DAY-TO-DAY APPROACH FOR PATH CHOICE MODELS IN THE TRANSIT SYSTEM: ANALYTICAL EVALUATIONS AND SIMULATION RESULTS

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1 INTRODUCTION

Over the last few years the introduction of models of dynamic process in the analysis of the assignment to public transport has become more and more important because it allows the explicit simulation of the evolution of the system in time and the evaluation of the link flows and of the networks as regards time and service levels. However, the most common method used in the assignment of the demand to private and public transport networks is based on models of equilibrium of the users. In these models a particular state is looked for, where the costs of transportation cause some flows, which, in their turn, determine the costs of departure (that is a fixed-point state). Thus, the explicit representation of some characteristics of day-to-day dynamics, such as the users’ memory and the mechanisms of learning and forecasting, is avoided. This method leads to a reasonable mathematic formulation of the problem, which can be solved through the operating tools applied to the networks of real dimension (Sheffi, 1985 and Cascetta, 1998).

Yet, it should be pointed out that the transient caused by variations in the demand and/or in the supply cannot be simulated through equilibrium models, and statistic descriptions of the state of the system concerning mean, fashion, moments and, in general, frequency distribution in time, cannot be obtained. Actually, this fact implies that the control strategies (such as adaptive traffic lights, variable information messages, etc.), the information systems for the public, which are strictly tied to variations of the demand and/or the supply, cannot be simulated through an equilibrium approach.

A generalization of the equilibrium paradigm can be found in the day-to-day dynamic approach. This term indicates a simulation of the evolution in time of the state of the transport system; moreover, the term “day-to-day dynamics” is used in order to stress how the state of the system can change day after day according to the different choices of the users (choices which, actually, are not static).

Among the most important advantages of the day-to-day approach there is the possibility to simulate some significant aspects such as the transient (elaboration of the model of the evolution through which the system reaches a certain state), time fluctuations, the
multidimensional dynamics with different behaviours of “reply” on the various choice dimensions (such as the travel frequencies and the distribution, the way and the choice of the path) caused by variations in the state of the transport system (i.e. the location of the activities). Moreover, the day-to-day models can be considered as an instrument for the analysis of the theoretical properties of the system as regards the convergence towards different attractors (not necessarily of equilibrium or fixed-point), for the analysis of the existence, singleness and stability of the final state towards which the system tends.

Two types of dynamic models can be formulated. The models of deterministic process, based on the theory of the nonlinear dynamic systems, can be used to analyze the asymptotic behaviour of the system. Moreover, they can be used to study the properties of the equilibrium state, because this state can be considered as a fixed-point attractor of a deterministic process according to some hypotheses about the users’ learning mechanisms and the threshold behaviour (the possibility that the individual changes his own choice according to variations in the system or, in general, in the background conditions defining his behaviour). The models of stochastic process, based on the theory of the stochastic processes, allow an explicit simulation of the intrinsic randomness both of the demand and the supply.

Today, it is fundamental to make use of more or less sophisticated instruments in the planning of a transport system, in order to give concrete answers to application problems. It is necessary to investigate in this direction in order to find new instruments, such as those of the dynamic analysis, and to answer in an effective way to the problems characterizing, above all, modern urban contexts.

Today, the analysis of the high-frequency public transport systems demands a greater attention to the phenomenon of traffic congestion determining the movement of the public transport vehicles in promiscuous lines, with significant irregularities in the service and a lower capacity to meet the needs of the users interested in the service and of the whole community, which suffers the negative effects of a wrong transportation policy.

Therefore, it emerges the necessity of a direct interaction between transportation companies, transportation planner, users and community, in terms of exchange of information, which will be necessary to prevent or correct the possible faulty operation of the transport system.

That is why it is important to study the day-to-day dynamics of the public transport system, that is the variations occurring, day after day, on the flows and on the network performances because of variations of the demand and/or the supply, in order to allow the analyst-planner to give more significant answers. Figure 1 points out the importance of a dynamic analysis; given a public transport service, offered by a company; found the irregularities of the service caused by traffic congestion; considered the congestion caused by the users of the service, the use of a dynamic model of process allows to evaluate, day after day, the flows and the possible critical elements, offering good keys to the improvement of the quality of the service.
2 METHODOLOGY

The aim of this paper is to evaluate link flows and networks performances, such as travel times and levels of service, in day-to-day dynamics. In this paper the formulation of the modal split model is recalled (Nuzzolo e Russo 1997, 2000), stressing the dependency of within-day and day-to-day dynamics of the transit service. The modal split is influenced by the day-to-day learning components, like in the private transportation systems (Cantarella e Cascetta 1995, Cantarella e Velonà 2001). Once identified some components subject to day-to-day modification (Russo 2001), some examples of system dynamics according to different supply evolution typologies are introduced. An analysis of the weight of the control parameters in the dynamic process is developed, considering the stability system conditions.

A simultaneous path choice model is considered, taking into account the dependence of some attributes, present in the function of systematic utility, from the congestion caused by the flow of the users of the service and from the congestion caused by the promiscuous lines where the public transport vehicles move.

3 CONCLUSIONS

Even if the results refer to a simple case, they are interesting and support the idea to extend the analysis to real networks in the subsequent works.
REFERENCES


