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Handling Traffic Modelling Networks in GIS, Conflicts-, Solutions- and Applications

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Traffic analysis of the Copenhagen Harbour Tunnel Project, Preconditions and results.

General information
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When standard GIS are used for traffic noise impact assessment, this has usually been done by using the built-in buffer-and overlay tools. However, recent research by IFP and TetraPlan Ltd. shows that the use of these tools can result in a crude and systematic misestimation of the noise level along building facades and thereby also the number of residences affected by noise of certain levels. New methods developed by TetraPlan Ltd. consider the barriers of different buildings...
as well as noise reflections. As part of the work a methodology for creating a 'synthetic' 3-D model based on GIS-maps and the Danish Building register has been developed. The work builds on two pilot projects ('Svendborg' & 'Middelfart') named after the concerned cities.

In the second phase of the GIS-T programme, the evaluation of traffic noise based on detailed map and register data are continued. A method to split buildings in floors and apartments has been developed. Based on this, analyses of coherence between noise and different socioeconomic data from the Danish Building Register (BBR) and personal register (CPR) are carried through. This provides a first step in the direction of analyses of traffic noise's relationship with socioeconomic data.

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Collaborators: DELTA - a Part of FORCE Technology, The municipality of Middelfart, Tetraplan A/S, The Danish Environmental Protection Agency, Danish Geodata Agency
Award relations: Noise Impact Analyses based on GIS- and BBR-registers
Project: Research

The Copenhagen Harbour Tunnel Project

The initial stages of the planning process concerning large infrastructure projects are often based on rather simplified modelling efforts - if any. Based on this, large-scale traffic modelling studies are often agreed upon. However, even though traffic models are becoming more and more complex, a number of simplifications are often decided upon in the early stage of the study, e.g. whether to model induced traffic and land use interaction. Even if the best practice is followed, the forecasts may turn out far from the actual flows. In addition, the work is often so comprehensive, that only few alternatives are examined thoroughly (although the GIS-technology has eased the work process). As a result, the reasonableness of using traffic models in the planning process has often been debated.

The Harbour Tunnel project is an early GIS-based assessment of the impacts of a proposed road-tunnel under the harbour of Copenhagen. Besides relying as much as possible on existing models, the study has used a minimum-maximum strategy to search for critical and non-critical traffic components. As an example induced traffic may be difficult to assess, but the 'maximum reasonable induced traffic' could clarify whether it is relevant to consider induced traffic at all. In the same manner recommendations could be given to the need for detailed investigations of e.g. land-use interaction, truck-traffic, detailed route choices, traffic calming, trip distribution and mode choice. A large number of alternatives were examined, several of which could clearly be rejected. In addition, the study provided useful recommendations for a subsequent full-scale modelling study (not yet started). Some of these recommendations were surprising even for experienced modellers.

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Collaborators: Tetraplan A/S, Grontmij A/S
Project: Research

Probit models for mode choice

Logit-models are almost solely used for mode choice modelling. Often, the model-type is used also to model trip distribution and sometimes trip production. The relatively simpleness of the logit-models and the availability of standard software packages are some of the reasons for its prevalence. The disadvantages by logit-models on the other hand are their premise of indepen-dence between alternatives, which is problematic when dealing with many alternatives partly dependent of each other (e.g. car, bicycle, bus, light rail and rail). This can be avoided by using probit-models. However, the multinomial probit-model have so far been difficult to handle for real-scale cases, but recent developments in computer technology and mathematical simulation methods have given new possibilities for use of this model.

The project investigates both from a theoretical and practical point of view the possibilities of using Probit models for mode-choices. In addition the subjects of mode-chains and trip-chains are dealt with.

For organizational details on the traffic model sub-projects; see the GIS-T programme.

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**Methods for trip matrix estimation**

Most conventional methods for estimating trip matrices from traffic counts assume either that the counts are error-free deterministic variables or they use a simplified traffic assignment model. Without these quite rough assumptions, the methods often demand prohibitive calculation times. In the project a new matrix-estimation method, 'Multiple Path Matrix Estimation' (MPME) has been developed which do not have these properties. Regarding route choices it corresponds to the models developed in 2a.

For practitioners, MPME is most promising in cases where an old trip-matrix needs to be updated for use in sketch-plan models or as pivot-matrix in larger traffic models. MPME has been tested and used successfully in several full-size cases (from small cities with 25,000 inhabitants to metropolitan areas with 5 million inhabitants). In all cases, the method gave lower deviations between traffic counts and estimated traffic than other tested methods. It converged smoothly within acceptable calculation times. It is now being implemented in the US GIS-T, 'TransCAD', which is produced by the Boston company, 'Caliper Corporation'.

**Route Choice Models and Traffic Assignment**

Route choice models are critical as they provide the final output of traffic models and thus give input to impact analyses on link-level, e.g. local environmental and safety considerations. As such, it is mostly the results of route choice models that are directly addressed by the political decision maker.

A major task in the project has been to develop route choice models which consider delays in intersections. In addition the traditional Stochastic User Equilibrium Model has been extended to consider differences in road users utility functions. These two theoretical developments has proven successfully in several applied projects. Sub-projects have carried out together with Tetraplan and Hague Consulting. Issues concerning passenger's route choices in public transport, multiple-class assignment and methods to enumerate cost from assignment models are now being developed.
In recent years a Danish debate on the use of traffic models have taken place in the professional community. IFP has among others participated intensively in this debate. One of the conclusions has been that many reminiscences of the early development of traffic models still exist - despite the recent development in computer and software technology, as well as theoretical development. A number of fundamental problems are:

1) That the coherence between sub-models seldom equals the road users and passengers decision-making process.
2) That the use of variables in different sub-models seldom are consistent with each other.
3) That advantages and disadvantages with the sequential versus other more recent model approaches have not been discussed thoroughly.
4) That people do not act rational as most models assumes.
5) That supply models (e.g. matrix estimation, route choice and traffic assignment) are too simplified in many decision making context.

In phase 2 of the GIS-T programme, the above problems are dealt with in more fundamental discussions, while the following sub-models are dealt with more thoroughly; 1) Route Choice Models, 2) Matrix Estimation Methods and 3) Probit models for mode choices.

The GIS-programme's underlying purpose is to renew the quantitative methodologies used in traffic planning and to open for the treatment of questions, which so far has been overwhelming of data- and software reasons. The main goals of the programme can be summarised as:

1) To clarify possibilities and limitations of the use of quantitative methods, including GIS-based methods, as basis for decision making regarding traffic and infrastructure.
2) Hence to develop new improved decision tools, among other approaches by utilising the possibilities in the GIS-technology.
3) To test the newly developed methods in applied projects.
4) To propagate theoretical and practical knowledge in Danish and International fora and to involve the results in the M.Sc.- and Ph.D.-education at the department.

These goals are to be fulfilled within the following areas of focus:

1) Methods for data-handling and quality control
2) Traffic models
3) Impact analyses (among others economics, accessibility, safety and environmental impacts)
4) Decision Support Systems and
5) Methods for quality control of models and their results.

The GIS-T programme consists of a number of coordinated projects, where GIS (Geographic Information Systems) are used. The projects have different focus within the area of traffic planning but they all have in common that GIS can ease and improve the methodologies and state of practice. The largest projects are described individually other places in this annual report. Otto Anker Nielsen is coordinator of the programme.
Route Choice Models for Car Traffic in the Ørestad Model

The purpose of this project is 1) To improve the laying concerning expenses as well as differences in the motorists’ preferences and knowledge of the road network. 2) To include calculation of delays in crossroads in the model. 3) To enable laying out the car traffic referring to different criteria (Multi-class assignment). Among other things this includes possibility of modelling different preferences (useful functioning) for different vehicles, excursion choice and time of the day. 4) To secure a consistent and improved feedback from the new route choice model to the rest of the model levels (excursion dispersion and choice of transportation means).

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Collaborators: Ørestadsselskabet, Tetraplan A/S, Hague Consult
Award relations: Route Choice Models for Car Traffic in the Ørestad Model
Project: Research

The toll ring project

Assessment of the traffic consequences of a payment ring including calculation of the model and adaptation of an assignment model.

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Collaborators: Danish Ministry of Transport, Building and Housing, Tetraplan A/S
Award relations: The toll ring project
Project: Research

The BASISNET-project; Analyses of different public transportation solutions in Copenhagen (basis networks)

The main purpose of the BASISNET-project is to map future demands and needs for public transport of high quality in Copenhagen, and to suggest specific solutions to meet these demands. The perspective is the period until 2010. Thus, it is examined which future traffic problems, the backbone public transport system must solve (basis network). The whole region of Copenhagen is dealt with and different system-solution, e.g. fast busses, trams, light rail and mini-metro are dealt with. The project includes traffic forecasts, impact analyses, sketch plans and economic estimates. It does not only consider technical solutions and analyses but also the infrastructures lay out within the city, including architecture and aesthetics.

IFP’s role is to coordinate GIS-data, carry through GIS-analyses and visualisations and to contribute to assessment and discussions of the results of runs with traffic models. Both the Greater Copenhagen Traffic Model and the ‘Ørestads’ Model are used for the study in order to get a more broad evaluation of traffic impacts.

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BRIDGES - A GIS-T for accessibility studies at an European level
The project's main focus is to coordinate strategic traffic models, GIS and decision support frameworks (mainly accessibility measures) to be used for strategic studies at EU-level. The name 'BRIDGES' refer to the intention to bridge different methodical approaches. IFP's contribution to the project are concentrated within the following work-packages:
WP4- Data links
WP5- GIS links
WP6- Links to Transport Models
WP7- Specialised GIS Interfaces
WP8- Decision Support System
WP10- User Demo-Workshops
Some of these can be grouped within the following fields (IFP's part is largest in WP5 and WP7):
1)Forecast interfaces implemented in GIS (WP5 & WP7). IFP is responsible for WP7.
2)Traffic models (WP6) and interfaces to traffic models (WP7).
3)Decision support (WP8) and validation of models (WP10) in a GIS-environment.
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Use of GIS-T for traffic planning in developing countries
It is widely recognised that developing countries face huge problems regarding traffic and infrastructures. This is not only the case in rural areas - the traditional focus of developing projects - but also in the urban areas. The traffic congestion causes that large resources in form of manpower, vehicles and goods are tied up in the traffic. This in turn results in less economic development, prohibitive pollution and a high rate of traffic accidents. If the traffic planners had better and more accessible tools for analyzing impacts of different project proposals, the scarce means in the developing countries could be used more efficiently. However, the existing research in traffic models mainly addresses issues and travel patterns in industrial countries. Due to among other things differences in standard of infrastructure, types of modes, economy, driving behaviour, available data, these models cannot directly be used in developing countries.
The joint research programme between IFP, DTU and Bandung Institute of Technology, ITB, will contribute to the development of such models. IFP has had a long-term relationship with ITB. The City of Bandung, Indonesia (5 mil. inhabitants) has so far been used as case for the work.
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01/09/1994 → 01/12/1996
Collaborators: Bandung Institute of Technology
Project: Research