ENZ TRANSPORTATION GROUP 2019 CONFERENCE
APPLYING GERMAN SPATIAL PLANNING IN AUCKLAND

PRESENTER DETAILS

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ABSTRACT

Efforts to answer where and how people choose to live, work and travel by using Integrated Land Use and Transport (ILUT) models have been underway since the 1950s. ILUT models have been continuously recognised as the best practice in city planning, but their applications in New Zealand have been limited in recent years.

Transport and land use are intrinsically linked. The changing face of social patterns, including development density, demographics, employment and property prices affect land uses, and transport should both inform and be informed by these changes. In Auckland the housing shortage, social inequity and traffic problems highlight the need for integrated transport and land use planning.

This study looks at using an ILUT model in an urban development area in Munich, the state capital of Bavaria, Germany, and how this model can be applied in Auckland. The study specifically investigated the possibility of a development project alleviating housing shortage issues in Munich. The City of Munich's Department of Urban Planning and Building Regulation team was interested to use the findings of the model to guide their planning, especially as the study modelled multiple underground service extension options into the proposed development area.

The study showed how expected changes in population, population by income, number of dwellings, dwelling occupancy rates, property prices, number of jobs and accessibility levels would address the current housing and transport disconnect. The outcomes of the modelling indicate the outcomes of different routing and station placements for new public transport services. Modelling similar spatial models in Auckland can equally inform how the face of Auckland and New Zealand can and should change to meet current challenges.

INTRODUCTION

Large urban developments highly effect the economic, structural and cultural development of a city. For most developed cities, forecasting and investigating the impacts of proposed urban development projects are of great interest to both the public and private entities. Topics of interest to both the city planners and new tenants are generally, affordability, accessibility, sustainability, attractiveness and vitality. These properties are mostly achieved with the correct land use plan and an efficient transport network. Fortunately, land use and transport planning for such urban development projects can be modelled before any implementation is actioned.

Efforts to answer where and how people choose to live, work and travel by using Integrated Land Use and Transport (ILUT) models have been underway since the 1950s. The changing face of social patterns, including development density, demographics, employment and property prices affect land uses, and transport should both inform and be informed by these changes; And as transport and land use are intrinsically linked, future effects of transport projects and urban developments can be assessed and ascertained.

This paper is based on the integrated modelling suite used for the study is the Munich Metropolitan Area (MMA) model that is currently under development by the research group, Professorship for Modeling Spatial Mobility, at the Technical University of Munich. The research group is currently developing an integrated land use and transportation model by linking the land use model SILO (Simple Integrated Land-Use Orchestrator) with the transport model MATSim (Multi-Agent Transport Simulation). The area of interest for the study is called the 'Northeast Munich' by the City of Munich.

Housing shortage and population growth is a ubiquitous phenomenon in developed cities and thus the study specifically investigated the possibility of the city's development project alleviating housing shortage issues in Munich. The City of Munich's Department of Urban Planning and Building Regulation team was interested to use the findings of the model to guide their planning, especially as the study modelled multiple underground service extension options into the proposed development area.

Although almost antipodes, Munich and Auckland are cities with a similar population, 1.5 million and 1.6 million (stats.oecd.com, 2016), respectively, and urban area size. Furthermore, one of the most pressing issues of both cities is the lack of affordable housing. The study of 'Northeast Munich' can show how models such as the MMA model could be used for answering similar questions for Auckland. Looking at Munich and Auckland side by side, this is what we can observe (as shown in Table 1).

		Munich	Auckland
Population[1]		1,450,380	1,614,400
Density[2]		4,400 per km^2	2,800 per km^2
Car ownership[3]		610 per 1000 inhabitants (Germany)	839 per 1000 inhabitants (New Zealand)
Mode Share[4,5]	Private Vehicle	33%	85%
	Public Transport	23%	9%
	Cycling	17%	1%
	Walking	27%	4%

Table 1 Comparison of Munich and Auckland

[1](stats.oecd.com, 2016)
[2](Demographia, 2018) http://demographia.com/db-worldua.pdf
[3]https://www.acea.be/statistics/article/vehicles-per-capita-by-country; https://www.mia.org.nz/Portals/
[4]https://web.archive.org/web/20140408041150/http://www.ris-muenchen.de/RII2/RII/DOK/SITZUNGSVORLAGE/2497925.pdf
[5]http://nzdotstat.stats.govt.nz/wbos/Index.aspx?DataSetCode=TABLECODE7432

WHY INTEGRATE LAND USE AND TRANSPORT?

Integrated Land Use and Transport (ILUT) models were primarily founded in the 1950s and have been of interest in the land use planning and transport planning sectors to date. Initially, Hansen (1959) introduced a tool for the purposes of exploring accessibility patterns within a metropolitan area and subsequently used it for planning. The process involved a distribution of the anticipated future population into the study area. Consequently, Hansen found that the existence of public transport points accelerated development in the vicinity of the stops, thus, showing the relationship between the development of land use and transport.

ILUT models have since been continuously recognised as the best practice when it comes to city planning. The history of ILUT models show how the major overarching motivation, development and integration of such models are essentially unchanged during the 60 years. Most initiate a ILUT model for the purposes of forecasting future land use and transport development for a specific urban region or regions. Usually the development of the regional models include the main modules of the known population, employment and land availability figures. Then the integration involves the land use model producing travel demand which feeds into an aggregate or an agent-based transport model. Finally, the transport model generates the travel distances and times (skims), used by the land use model to quantify accessibility rates and corresponding choices for dwellings and jobs once again. This loop process has been presented as a land use and transport feedback cycle by Wegener (1994), as shown in Figure 1.

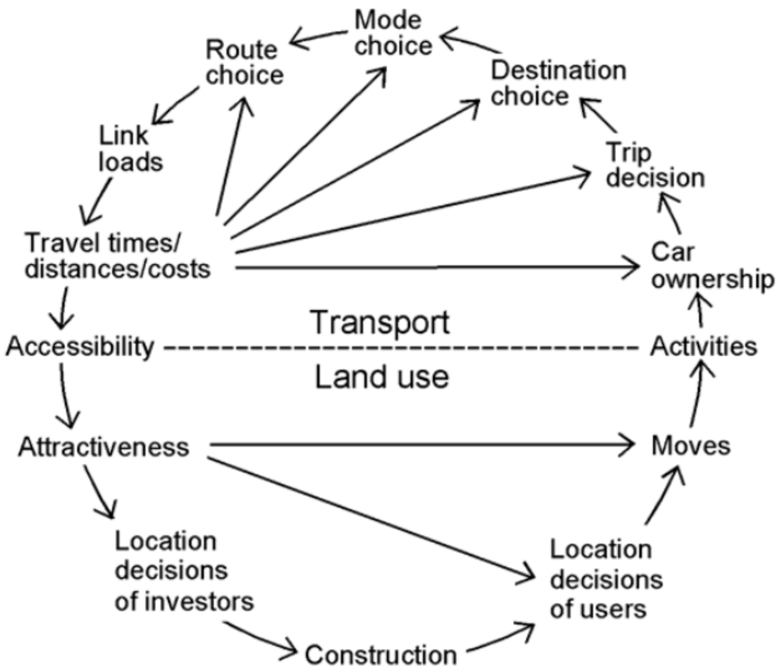

Figure 1 Land Use and Transport Feedback Cycle (Wegener, 1994)

WHAT THE GERMANS ARE DOING?

As a part of the research group in Munich, Professorship for Modelling Spatial Mobility (the Professorship, MSM), at the Technical University of Munich (TUM), Kim (2017) (the Author) was involved in building and using the Munich Metropolitan Area (MMA) model. The research group is currently developing an integrated land use and transportation model by linking the land use model SILO (Simple Integrated Land-Use Orchestrator) with the transport model MATSim (Multi-Agent Transport Simulation). A short history of SILO is described followed by an introduction to MATSim.

SILO began with the creation of the land use inputs in the form of a synthetic population by Moeckel, Spiekermann and Wegener (2003). The need for more detailed data about a city's population for the purposes of activity-based models was the driving factor for the creation of a synthetic population. They found that ILUT models should be capable of modelling for the disaggregate population and workplaces in order to successfully use activity-based models for the new environmental debate and more detailed neighbourhood planning. Thus, a Monte Carlo microsimulation methodology was adapted to create a synthetic population using the known aggregate population and employment data. The synthetic population embodies individuals, their households, workplaces and basic demographics that are used with decision making models. Household addresses were also created using land-use data which were available at the raster level with the use of Geographical Information System (GIS) methods. The implementation of creating a synthetic population using the above method has been applied to the city of Netenya, Israel and Dortmund, Germany.

Not long after, and due to similar restrictions of many complex land use models at the time Moeckel (Moeckel, 2011, 2015) built the simple but robust land use model SILO. SILO was built to integrate with both aggregate and disaggregate transport models. Each person and household is simulated individually for households and the real-estate market with the intention to further expand into the areas of simulating employment and non-residential land availability. The model introduces a time and money constraint framework where households do not exceed their household and travel budgets. Households are required to balance their expenditure between dwelling costs and travel costs (time and other costs) thus, decisions to move to a more appropriate dwelling (less costly dwelling) or area (closer area to commute to work) can be triggered. The initial pilot study was made for the Minneapolis/St. Paul Metropolitan Area in Minnesota.

Again, Moeckel (2017) explains how the integrated land use model SILO can be more representative of real life household relocation decisions. This is achieved by the aforementioned constraints for housing price, commuting times and a household’s transportation budget in terms of time and money. This is because SILO is based on the fact that 86% of all workers commute for less than 60 minutes to work and 99% commute less than 120 minutes to work (2007-2008 Household Travel Survey for the Baltimore/Washington region). Furthermore, SILO assumes a constant travel time budget, which has been seen to undergo almost no change throughout history (Zahavi, 1974). This travel time budget is approximately 18% of the net income of a household according to a Consumer Expenditure Survey in the United States (U.S. Bureau of Labor Statistics, 2017).

SILO & MATSIM

The SILO workflow starts with the synthetic population holding the data for the population (households and persons), dwellings and jobs (silo.zone, 2016). The synthetic population has been developed by the Professorship for the MMA, formed from a collection of official data sources. These include, the Household Census microdata (from the German State Statistical Office), and the more aggregate data from the German GENESIS-Online database, the German Household Census and the European CensusHub. As the micro-census data provides no location detail it is distributed amongst the MMA using the more aggregate data available for counties and municipalities. The MMA includes five central cities (Augsburg, Ingolstadt, Landshut, Munich and Rosenheim). The total population of the MMA is approximately 4.5 million people or 2.1 million households. Dwellings are then defined by their type, size and quality. Jobs are classified into ten job types. The final collection of the households, persons, dwellings and jobs are used to simulate demographic changes and real estate development.

The agent-based transport model MATSim (Horni, Nagel and Axhausen, 2016) is a powerful yet fast large-scale traffic simulator that has been often integrated with a land use model (Hao, 2009; Nicolai, 2013; Dobler, Horni and Axhausen, 2014). The model simulates an individuals typical day by reading the dwelling location, activity locations and the consequent trips in between activities (matsim.org, 2017). This typical day is run repetitively for a stated number of iterations in which the individuals test various routes and travel options. The repetition consequently achieves a ‘relaxed’ or ‘noisy’ equilibrium where individuals decide on their most attractive travel methodology after a series of evaluation and memorizing of previous experiences. The flowchart summarising the integrated models of SILO and MATSim is shown in Figure 2.

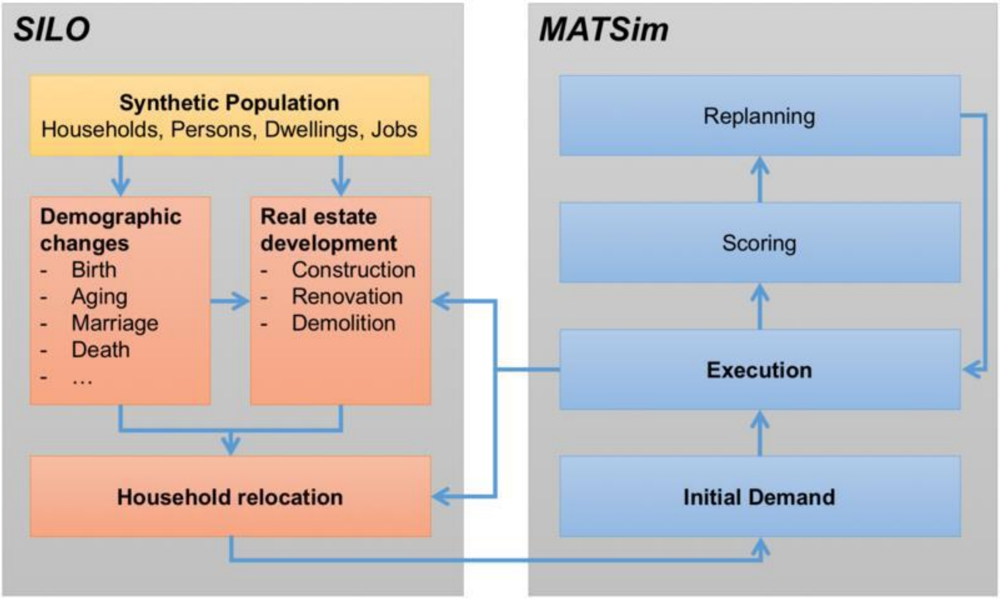

Figure 2 SILO and MATSim Flowchart

HOW ARE THEY USING IT?

With the future population of Munich to reach 1.8 million, an increase from 1.5 million, by 2030 (Landeshauptstadt München, 2017), urban development to accommodate for the anticipated demand is vital. As part of the solution, The Referat für Stadtplanung und Bauordnung, 'Department of Urban Planning and Building Regulation' (DUPBR) from the City of Munich (CoM) are currently investigating concepts for developing the Northeast area of Munich. Kim (2017) investigated the 600 hectares of land under consideration situated on the east of the airport line (S-Bahn line S8), at the Bogenhausen and Trudering-Riem area. Development is to take place gradually in the coming decades and the DUPBR have proposed three possible scenarios.

The DUPBR is in the process of developing the final conceptual design for the urban development in the Northeast. The project is regarded as one of the largest remaining potential for the future development of settlements in Munich. The plan is to undergo a multiple staged approach to decide upon the final structural concept, after which, steps for further implementation will be commissioned. The approach involves a careful investigation of the development landscape, settlement and transport.

The refined model is applied to the three development scenarios proposed and the results are compared to the base scenario. As expected, an increase in population, number of dwellings and number of jobs are found with all three scenarios of the urban development showing the attractiveness of the new development. The population increase is highest in Scenario 1 which almost quadruples between the first and last simulated years of 2011 and 2050. A higher increase of people in lower income groups is evident in all scenarios. Scenario 1 has the highest number of new MF234 (Multi Family duplexes and buildings of two to four units) dwellings, while Scenario 3 has the most MF5plus (Multi Family houses with five or more units) dwellings. The dwelling occupancy is similar for all development scenarios with the maximum occupancy at 98% in the first year 2011 and then 93% in year 2039. The level of occupancy drops each time new dwellings are added; however, the occupancy increases again at a very fast pace. Dwelling occupancy with the development is lower in 2050 compared to the base suggesting a slight relieving of pressure on the current housing market. As hypothesised, the average price decreases constantly for all scenarios however has slight increases with additional dwellings. This is seen to be an unrealistic increase in price due to exogenously added price values. The number of jobs increase in all scenarios with Scenario 3 producing the greatest number of jobs in the Northeast.

CONCLUSIONS: WHAT CAN AUCKLAND LEARN?

This thesis endeavoured to forecast the anticipated land use and transport effects with the Northeast urban development, acknowledging the permanency of such establishments once constructed. Three scenarios had been proposed by the Referat für Stadtplanung und Bauordnung, from the City of Munich. Each scenario encompasses different numbers of population and job targets, development density, timeline, road system and public transport upgrades. The Munich Metropolitan Model of the integrated model of SILO and MATSim is refined for the modelling years between 2011 and 2050 and used to simulate the changes.

Much like Munich, Auckland's population is expected to increase with limited housing. Urban development is critical and ILUT models can be used to forecast different development scenarios. The assessing of results will help to make the right decisions before any permanent changes are implemented.

Overall, this thesis largely contributes to the field of land use and transport integrated modelling. The first integration of SILO and MATSim has been achieved for the Munich Metropolitan Area and a scenario analysis has been implemented. The ability to forecast and compare different scenarios is evident and adds to the argument of the usefulness of land use and transport integrated models in planning while adding to the conversations for the Northeast Munich urban development.

Lastly, this thesis shows the benefits of universities, students and the City of Munich working together to generate synergies in their work. Each entity has given something and received something is return, adding to the benefit of the whole city itself. This paper encourages Auckland and New Zealand to review their ILUT models and work together to apply best practice for developing a robust model.

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