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A COMPARISON OF INTERACTION AND INTEGRATED MODELS OF LAND-USE AND TRANSPORT

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1. INTRODUCTION

It have long been understood that the urban land-use and transport have a tight interaction between each other, and that any transport or land-use specific policy will affect the other sector, though not necessarily on the same time scale. Therefore there have been a general consensus among the urban model builders that both of these sectors and their interactions are to be taken in to consideration in order to predict the changes in either of the two sectors.

Nevertheless, there have been different approaches in modelling these interactions. There appear to be two types of procedures to simulate land-use and transport changes; by linking independently developed land-use and transport models through inputs and outputs, and integrating both in a single model framework. The first part of the paper defines and compares the relative merits of the two types of integration.

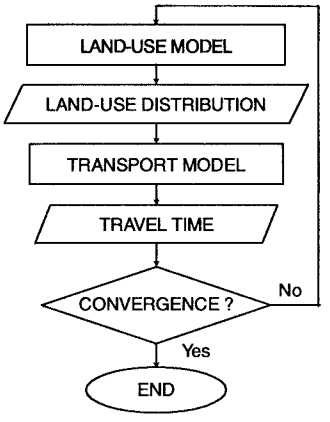
In the latter part of this paper, the development of an integrated land use, transport and environment model that is applicable to evaluate integrated sets of policy measures, is presented. The model is built based on the structure of Random Utility/Rent-Bidding Analysis (RURBAN) model. In this improvement, the choice in location and trip are modelled within a single model framework.

2. INTERACTION AND INTEGRATED MODELS OF LAND-USE AND TRANSPORT

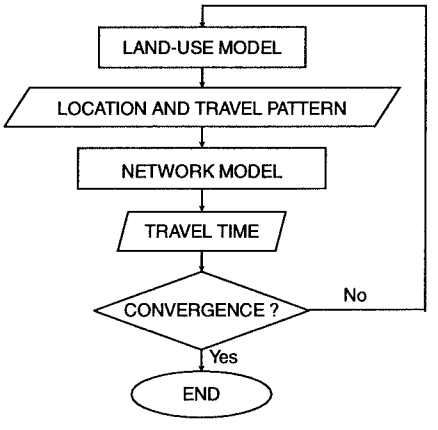
Depending on the procedure to simulate the interaction between land-use and transport, there are two types of models. Models belonging to the first type are actually composed of independent land-use and transport submodels interacted only through the outputs of each other. In this paper we call this type of models as Interaction Models. The second type models are those in which land-use and transport are organically integrated in a single model framework. We call this type of models as Integrated Models.

Basic structures of Interaction and Integrated models are shown in Figure 1. In the Interaction models, output of land-use model is used as input to the transport model and vice versa. In this structure converged travel times may or may not be consistent with the travel times used in the previous iteration to predict the land-use distribution. But the modelling structure is simpler, and sequentially interconnect the submodels making it easier to program and incorporate other submodels. It is also possible to validate or calibrate submodels independently.

Basic structure of an integrated model is shown in Figure 1(b). Travel pattern as well as the location is predicted by the land-use model and is an input variable in the network model that estimates travel times. Despite the difficulties involved in the development process, Integrated models enjoy better theoretical consistency and operationality.



a) Interaction Models



b) Integrated Models

Figure 1 : Basic Structures of Interaction and Integrated Land-Use Transport Models

Two types of models have their own merits and demerits. Some of which are stated in Table 1.

Table 1: Comparison of Interaction and Integrated Models of Land-Use and Transport

	Interaction Model	Integrated Model
Theoretical Consistency	Low	High
Model Structure	Simple	Complex
Programming	Easier	Complicated
Adaptability of Submodels	Easy	Difficult
Operationality	Low	High
Number of Iterations Needed	More	Less
Data Requirements	Less	More
Calibration Method	Easy	Difficult

3 AN INTEGRATED MODEL OF LAND-USE AND TRANSPORT

The integrated land-use, transport and environment model is developed by improving the land-use model RURBAN.

RURBAN is a land-use model developed based on the general equilibrium of the demand for land, derived from the random utility analysis, and the land supply, derived from random rent-bidding analysis, to simulate the land use in a closed metropolis by small units of land [Miyamoto et.al.(1992)].

The main part of the analysis system is an integrated land-use and transport model. In this study, RURBAN model has been improved to represent transport more explicitly. The improved model can be operated not only by directly integrating land-use and transport but also by separating them. The RURBAN improvement is being done along with the same aggregate logit model structure.

The choices in location and trip are viewed as outcome of a probabilistic choice process. The process is simply described by four levels of choice hierarchy in decision-making chain starting from location choice and destination choice in land-use level, to mode choice and route choice in transport level.

The utility function of a particular locator group is explained by four types of location conditions; "accessibilities" for different trip purposes represented by both the attractiveness of available destinations and the transport conditions explained by the nested tree structure for the transport choice, characteristics of the locating zone itself, all environmental aspects determined by the land-use and traffic conditions of the neighbouring zones, and the representative rent of the zone.

The nested tree structure for the transport choice consists of destination, mode and route hierarchy with destination being the top choice (Figure 2). Mode choice includes not only vehicular modes but other types of communication modes also. In the route choice, since each route consists of several links and some links are shared by several routes, it is necessary to aggregate trips of all routes sharing a particular link to obtain the link traffic volume. Link traffic volume together with the conditions of the link determine the service level of the link. Subsequently, this service level determine the energy consumption and pollutant emissions in relation to the transport.

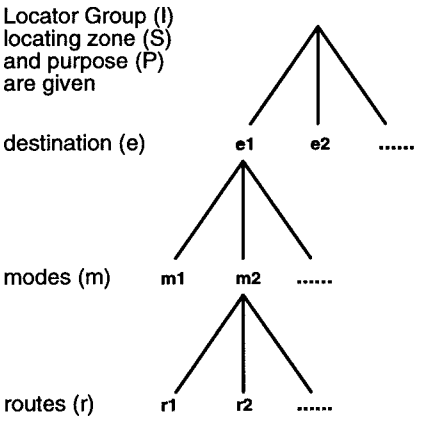


Figure 2 : Nested Tree Structure for Transport Choice in the Improved RURBAN

Also in this improvement of the RURBAN, the basic concept of the model consists of both random utility of the locator group in location choice and random rent-bidding in locator choice of the zone.

4. CONCLUDING REMARKS

Depending on the way the Interaction between land-use and transport is represented in the model, there are two types of land-use - transport models; Interaction Models and Integrated Models. There are merits and demerits of both approaches.

Development of an integrated model of land-use, transport and environment is presented. In this model transport choice steps are fully and consistently integrated within the location choice. Therefore, land-use and transport are modelled within a single model framework.