GIS Support for Sustainable Regional Transport System

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1. Introduction

Sustainability is a long term and strategic objective. Sustainable transportation planning on a regional scale can be divided into at least three levels: strategic, tactical (traditional four-step model) and operational (detailed) or alternatively macro, medium and micro, each with varied foci and functions but they will require different data and modeling detail. The strategic level of regional urban transportation planning is policy driven and works at an aggregate level of analysis. The policies that are normally implemented are aimed at the balance of transportation and land use on one hand and, on the other hand, the balance of private and public transportation. A sustainable transportation system should encourage the use of economically efficient, environmentally clean and socially acceptable trip model. A direct result from this principle is attracting people to walk, cycle and, in particular, to use transit systems. Perhaps the most widely used model is the transit-oriented development model which encourages development along the transit line or modal interchange nodes (Kwok and Yeh, 2004). This paper, using a case study of Amsterdam urban region, presents an empirical sketch- planning transport model that is aimed at support for sustainable regional transport systems under a GIS analytical environment.

2. Methodology

In traditional transportation modeling, the four-step model (trip generation, trip distribution, modal split and trip assignment) is the primary tool for forecasting future demand and performance of regional transportation systems. This full-scale transport modeling, given a transport network and a set of data representing the spatial distribution of urban activities and their intensities, can provide valuable insight into the effectiveness of transportation policy on the performance of the transportation infrastructure by testing various 'what-if' scenarios. However, its development and application in empirical settings often face critical obstacles. The first difficulty is related to the fact that conventional strategies apply sequential modeling of the four transport model components. A second difficulty is a result of the need to manage the spatial data required for a regional scale transport modeling. On most occasions, required data sets are not sufficiently available at specialized level and in preferred detail. Consequently, at strategic level, the reasonably simplified process of the full-scale modeling can not only improve the effectiveness of modeling but also quickly test the thoughts of users as a conceptually experimental lab using limited data sets.

Sketch planning, in the field of urban design, is a subset of planning but with some modifications, which is focused on a certain degree of abstraction. Sketch planning is the preliminary screening of possible configurations or concepts. Singh (1999) reported a potential application of GIS techniques for such sketch planning. Harris (2001) described a sketch-plan-based planning support system. Sketch-planning modelling aims to realize highlighted objectives based on simplified process, released parameters estimation, and using data sets at rougher level or with coarser resolution. In comparison with a full-scale model, it can offer such merits as quick response, ease of use and understanding, and low cost development. The key idea of sketch planning method is to facilitate the generation of alternatives quickly and easily. The development and test of a new sketch-planning model is a challenging task, given the requirement to produce reasonably accurate results with relatively aggregate level inputs (Batty, 2004).

In this study, sketch-planning modelling is intended as "rules of thumb" to provide the regional planners with a general picture of the problems against sustainable transportation systems. Sketch-planning tools were developed specifically as a quick response model to analyze:

- Regional activity centres;
- Identify areas with the potential for successful transit service but where service currently does not exist;
- Identify areas that currently or in the future may be underserved by transit and for which service improvements may be needed.

The main steps in the defined sketch-planning modeling can be summarized as follows:

- Adopting the logic structure of the traditional transportation modeling process;
- Limiting the purposes of trips (working and visiting) and trip modes (car and transit);
- Zones (residents and activities) grouping;
- Network aggregating;
- Modest model calibration.

GIS is employed here primarily for data processing, data integration (aggregation and dis-aggregation), network analysis (shortest path) and communication with users. Figure 1 shows its flow chart.

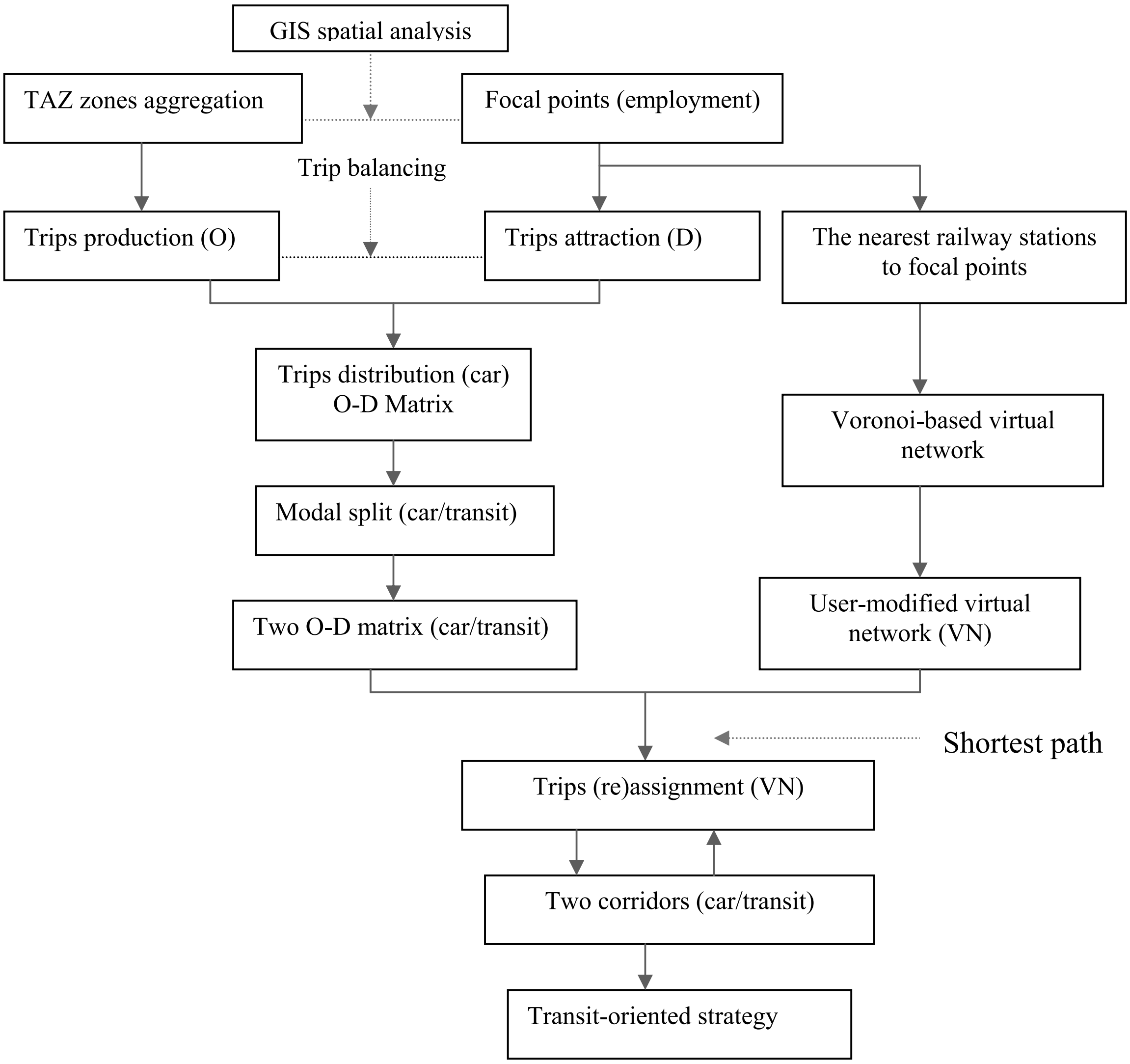

Figure 1. A sketch-planning model for transit-oriented development strategy

3. Results

Amsterdam urban region consists of the ‘mother’ city of Amsterdam and other smaller cities around it, which have become specialized centres in the region. Today, with increasing specialization and the expansion of activities, the challenge is rather the development of a regional transit system and the introduction of hierarchies in the motorway system, which will allow for the fact that different cities, towns and major exurban activity concentrations function as complementary centres in a more horizontal fashion. The sketch-planning modelling should be developed such that it is entirely based on readily and generally available statistical and survey information. No dedicated data collection is involved: most data can be freely downloaded or purchased at a low cost

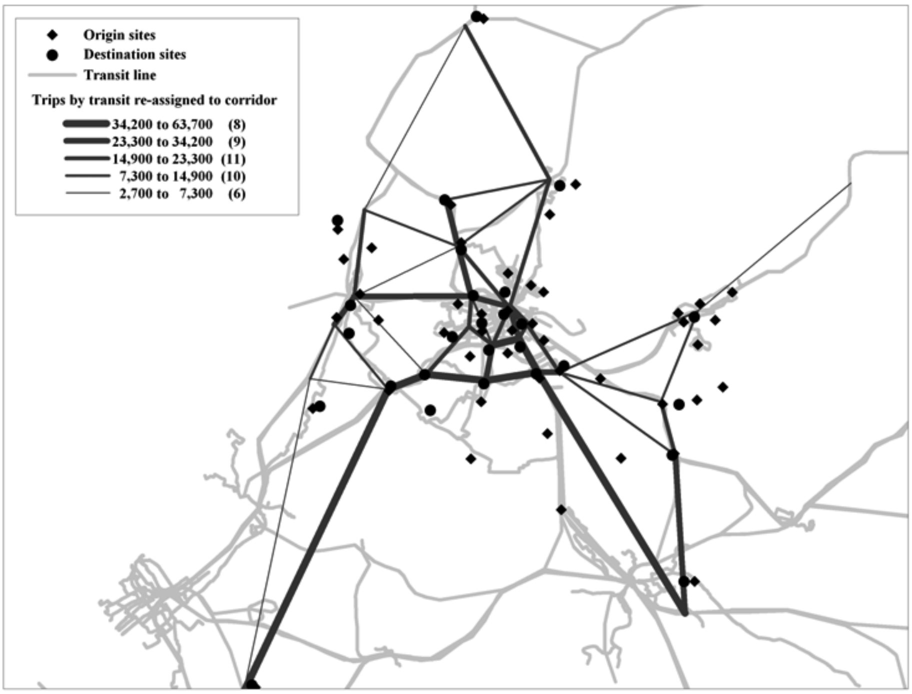

Figure 2. Transit corridor and re-assigned trips

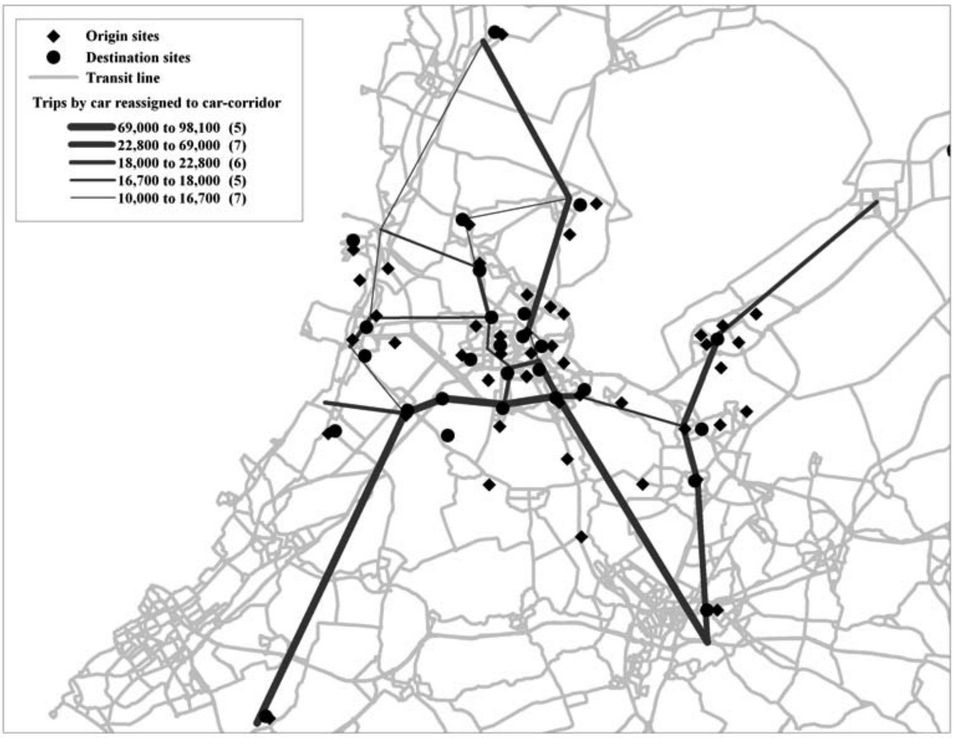

Figure 3. Car corridor and re-assigned trips

from official commercial and noncommercial sources. Major data currently available are as follows:

- Road network: four classes (e.g. motor-way), and having attributes (e.g. speed and direction);
- Transit network: four classes (bus, tram, metro and train) and including attributes (e.g. average speed);
- Bus stops and railway stations;
- Demographic: sex, age, household, income etc. at neighbourhood level;
- Employment: types, number, floor-space etc. at postcode level.

Taking home-based work trips as examples, analyses are designed and implemented including focal points (clusters of employment) based on local G measure, TAZ zones aggregation, definition of virtual network based on user participation, and trip assignment and corridor search based on the shortest path algorithm. The parameters used in the models of trip generation, trip distribution and modal split are gained from previous projects and inputs of local knowledge. The main intermediate steps are shown in figure 2 and 3. Figure 4 indicates the final classification of the corridors where Class 1 displays the corridor that is greater than average visual speed and lower than average transit share and class 2 (greater than average visual speed and greater than average transit share), class 3 (lower than average visual speed and lower than average transit share) and class 4 (lower than average visual speed and greater than average transit share).

4. Conclusions

The tested methodology is able to provide sketch-level estimate of the interaction between transportation and land use systems. However, this paper does not mean that sketch-planning modeling can replace a full-scale one, the latter should represent the long-term pursuits in this area. This paper concludes that the sketch-planning modelling can be focused on a strategic level such as that required by a regional development plan and then offer a intermediate stage and guide for the next detailed modeling in practice. The validation of modeling needs the local knowledge and experiences from professionals. In this project, the research group includes the local professionals in urban planning, transportation planning and transportation modeling respectively. The development of spatial analysis and modeling must be understood and accepted by them first. Then the results from modeling will be compared with their mental images. The divergence can be clarified during planned workshops. The planner usually remains in the sketch-planning mode until s/he completes the comparisons of possibilities or finds a strategic plan worthy of consideration at a finer level of detail.

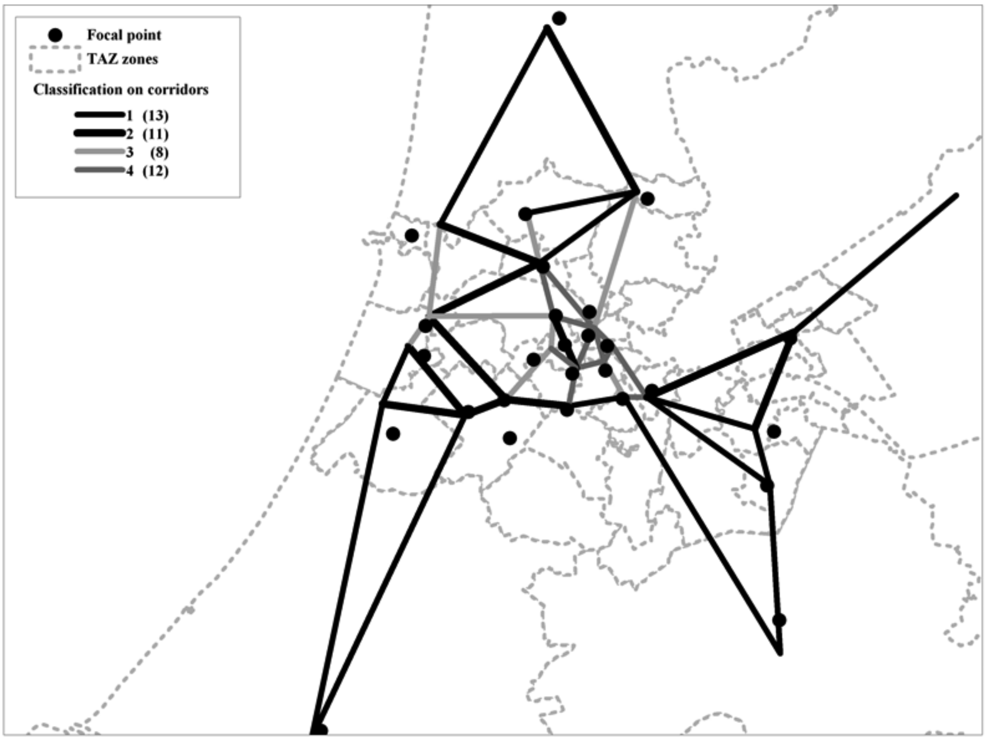

Figure 4. Classification of corridors

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Biography

Dr. Jianquan Cheng is a lecturer and has main interests in developing GIS socio-economic applications including transport. Dr. Luca Bertolini is an associate professor in urban and transport planning.