

# The Opportunities of System Dynamics in the Transport Planning

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**Abstract:** One of the tasks of transport planning is to support the development of the sustainable and operable transport system. The deficiency of the data causes a problem because of the change of exterior circumstances during the long term planning. We can supplement it by the system dynamics.

**Keywords:** *system dynamics, transport planning*

## 1. Introduction

One of the tasks of transport planning is to support the development of the sustainable and operable transport system. It is impossible to talk about production because the environment in which the system works changes continuously in sense of economic and transport politics. It is difficult to produce short or long term planes in such an environment due to the change of many external factors. In the past years or decades experts have made several models and model systems. The most often used model is the four-step model. When planning in the long term problems may arise while using the model due to lack of or not enough data. We can supplement it by the system dynamics.

## 2. The Four-step transport planning model

The Four-step transport model, and its methodology comes from the USA where in the fifties it was necessary to create a uniform planning methodology in order to make plans for the increasing transport demands of big cities. It is usually called Chicago-model originating from the name of one of its big cities.

### 2.1. Generation

The tasks of this step are to examine and to discover. The result of this step is the incoming and the outgoing traffic volume in each zone (in number of passengers and in number of vehicles). In practice this means the filling in of the sum of the origin-destination matrix rows and columns.

Several models are used in generation step:

- Trend and time line models
- System dynamics models.
- Models based on the attractivity of the zones.

Except for system dynamics model, the models in general do not contain information about the cause-effect interaction or effect each element has on each other. Furthermore they are not able to realise the aims of transport policy.

## 2.2. Mode-choice

During this step we can calculate what types of transport modes are available and to what extent while travelling:

- Aggregate models
  - Growth-factor models
  - Regression models
  - Category models
- Disaggregate models

On the one hand the advantage of an aggregate model is that it requires less data in order to complete the task. On the other hand the disaggregate model require more and sophisticated data although they make it possible to examine transport policy intervention.

## 2.3. Distribution

The aim of the traffic distribution model is to fill in “the centre” of the origin-destination matrix in other word we divide the sum of the rows and the columns.

Models used are [1]:

- Analogue models
  - Growth-factor models
- Synthetic models
  - Gravitation models
  - Probability models

## 2.4. Assignment

This is the last of the four major steps of transport planning process. During the assignment we assign traffic demands which come from the OD matrix to each element of the transport network. As a result we get the traffic volume of the nodes, links and traffic situation of the network. With the use of this data we can calculate other important parameters.

Models used are:

- All or nothing assignment
- Congested assignment
- Dynamic traffic assignment

## 3. The possibilities of the system dynamics

The models used in the four-step methodology work well in the short term while problems may arise in long term planning. The growth factor model may appear in

several steps to which we most assign a growth factor from time to time taking into consideration the actual situation and environment. This environment is none other than the effect these processes have on each other for the examination and representation of which system dynamics is a good tool. You can see the process of the interaction between car and public transport in Figure 1.

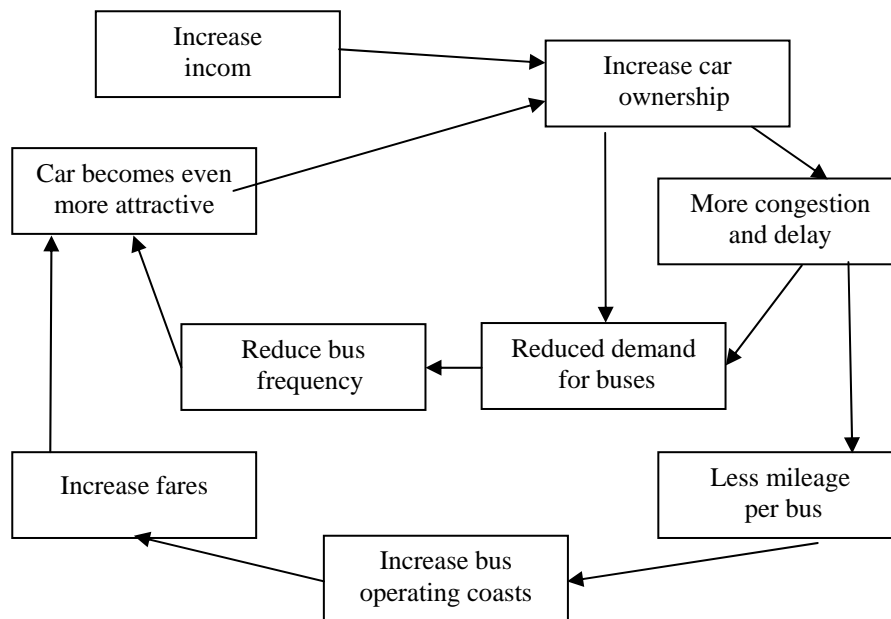


Figure 1. Interaction between car and public transport[2]

A circular process can be seen in Figure 1 which may lead to end of public transport without external intervention. Through system dynamics the process shows a positive confirmatory direction which is usually called “reinforcing loop”. The positive reaction destabilizes the system and leads to running away of the system so the system constantly increasing. This does not happen like this in reality because there are restrictive elements for example the level of motorization saturation. The advantage of the system dynamics is that it is rather simple to build this incremental information into the model that result in better models. When planning in the long term accuracy is not the accuracy in a mathematical point of view, because there are lots of distracting factors. So it shows a kind of situation close to reality.

#### 4. System dynamics and the four-step model

We can implement system dynamics possibilities in several steps. For example population, work force can easily be estimated using system dynamics models. It can have a role in mode-choice step of interaction between car and public transport described in Figure 1. The distribution step relates to the economic environment which can be portrayed easily. In the fourth step it is less useable because here we are looking for a short path.

## 5. Conclusion

Mathematical models can't solve or "reflect" the traffic problems of every day life but they are suitable in the decision making process especially in relation to traffic. Using simplified model we can reduce the necessary amount and detail of the data.

System dynamics studies problems with the help of cause and effect links. It is relatively simple to build models knowing cause and effect links. This has two advantages: on the one hand you can build a working model with even a small amount of data by which you can investigate the effect of individual ideas. On the other hand, investigation of the links of the problem helps to solve the problem. It is often problematic that the link between the cause and its effect is faded by their relative distance in time. It is typical of transportation as well that the result of a decision does not appear immediately but only months, years or decades later. The tools of system dynamics can also be used to investigate such problems by investigating links otherwise which might remain hidden due to time constraints, while building a system dynamics model.

## References

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