Universidade do Minho
Escola de Engenharia

Semana da Escola de Engenharia
October 24 - 27, 2011

A SIMULATION APPROACH TO SUPPORT THE DESIGN OF FLEXIBLE PUBLIC TRANSPORT SYSTEM

Ana Dias, José Telhada and Maria do Sameiro Carvalho
Department of Production and Systems
E-mail: anadias@dps.uminho.pt

EXTENDED ABSTRACT

The provision of traditional public transport services in rural areas have shown to be very inefficient and ineffective. In fact, rural areas are typically characterized by low levels population density leading to complex demand patterns (demand is low and spread over a large area) which leads to low levels of service of conventional transport services (low frequency, old vehicles, etc). Demand Responsive Transport systems have been seen as an interesting alternative solution already adopted in several countries.

A DRT system can receive trip requests either for an immediate service or as an advanced reservation. Trip requests are made by telephone or internet, stored in a database system. A travel dispatch centre (TDC) coordinates a heterogeneous fleet of vehicles. It should have the capacity to organize routes and schedules to accommodate trip requests, aiming to respond in real time to user's mobility needs. Its implementation typically involves the use of information and communication technologies as shown in Figure 1.

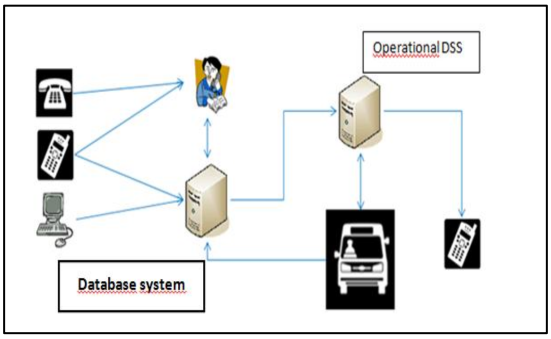

Figure 1. Elements of a demand responsive transport system.

DRT success depends on the use of intelligence solutions to process trip requests, to optimize routes and schedules in order to respond in real time to users. Additional issues are related to system sustainability (economic, financial and environmental), and to the legal framework of the real context

According to the literature review, there is a lack of comprehensive methodologies to address the problem of designing and planning DRT systems.

The objective of this research project is to develop an integrated decision support system (DSS) to help decision makers developing intelligent strategic solutions at the design phase. The main objective of the DSS is to configure a DRT system that incorporates a high level of flexibility and that responds in real-time to users demand taking into account the real context: socio-economic, demographic, legal, etc.

The DSS incorporating mathematical models (optimization, simulation and statistical methods) and integrating important characteristics of real context, will provide an effective support in the decision making process.

A data warehouse for the DSS system is used to assemble, organize and link all the relevant data: transportation network, trip requests, user's data, available resources, network, scheduling plans, etc.

The information system will be able to combine data with analytical tools to provide insight on system's performance and can also be used as an operational tool.

The DRT simulator, based on information of the real area network such as demand patterns and the road network, generates trip requests and produces routes and schedules that will allow to simulate different alternatives in order to assess, in advance, wide-ranging scenarios or management strategies. The production of routes and schedules follow some pre-defined objectives established by the user such as: distance minimization, minimization of the number of vehicles; minimum user delay; minimum time, minimum costs (a generalized distance/time cost function or multi-objective function can also be used), etc. Constrains associated with physical resources availability and system operating parameters must be also set to configure the operational context. Additionally, associated to the production of each solution, several performance indicators are produced to allow decision maker to assess solution's quality.

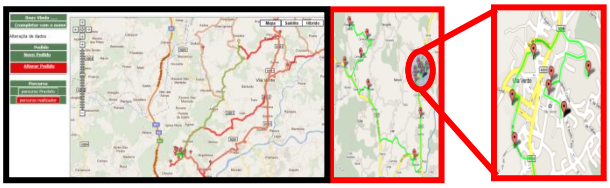

Figure 2. Example of output of the DSS.

Both advanced booking and on-line trip request are accepted and, therefore, a highly dynamic routing and scheduling approach is highly desirable.

Specificities of DRT systems must also be taken into account: spatial aspects of public transport such as the characteristics of the local population, transport network, the patterns of commuters, and the framework within which the system works, determine the demand and operational scale of system and, as such, can affect performance and efficiency.

The analytical tool to be used depends on the typology of the problem to address and the time available to calculate the solution (e.g. can range from an exact dynamic programming method to alternative heuristic procedures).

The software application has the ability to choose the best method(s), allowing planning effectiveness and efficiency.

Scenarios that can be performed may include: spots of population concentration within counties; different routes and stops in a particular area; DRT system integration with regular transport service; flexibility of services as a function of economic efficiency, costs effectiveness and resources availability (fleet size).

The performance evaluation module is intended to be as much comprehensive as possible, including a wide set of dimensions: social, economic and environmental. Based on the literature on transport performance systems, there are a large number of measures that can be grouped in four categories: preservation of assets; mobility and accessibility; operations and maintenance and safety.

The result of the assessment process will provide guidelines and the required feedback to adjust system resources and operating parameters.

Performance measurement is essential to monitor progress toward a result or goal.

In summary, prior to the implementation of a DRT system there are a lot of issues that must be properly addressed at the design and planning phases of its project. Many DRT projects has been implement world-wide without taken adequate care of such issues, and therefore some related failures have been reported (that have led to system re-engineering or even project withdrawal). In addition, there is currently a lack of comprehensive methodologies to address the problem of designing and planning such systems.

In this research, an attempt is made to develop a framework that will provide an integrated decision support system to enable decision makers to perform systematic analysis leading to intelligent strategic solutions. The proposed approach includes a realistic micro-simulator of alternative transportation scenarios and functional parameterization (*e.g.* flexibility and operating rules) allowing planners to estimate accurately the correspondent performance indicators. Additionally, there is an evaluation module to incorporate sustainability of alternative transportation systems, including financial and economic viability and sustainability.