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OVERVIEW OF THE IMPLEMENTATION OF ACTIVITY-BASED MODELS IN CITY PLANNING

Key Words

Transportation planning; Population activity; Sustainable mobility; Disaggregate approach

Abstract

Transport system planning and modelling traffic demand in cities and / or urban areas oriented to the needs of the population are key to create and implement a safe, efficient, environmentally friendly and sustainable transport system. The trend of population growth in urban areas also carries with it an increase in the number of activities resulting in more trips made. By grouping population activities, it is possible to predict future transport demand. The classic approach to transport planning uses a four-step aggregate travel demand model. With the development of information and communication technologies, the possibilities for increasing the mobility of the population are further expanded. Due to the complexity of this problem, the classical approach does not provide the optimal solution. The new approach based on population activity allows for a more detailed and accurate representation of the habits of the population during different periods of the day and thus influences the number, type and characteristics of their travels. This paper will provide an overview of current research on predicting transport demand in urban areas, based on population activity through a disaggregated approach. The methodology, discussion of the topic, evaluation of future research on the subject matter and conclusion will also be presented.

1. INTRODUCTION

Transport planning, as part of spatial planning in cities that are urbanized centres, areas or regions, is a core activity of the transport profession and science in detecting population needs for mobility in urban areas and cities. The constant migration of residents from rural areas to urban areas and cities increases the need to build additional capacity for economic, social, health and educational activities. Increasing population and their mobility within cities and urban areas has caused a lack of free and public space and various negative effects such as increased energy consumption, increased noise levels, environmental pollution by emissions of harmful exhaust gases, etc. Four-step transport modelling is a globally acceptable process for creating mobility and flows of goods in a specific area that has been in use since the 1970s around the world. Limitations of the Traditional Four-Step Traffic Modelling Process has resulted in the need to define measures and solutions that are tailored to human lifestyles, their attitudes and thinking. Traffic modelling methodologies based on travel tours and population activities have shown improvements in the areas of transport policy implementation and solutions based on traffic demand management. A process based on population activity describes a set of processes that influence the decision-making process of a population during a trip, through the choice of destination location, travel time, mode of travel, purpose of travel, etc. Improvements can be justified through the disaggregation of the population according to certain characteristics affecting activity and mobility and a more detailed elaboration of the choice of travel and route.

2. THEORETICAL BASIS OF THE ACTIVITY-BASED MODEL CONCEPT

An approach to traffic demand modelling based on population activity began to develop during the 1970s [1]. The basis for the development of such an approach in traffic modelling is the ability of computerized data processing, simulation of traffic demand, and the availability of multiple data sets. Aggregated data relies on demographic data through traffic analysis zones (TAZ) [2]. The use of aggregated data allows a general assessment of traffic flows on a network but does not describe the behaviour of the population when traveling according to time, space and other types of constraints. The activity-based concept is based on disaggregated data in relation to the classic four-step concept of the traffic modelling process [3][4][5]. Research [6][7][8][9] has shown certain advantages of applying this approach over the classic Four-Step approach. The four-step approach shows "rigidity" and the methodology defines exactly four steps that need to be carried out in a specific sequence in order to generate relevant data [10]. The disaggregated data used in the activity-based traffic modelling process allows the assessment of the population's behaviour when planning and carrying out trips, it also identifies when certain elements of the transport system or other external elements affect its behaviour.

The structure of the concept based on population activity in traffic modeling is as follows:

- Population synthesis [11];
- Long-term definition of population decisions (location of living, car ownership, etc.);
- Mid-term definition of population decisions (job location, education location, etc.);
- Short-term definition of population decisions (daily activity, tours, distribution of trips);
- Assigning travel [12].

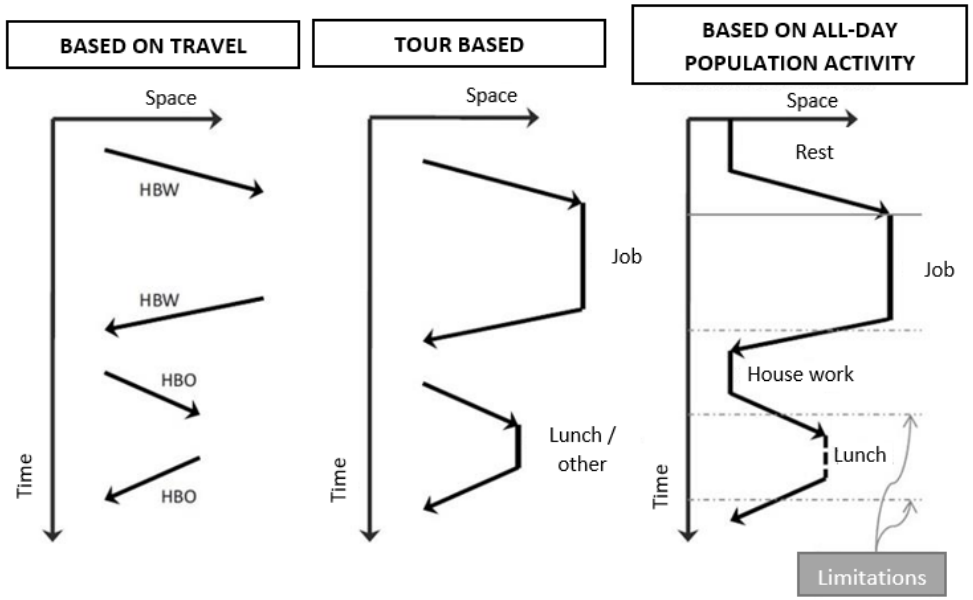

Figure 11. Comparison of individual travel, tours and day-long activities [12]

3. OVERVIEW OF CURRENT SITUATION IN TRAFFIC PLANNING AND MODELING FROM THE ASPECT OF THE ACTIVITY-BASED CONCEPT

The current situation in transport planning is based on multidisciplinary where a set of multiple professions and scientific branches are involved in the process decision making as realistic and achievable as possible. The interdisciplinary approach includes the basic scientific field: Traffic Technology and Transport and a set of several other scientific fields: psychology, natural sciences, construction, information and communication technology, etc., which aim to provide relevant facts and information with the best possible description of the real situation. The interdisciplinary structure of the activity-based approach is evident throughout the

paper [13] where behavioural segment is increasingly used as a fundamental feature of describing the population structure in the observed area and their desires and needs to define the process of selecting activities, travel times, travel modes and destinations. In addition to the classic way of collecting traffic system data through surveys and field research, mobile technologies are being increasingly used to determine travel characteristics and source-destination matrices. Defining source-destination matrices using data from mobile technologies makes it possible to streamline the collection process, reduce the resources required, and speed up the process itself. In this way the data collected can serve not only as an input parameter for traffic modelling, but also as data for calibration or evaluation of the created model. Data can also be collected using Smart Cards [14]. The required amount of data should be determined by a relevant sample for the observed area. After collecting the relevant sample and defining the catchment areas of the transport network and system, focus moves towards establishing population synthesis. Population synthesis is determined by a set of established statistical models, of which the "Annealing algorithm" shows the highest accuracy of the entire population and its characteristics [13]. Population synthesis approximately determines the population size, their spatial distribution by TAZ or households, and their characteristics by individual simulated populations. Recent research has developed several types of activity-based concepts in traffic modelling:

- FEATHERS;
- SCHEDULER;
- AMOS;
- ALBATROSS;
- TASHSA;
- ADAPTS;
- SIMTRAVEL.

Figure 12 demonstrates an example of an all-day decision-making process that follows long-term and medium-term selections. After selecting a daily activity, comes the selection of tours and travel times, followed by the choice of destination and mode of travel to the desired location. The final selection steps are the need for added trips within the defined tour and the possibility or need to stop.

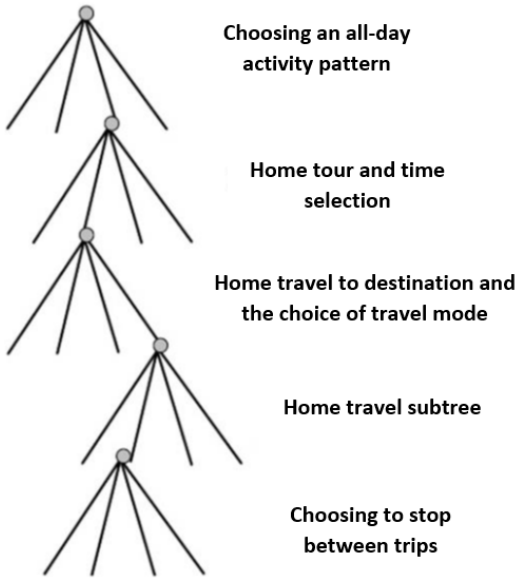

Figure 12. An example of the structure of the decision-making process of an all-day activity of an individual resident [12]

Validation is an essential part of the model development process for the practical application. The papers [15] show how and at what level it is necessary to carry out validation of the traffic demand model based on activities.

4. POSSIBILITIES OF FURTHER RESEARCH IN THE AREA OF ACTIVITY-BASED MODELING

Application in the real sector is made possible through increased availability of relevant data and the development of computer technology, allowing computer circuits to process large amounts of data and simulate large sets of variants based on certain variables. The disaggregation of population data is largely dependent on two components:

- Sample size and accuracy;
- Statistical method of sample dispersion and creation of simulated (artificial) population.

The disadvantages in researches are manifested through the insufficient description of selected sample sizes and outdated data [2]. The statistical data dispersion methods used are largely dependent on the model maker himself and the researcher who choose the statistical method independently. The variable methodology of the activity-based modeling concept in the segment of describing travel by synthesizing the population also depends on the individual researcher or

team of researchers and the area in which the research was conducted. A study showed the possibility of implementing another set of data into a concept based on population activity, but this is not sufficient to be fully accepted as a basic knowledge for processing this data. Failure to capture transit and external travel data to or from the coverage area can potentially lead to a significant error in the simulated traffic flows, thus multiplying the error when assessing the impact of different solutions or measures.

5. CONCUSION

The concept based on population activity in the process of transport modeling, as a part of overall transport planning, is a new concept based on the disaggregation of a data sample by describing the characteristics of each individual household and / or resident in an area and more accurately describing their travel habits, mobility characteristics, population flows and the flows of goods. This paper gives a brief overview of the theoretical background, the analysis of the scientific literature in the field so far, and the possibilities of further research. The possibilities for further research are evident through:

- Defining sample size and accuracy;
- The selection of statistical methods;
- The mode of population synthesis;
- Selecting a subtype of activity-based concept methodology for the defined scope;
- Method of evaluating output parameters after data simulation;
- Completely unexplored allocation of travel on the transport network after the approach is used;
- Optimal approach to the implementation of transit trips and trips whose source and destination are outside the scope of the research.

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