodge, Southampton, SO40 7AA, UK. All rights reserved. Web: www.witpress.com Email witpress@witpress.com

Paper from: Urban Transport VIII, LJ Sucharov and CA Brebbia (Editors).

ISBN 1-85312-905-4 44 *Urban Transport in the 21st Century* 

goals. The starting point for this type of planning is often social injustice. It is a centralised decision-making process (ibid). Since rationalism was the dominating doctrine, planners enjoyed high status. Thus accessibility to a limited number of activities was decisive for localisation of housing and activities.

Policy analysis - is a purely rational model. Planning is efficiencyoriented and only carried out by highly specialised practitioners. Analyses are based on economics, mathematics and statistical calculations with the use of advanced computer technology (ibid). Measures of accessibility can only be carried out by certain experts who are familiar with modelling techniques. Others involved in the planning process must therefore take this into account and follow their recommendations. At best, the models are used by others as "black boxes", i.e. the user has no control over the process but relies blindly on the measurement results.

Social learning - is dialectic. Planners, politicians and public opinion have an open dialogue and learn from one another's experiences. Social experiments and pilot projects can e.g. provide knowledge and a basis for future planning (ibid). Here, accessibility may well be expressed as a simple index easily understood by all the involved parties. AI become an instrument with which to spread information and knowledge, a tool for fruitful dialogue.

Social mobilisation - has its staring point in the belief that people should act collectively, and can be inspired by revolutionary ideas like anarchism and Marxism. Planning here is seen as system-changing rather than system-retaining. This is more an ideology than a method. The planner has no real power other than through the people for whom he is planning. An measure is produced by him at the request of the collective and constitutes a basis for their collective decision-making.

Planning is a continuous process involving a lot of decisions which may in turn lead to deadlocks, gradually decreasing the room for negotiation. If, for example, a decision is made at an early stage, there is a risk that the planning process will have to be started again. To avoid such deadlocks, a decision can be made subsequently as required. This planning procedure is called "incrementalism" (Nyström, 1999). Since AI are easy to produce, they can be useful tools in incremental planning.

At the end of the 80s the public sector's resources began diminishing at the same time as private actors became more dominant in land-use planning. This led to a new phenomenon of municipality representatives making agreements with private developers. Although this was undemocratic, it was done to keep the developers interested and to guarantee that the plan would not be changed. This is referred to as "negotiation planning" (ibid). This form of planning is often carried out above the head of the planner. There is a distinct lack of an holistic approach and participation by citizens. Accessibility is certainly very important to investors, but is often directed at mobile social groups with considerable purchasing power. This situation presents an opportunity to use AI to, for example, describe the effects of localisation and discuss aspects of equity.

© 2002 WIT Press, Ashurst Lodge, Southampton, SO40 7AA, UK. All rights reserved. Web: <u>www.witpress.com</u> Email <u>witpress@witpress.com</u> Paper from: *Urban Transport VIII*, LJ Sucharov and CA Brebbia (Editors). ISBN 1-85312-905-4 *Urban Transport in the 21st Century* 45

From the 60s onwards it is possible to distinguish three epochs in Swedish traffic planning (Davidsson, forthcoming). The first was the "Criterion epoch" where norms or national values were used for securing the quality and standard that were sought in physical planning (e.g. Swedish Parking Regulations, SCAFT 1968). The second was the "Adjusting epoch" where plans were evaluated according to scales, for example, walking distances from a bus stop, vehicle speeds and safety at crossings, in order to accord it a level of quality (e.g. TRÅD 1982). Now, we are heading into the "Direction epoch" where planners and politicians at regional and local levels are given overriding goals that have to be put into operation. This is a difficult task but it also gives a certain freedom of choice of interpretation. Easily understood indicators, used to check whether a change is in the direction of the goal, are suitable tools for direction planning. Even if the various measures counteract one another, this does not necessarily impede their use and development. On a national level the counterparts for these indicators are "the green key figures" developed by the Delegation on the Environment for the Swedish government.

### 6. General Conclusions

The discussion conducted in this paper covers only a small section of the many dimensions of planning theory. Different types of planning, decisionmaking levels, methodology, tools of implementation, organisational issues etc. have not been taken up here. The overall conclusion is that accessibility can be expressed and used in many ways. Since different situations and purposes demand different approaches, there is no best approach to measuring accessibility. An awareness of the assumptions upon which each method is based is a prerequisite when choosing a method to determine accessibility.

The accessibility indices that is most suitable ought to be decided by the issue at hand, the practical constraints in any given situation and the planning tradition in his professional context. Since different planning situations demand different information, it is appropriate to make new choices every time new planning issues are dealt with.

What is vital is that the practitioner is aware of the whole spectrum of opportunities so that he can choose the most fitting measure. More importantly, the way in which the AI are applied will have consequences for the end product, the built-up environment. In the aim to achieve an "accessible" and "good" society, transparency, information dissemination, co-determination and communication are principles that should be given priority at all levels of physical planning.

### References

- (1) Breheny, M., Sustainable development and urban form, London, 1992.
- (2) Brodde Makri, M-C., Accessibility indices as instruments of physical planning an evaluation, Department of Technology and society, Lund University, forthcoming 2002.

© 2002 WIT Press, Ashurst Lodge, Southampton, SO40 7AA, UK. All rights reserved. Web: www.witpress.com Email witpress@witpress.com Paper from: Urban Transport VIII, LJ Sucharov and CA Brebbia (Editors). ISBN 1-85312-905-4 46 Urban Transport in the 21st Century.

- (3) Davidsson, T., Stadsmiljö och trafik, National Board of Housing, Building and Planning, Karlskrona, forthcoming 2002.
- (4) Faludi, A., Planning Theory, 4th edition, London, 1984.
- (5) Friedman, J., Planning in the public domain: From knowledge to action, Princeton, New Jersey, 1987.
- (6) Geertman, & Ritsema van Eck, GIS and models of accessibility potential: an application in planning, Int. J. Geographical Information Systems, vol. 9, no. 1, pp. 67-80, 1995.
- (7) Goodwin, P., Solving Congestion inaugural lecture for the professorship of Transport Policy, University College, London, 1997.
- (8) Handy, S., & Niemeier, Measuring accessibility: an exploration of issues and alternatives, Environment and Planning A vol. 29, pp. 1175-1194, 1997.
- (9) Hägerstrand, T., Carlestam, G., Sollbe, B., What about People in Regional Science?, Ninth European Congress of the Regional Sience Association, Regional Science Association Papers, In "Om tidens vidd och tingens ordning". BFR, Stockholm, 1991.
- (10) Ingram, The Concept of Accessibility: A Search for an Operational Form, Regional Studies, vol.5, pp. 101-107, 1971.
- (11) Krantz, L-G., Rörlighetens mångfald och förändring: befolkningens dagliga resande i Sverige 1978 och 1996, Dissertation, School of Economics and Commercial Law, Göteborg University, 1999.
- (12) Khakee, A.,. Samhällsplanering, Lund University, 2000.
- (13) Kwan, M-P., Space-Time and Integral Measures of Individual Accessibility: A Comparative Analysis Using a Point-based Framework, Geographical Analysis, vol. 30, no.3, pp. 191-216, 1998.
- (14) Makrí, M-C., Folkesson, C., Accessibility Measures for Analyses of Land-Use and Travelling with Geographical Information Systems, Department of Technology and society, Lund University, 1999.
- (15) Miller, H., Measuring space-time accessibility benefits within transportation networks, Basic theory and computational procedures. Geographical Analysis, 31, 187-212, 1999.
- (16) Naess, P., Saglie, I-L., Surviving between the trenches: Planning research, methodology and theory of science, European Planning Studies, Vol. 8, No. 6, 2000, pp. 729-750, 2000.
- (17) Nylund, K., Det förändrade planeringstänkandet, NORDPLAN, Dissertation no 19, Stockholm, 1995.
- (18) Nyström, J., Planeringens grunder, Lund University, 1999.
- (19) Sonesson, Estimering av efterfrågan på långväga persontransporter: En ekonomisk-teoretisk belysning av gängse modeller samt en ny ansats till uppskattning av efterfrågesamband, Dissertation No. 36, Linköping University, 1998.
- (20) Song, Some tests of alternative accessibility measures: A population density approach, Land Economics, 72(4), pp. 474-482, 1996.
- (21) Vilhelmsson, B., Tidsanvändning och resor att analysera befolkningens rörlighet med hjälp av en tidsanvändningsundersökning, School of Economics and Commercial Law, Göteborg University, KFB-report 1997:12, 1997.