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Urban Sustainability and Transport: Research Framework for (M)edium and (L)ong Term Planning

Keywords: Multi-agent activity-based transport modelling, integrated transport planning for sustainable cities.

SINGAPORE – In this presentation the framework of the Future Cities Laboratory Module VIII 'Mobility and Transport Planning' title Daily Flows, (M)edium and (L)ong Term is outlined. The main objective of the project is the integration of two time scales of transport planning allowing for managing, planning and optimising the flow of people and goods and its interaction with all elements of the future, sustainable city.

The medium term refers to changes within the current situation, such as changes in infrastructure, regulation and pricing but still takes the current situation as starting point. The long term refers to changes over a longer period of time, such as household location choice or the choice of service providers. Long-term processes over time make it possible to consider the changes required to achieve the overarching policy goal of a sustainable city.

The starting point of the framework is the current version of the large-scale, activity-based transport demand and traffic flow simulation toolkit MATSim which follows an activity-based demand generation approach. To address the demands of assessing medium term transport control strategies two innovations are considered. First, the time horizon for modelling the choices of daily behaviour is extended to a weekly rhythm based on the idea of an activity calendar. This ensures the inclusion of an additional degree of freedom of transport demand reactions that is not covered in current transport modelling frameworks. Second, an optimisation approach for road pricing based traffic management will be developed. An optimal toll system is of central importance for a sustainable city, since it facilitates the internalisation of congestion imposed externalities.

To account for the evolution of urban transport systems, and hence its long term sustainability, the framework acknowledges that the urban system is in constant evolution. One the one hand, one needs to account for changing demographics and the social structure which is described by the networks between people, and between people and firms. On the other hand, the interactions between the actors who supply the built environment and the associated services are not yet well understood. Based on new qualitative and quantitative survey work, such actors (or agents) will be integrated into the simulation. In the first instance, the retailers and providers of consumer services will be considered, such as car sharing companies, restaurants, child care institutions and doctors, but also real estate developers. ALEX ERATH

Alex Erath

Biography. Alex Erath is currently senior researcher and research module coordinator (Deputy PI) at the Future Cities Laboratory. He obtained his PhD from the Swiss Federal Institute of Technology ETH where he studied the vulnerability of transport infrastructure. His MSc thesis in civil engineering at ETH was awarded with the VSS prize for the best thesis in Road and Transportation research

Academic Qualifications. Dr. sc. ETH.

Publications/Exhibitions/Awards. Erath, A. (2011) Vulnerability assessment of road transport infrastructure, PhD. Thesis, ETH Zürich. Erath, A., J. Birdsall, K.W. Axhausen and R. Hajdin (2009a) Vulnerability assessment of the Swiss road network, Transportation Research Record, 2137, 118–128. VSS Award for the best thesis in the field of Road and Transportation 2005 for the MSc Thesis: Erath, A. (2005) Zeitkosten im Einkaufsverkehr, Master Thesis, IVT, ETH Zürich.

Making Future Cities

Future Cities Laboratory First International Conference 12-14 September, Singapore

12 September PM

Singapore's Daily Flow: (M)edium and (L)ong Term

SINGAPORE – The flow of people and goods within and through city areas is a fundamental dimension of contemporary urban design, planning and management. How these flows are accommodated and integrated into the fabric of the city impacts profoundly on the health and satisfaction of residents, and the economic prosperity and long-term sustainability of the city. The simulation and evaluation of such flows is crucial for understanding and optimising urban systems. This issue of *Gazette* features examples of the vast range of sub-models and data analyses that are needed to establish such a simulation model.

In my own presentation, I set out the framework of this research project, highlighting the relevance of integrating medium and long term time scales when simulating transport flows. Sergio Ordóñez presents public transport supply modelling that allows for interaction both with demand and other transportation modes such as cars. Pieter Fourie examines techniques for a more accurate understanding of trip making behaviour. Artem Chakirov applies various data mining techniques to detect patterns of public transport usage in Singapore. Michael van Eggermond presents advanced regression techniques to estimate the monetary value of residential property.

Modelling Transport Supply for MATSim

Keywords. Public transport schedule, map-matching problem, semi-automatic tool, navigation network, routing.

SINGAPORE – The multi-agent, activity-based transport simulation framework MATSim has recently been expanded to include public transport (Rieser, 2010). The implementation handles private and public transport in an integrated way and is applicable to large-scale scenarios with millions of agents. On the transport supply side, MATSim needs not only a high-resolution network, but also full public transport information. A central requirement is to accurately map the routes of public transport lines to the navigation network.

To tackle this problem, map-matching algorithms are becoming very relevant due to the increasing availability of GPS tracking data. However, they are usually not designed to account for peculiarities of the public transport routing. Besides, the results are very sensitive to errors in the network coding, to inaccuracies in the bus stop locations, and to simplified shapes of the links in the model.

First, an automatic map-matching approach is presented. It combines the sequence of consecutive stop points with the sequence of geo-referenced points provided by General Transit Feed (defined by Google) in an automatic way. The approach is especially designed to account for: a) low spatial resolution of the geo-referenced points included in General Transit Feed and, b) to feature that a stop which is served by several lines is attached to one single link. Furthermore, to improve the detected sequence, link costs take not only the travel time into account but also are augmented by the distance to the geo-referenced points.

Since in some situations, network or GPS points inaccuracies produce routing problems, the approach includes an interface which allows visualising and modifying the network and the sequences interactively. Several editing tools make it possible to manipulate links, replace link-stop relationships in several routes, and review the correctness of the result. The effectiveness of the approach is reported and strands for further improvement are evaluated. SERGIO ORDÓÑEZ

Publications/Exhibitions/Awards. Ordóñez, S., A. Triana and J. T. Hernández (2010) 'Methodology for automatic generation of distributed urban spatial models from GIS data', *Proceedings SIGraDi*, Bogotá, November (2010). Romero W., J. Ibarra, J. T. Hernández and S. Ordóñez (2009a) 'Multimodal simulation for urban mobility analysis: An approach based on a model of behaviors and infrastructure-related anomalies', *Proceedings SIGraDi*, Sao Pablo (2009). Romero W., J. Ibarra, J. T. Hernández and S. Ordóñez, 'Simulation and visualization platform for supporting analysis and decision-making in urban mobility projects', Revista de Ingeniería, Universidad de Los Andes, Bogotá (2009).

Sergio Ordóñez

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Application of Data Mining in Transport Research – the Case of Singapore

Keywords. Travel behaviour, public transport, smart card data, travel patterns, activity locations.

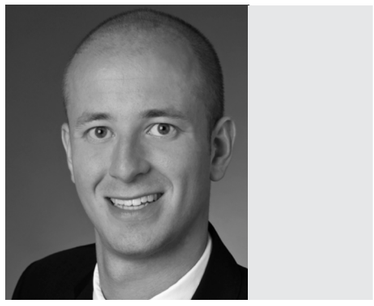
SINGAPORE – With the introduction of electronic payment systems for public transport in many cities all over the world, generated data records with history of public transport journeys become available and open new opportunities in transport research. Consequently, the processing and analysis of these substantial amounts of data are becoming more and more emergent research topics. In this context, the example of Singapore as a highly dynamic city with a centralised, long-term oriented transportation planning policy and fast growing commuter population represents an interesting study case. The combination of a distance-based fare scheme for public transport and the use of contactless stored value cards (so called EZ-Link cards) for payment of public transport fares, provides a comprehensive data record of public transportation usage for the entire island. The availability of alighting times and destination location for all bus and mass rapid transit (MRT) trips in the EZ-Link data, distinguishes the Singaporean smart card data from those collected by the majority of other systems and allows detailed assessment of travel routes and mobility patterns.

This presentation summarises the results of the analysis of transit smart card activity record for the entire Singapore. The main focus hereby lies on the investigation of data's potential for identification and characterisation of urban travel behaviour and peculiarities of public transport system. Results of spatial and temporal travel behaviour assessment including mode choice, distributions of journey distances, travel speeds as well as travel- and waiting times using statistical tools and data mining techniques are shown. Thereby data also reveals country specific preferences and behaviours as the influence of overcrowded trains and seat availability on route choice decisions and travel times. Furthermore data's ability to detect periodical travel patterns and infer peoples travel purposes and locations of regular activities is presented.

In conclusion opportunities and limitations of using the comprehensive smart card data sets to analyse travel behaviour and aid public transport planning are discussed. ARTEM CHAKIROV

Biography. Artem Chakirov is a PhD candidate at ETH Zürich and associate researcher in the areas of Mobility and Transport Planning at FCL. He obtained his Diploma in Electrical Engineering and Information Technology from Technische Universität München (TUM) in 2010. He studied at the University of Illinois at Urbana-Champaign and was graduate visiting researcher at the University of California San Diego. As a part of an international and interdisciplinary graduate programme at the Center for Digital and Technology Management (CDTM), he was awarded an Honours Degree in Technology Management. His current work focuses on travel behaviour and mode choice analysis within the Multi-Agent Transportation SIMulation toolkit (MATSim) in Singapore.

Academic Qualifications: Diploma in Electrical Engineering and Information Technology.



Artem Chakirov

Epilogue

Guest: Nice car, how much was it? Host: Well, essentially 100,000 SGD. Guest: How do you mean 'essentially'? Host: Well, in addition to the OMV, there is obviously also Custom tax, GST, ARF, COE and custom tax adding up to 325,301 SGD.
Guest: Wow, how can you afford this? Host: Well, do you see this construction site? Guest: Yes, they are building a new MRT line, but what has this to do with your car? Host: Well, when it opens I don't need the car anymore. Guest: Then, why would you buy one? Host: Look, in four years' time, I can get more than half of all that money back with PARF and COER. Guest: Still a lot of money for a car! Host: How much do you think my second apartment downstairs will sell after with the MRT being open? Guest Well, more than I need to spend on an acronym dictionary?

Comparison of Remembered and Recorded Public Transport Trip-Making Behaviour

Keywords: transport survey analysis, activity-based analysis, travel cards, transit

SINGAPORE – Starting in 1997, the Singaporean Land Transport Authority conducted three activity-based household travel surveys over the course of a decade, with a fourth survey planned for 2012. This Authority also has access to a wealth of real-time data sources of individual vehicle and commuter movement. Amongst others, such sources include records of travel card transactions when transit users board and alight from buses, or enter and leave rapid rail transit stations. This paper compares the reported transit usage from the 2008 household travel survey with a full day record of transit smart card activity for Singapore in 2010. Various mobility variables are calculated and compared from both data sources by time of day, including departure and arrival time distributions, transfer activity and travel- and walking/waiting times. Reported in-vehicle timings from the survey, recalled from memory, are compared with those recorded for similar journeys in the smart card data, as a function of transit distance. All these comparisons are generated by expanding the survey data on a per-trip basis, using trip inflation factors derived by the original survey analysts. These inflation factors produce trip volumes that match the large-scale flows observed in reality during the survey year. However, they produce difficulties in interpreting the trip-making behaviour of persons, as the various trips contained in a single person record get inflated to wildly varying levels. The second part of the paper proposes an alternative expansion procedure to inflate an individual's entire activity sequence and connecting trips to produce the observed flows, while matching zonal household demographics and removing the distortion in personal trip-making behaviour when the new inflation factors are applied. The paper concludes with a discussion of the solution quality of the new procedure by comparing the individual trip frequencies produced for transit-only records with those contained in the smart card data. PIETER FOURIE

Biography. Pieter Fourie is a simulation modeller specialising in transportation demand modelling. Before joining the Future Cities Laboratory, he was a researcher at the Council of Scientific and Industrial Research in South Africa, where he helped in developing the first integrated transport and land-use models for decision support to major South African MPOs. Pieter holds bachelors and masters degrees in Industrial Engineering from the University of Pretoria.

Academic Qualifications. MEng Industrial Engineering, BEng Hons (Industrial Engineering), BEng (Metallurgical Engineering).

Publications/Exhibitions/Awards. Joubert, J. W., P. J. Fourie and K. W. Axhausen (2010) 'Large-scale agent-based combined traffic simulation of private cars and commercial vehicles', *Transportation Research Record*, 2168, 24–32. Fourie, P. J. (2010) 'Agent-based transport simulation versus equilibrium assignment for private vehicle traffic in Gauteng', 29th Annual Southern African Transport Conference, Pretoria, July 2010. Fourie, P. J. and J. W. Joubert (2009) 'The first agent steps in agent-based transport planning', 28th Annual Southern African Transport Conference, Pretoria (2009).

Pieter Fourie

A Spatial Hedonic Regression Model for Housing Prices in Singapore

Keywords. Hedonic regression, hedonic pricing, real estate, Singapore, spatial auto regression, geographically weighted regressions.

SINGAPORE – Hedonic regressions are a well-established method to estimate the monetary value of housing amenities, publicly provided facilities and private services. Ordinary least square approaches are not able to account for spatial dependence and heterogeneity and will inevitably lead to biased parameter estimates. Therefore, in order to take into account the spatial effects, spatial autoregressive as well as geographically weighted regression techniques are applied in this study.

Data was gathered in February and March 2011. Asking prices are obtained from an online property portal which contains listings from the private market as well as listings from Housing Development Board (HDB) flats. Transaction prices are obtained for both the private sector and HDB flats. Data of nearby facilities, such as the availability of public transport, the distance to supermarkets, malls, car parks and parks is collected from different sources and is geocoded. These datasets combined lead to an extensive overview and make it possible to define several sub-markets with sufficient observations: the private rental, new sale and resale markets as well as the HDB rental and resale markets and compare asking and transaction prices.

Parameter estimates show the high significance of the floor area, construction year and distance to the CBD. Distance to bus stop influences the price – properties very close to bus stops (<200m) yield a lower price per square feet, which proxies the negative externalities of nearby traffic. The significance of the parameter estimate for the nearest MRT stop varies per market and property type. Proximity to top primary school is valued positive, as is a high floor level.

Preliminary results show that it is possible to use readily available online data for hedonic regressions in Singapore – both asking prices and transaction prices. In addition, this study can prove to be relevant for real estate professionals and developers as an input for cost benefit analyses and can aid in determining more exact prices for the scarce land and property in Singapore. MICHAEL VAN EGGERMOND

Biography. Michael van Eggermond is currently conducting his PhD at FCL within the transportation group headed by Professor Axhausen. He focuses on the development of choice models which will serve as input for MATSim. Prior to joining the FCL he worked as a consultant and subsequently R&D manager at INITI8, in Rotterdam. Here he worked on projects varying from port logistics to juvenile healthcare, focusing on performance management and simulation.

Academic Qualifications. Masters in Transport, Infrastructure & Logistics, TU Delft. Bachelor in Systems Engineering, Policy & Management, TU Delft.

Publications/Exhibitions/Awards. Eggermond, M. van and K.W. Axhausen, 'Using discrete choice models to support strategic decision-making of air transportation service providers', *Wirtschaftspolitische Blätter*, 56 (1) 37-58 (2009). van Eggermond, M.A.B., Schüssler, N. and Axhausen, K.W., 'Accounting for similarities in air transport route choice', *Arbeitsbericht Verkehrs- und Raumplanung* 496, ETH, Eidgenössische Technische Hochschule Zürich (2008). van Eggermond, M.A.B., N. Schüssler and K.W. Axhausen, 'Consumer Choice Behavior and Strategies of Air Transportation Providers', 7th Swiss Transportation Research Conference, Monte Verita, Ascona (2007).

Michael Van Eggermond