# Demand Responsive Transports in the Mobilities and Technologies Evolution. Context, concrete Experience and Perspectives

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**Abstract**. We present a research about Demand Responsive Transport (DRT) in a context of demand evolution, mobility increasing, and new information technologies development. A specific application we set in Besançon (France) with private carrier is described. This paper also opens onto future transport services and potential collaborations with other countries within enlarged Europe. Would we be able to identify and to build an adaptative and coherent DRT relating to a pan-european transport and mobility system ?

## 1. The new multifaced mobilities

The development of mobilities this last decade has been modified according to the social, economic and cultural evolutions. It can be verified for the goods exchanges and also for passengers mobility (Wiel, 1997). These last 30 years, distances covering and average speeds of daily trips doubled in France (Allemand, 2001). This evolution produces different effects.

At first, mobility is more extended over the time. A survey organised in 40 European cities for 6 different countries, reveals a stability of on peak hours and a decrease of the off peak (Sesame, 1999). The following diagram shows globally for the night peak the most numerous trips in all the studied cities (on average 8.2 % of trips between 04 PM to 07 PM). At the opposite, the morning peak is the least important with 6.4 % of the total trips for the period 07 AM to 10 AM. Moreover, 6.5 % of the trips are provided during the off peak hours of the day. Thus, the morning peak is no more a peak (Bailly, 2001). This situation can be verified in all the studied cities, excepted in Barcelona and the French cities. A lot of factors can explain this phenomenon:

·the working time: in Germany people finishes to work earlier than in Barcelona
·the part time job influences the mobility particularly in the Netherlands
·the amplitude of opening times of services like shops or schools is larger.

All these factors disturb the rhythm of urban time and contribute to redistribute the daily mobility.

Secondly, mobility is more extended over the space. A recent research study around 11 world regions shows that person spends 1.1 hour per day for travelling (Shaffer, Victor, 2000). Zahavi has already demonstrated in 1981 that travellers behaviour was largely determined by 2 fundamental constraints: fixed budget of time and money devoted to travel. Thus, the covering distances increases according to the speed and urban sprawl growth according to the trips length (Camagni, 2001). In France, the reduction of working time provides a larger time budget. So the distances between home to work can be grown as well and this phenomenon contributes to suburbanisation.

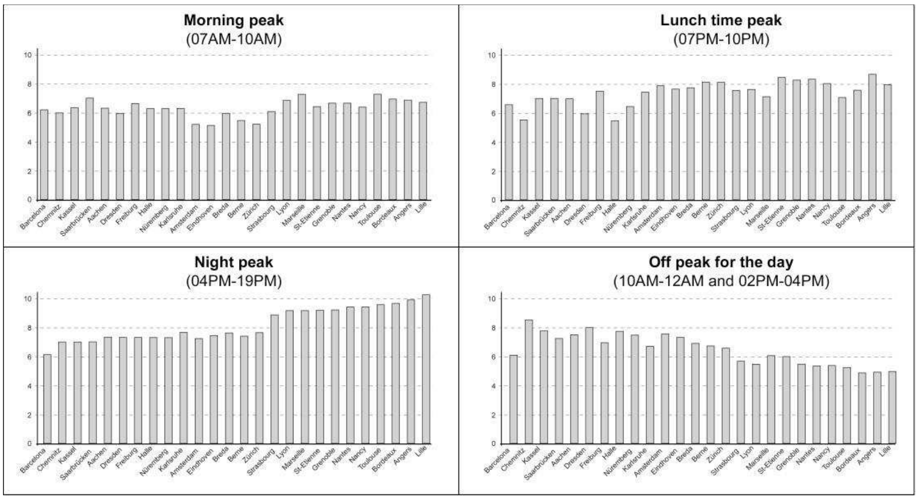



**Figure 1 - Trips distribution (in percentage of trip during the day)**

Thirdly, mobility is closer to life rythmes and must be adapted. Customers want to be able to go everywhere, at any time, from any point, with the mode they would choose. As they use their cellphone, they want to use their transport service... Indeed, mobility is much more complex, according to the leisure time of individuals. A mobility survey reveals a real change of trips behaviour. For instance, in French cities, trips for working decrease whereas trips for shopping or leisure activities increase (from 45 to 52 % of trips between 1981 to 1994). Some researches show that multiplicity of the motives plays an important role on the complexity of travel chain during the day or the week (Wiel, 1997).

These mobility effects have generated a new demand of transport. This new market niche requires a continuous service (24/24 hours, 7/7 days for the 365 days of the year), with a real time management and a lot of comfort. These requirements, satisfied by the car, constitute a real challenge for the public transportation operators (Bailly, Hurgon, 2001). Other solutions have to be proposed in order to offer a sustainable mobility.

## 2. From a deadlocked public transport to fit-to-use demand responsive services ?

Actually, it seems that only clearly identified customers flows are satisfied by the public transport. The transport supply involves mainly traffics between centers and peripheries. Thus, many flows in suburban or peripheral areas are neglected. Often whereas means are available, the service is more constraining for users. Technical issues can be provided, especially within the expansion of Information and Communication Technology (ICT) related to Intelligent Transport Systems (ITS) (Bergougnoux, 2000, Ygnace, De Banville, 1999). Two ways of improvement may be foreseen : or integrating high technology in public transportation, either developing new services, such as Demand Responsive Transport (DRT).

How ICT can make more performant and attractive public transport ? Maria Alafayate, member of the European Commission Transport Task Force proposes a typology in six classes of the ICT in transportation :

- embarked systems for navigation,
- traffic flows management,
- information boards for drivers (Variable Message Signs),
- location and fleet management by GPS,
- traffic controls strategy and planning,
- automatic tolls and intelligent payment.

Some of these technologies can be used by public transport directly, that is to say to improve the security, to communicate information with the travellers or even to manage the delays.

Interactive tools are available on Internet and make it possible the users to lay out information relating to the accessibility provided by the urban transport. ICT bring major improvements to the transport via a better accessibility. This can be highlighted through several experiences.

Buses fleet management by GPS makes it possible to follow and correct the shifts of schedules and to divert the vehicles following a barring event on the road network. This is a direct consequence on vehicle design and working. Other experiences concern intermodality: for example, the European Connex firm offers services for paths calculation, combined tariffing or automatic ticketing. There can be also indirect effects of ICT. In Paris, the RATP (Transport Company of Paris) provides a service to private firms for assessing accessibility and helping decision making for future implantation.

As we can see, ICT takes the form of many technologies, even in the well defined transport field. However, if new technologies (dynamical location systems, communication systems between clients and servers through mobiles, routing or paths finding softwares based on GIS and spatial databases...) make more effective the urban transport, they do not revolutionise it. In our opinion, it is necessary to develop new transportation services, much more related to the mobility demand of customers and population. These new systems may be the Demand Responsive Transports.

## 3. What is a Demand Responsive Transport ?

In this pregnant context of increasing flows and immediate transportation demand from clients, the market supply has to adapt. How to share the transport in order to make its cost acceptable by customers and carriers ? How to calculate the final price to make it attractive and profitable ? How to make more efficient public transport in terms of quality and times constraints ? How to improve the number of transported people (per kilometer) in each vehicle all journey long ?

Demand responsive buses or vans are a transportation concept at the interface between taxis and public transports (GART-PREDIT, 1997). It's an alternative way to respond to each singular client closely to its needs and to ensure the mobility of lots of people in a defined territory. The design of such services may be very various on spatial, temporal, social or technical aspects (Banos, Josselin, 1999, 2000).

First, the transport can serve a central point, join two flows generators, or spread on a large network, in town or in rural areas (Ambrosino et al., 1997). It can include lots of stops, mandatory or served when needed. The used system can create virtual lines at each stored demands for a specific area or for a given time meanwhile.

Secondly, numerous systems exist according to different time constraints. The time can be fixed for each stop but not the course, the reservation may be made just in time or a lot of time before the service. The clients picks up or drops times can be unchangeable, accurate or not. So can be the constraints on time very wide and highly influence the customer perception and the service usefulness.

Thirdly, the social conception of the service is very important. Its maintenance can be ensured by small associations or local groups, as much as large private companies in charged of urban transportation and related to political agencies. Also the market niche can be rather different. We may also mention that the country conception of transportation and spatial accessibility are very heavy criteria in planning decision-makers choices.

An ultimate level involves technology integration in the system (Engels, SAMPO, 1997): does it require new information and communication technologies ? Does it necessitate locational or spatial optimisation softwares ? Does it use interactive markers for numeric reservation ?

Anyway, independently of this multitude of alternatives, we can define a Demand Responsive Transport as a collective transport of clients activated at the time of a demand located in space and time.

If we set a short state of art of these kinds of transport, we may define two main opposite points of view about it, depending on whether the service is economically profitable and located on population high density quarters, or designed for serving the most numerous customers in the whole territory (Lebreton et al., 2000).

The first example is the Shuttle, a very efficient Demand Responsive Transport serving airports in (rather) big american towns. This service is quite expensive, very profitable, because the price is generally calculated from the covered distance. It often uses high technologies such as GPS and embarked location system with a simple but sufficient GIS.

The second exemple is the one we can find in Africa, called "bush taxis". No technology, and a price quite low, processed by different local and contextual rules... This system is also very efficient, if we compare the number of customers and the price of its activation, and the served territory is very large.

In Europe, and especially in France, our position is intermediate. We intend to develop profitable transport responding to the mobility evolution. We incorporate technology in our systems, keeping in mind the wish to serve a large territory and an important population, sometimes located in low density areas (THERMIE, 1994). This is a real challenge, because the more expended is the territory, the less profitable will be the service.

Different experiences have been leaded in Europe about DRT. They are very various, and some of them are very efficient. We present one we worked on in the town of Besançon (North-East of France).

## 4. Evolis: an experience of Demand Responsive Transport

The THEMA laboratory, in relation with a private carrier (Compagnie des Transport de Besançon, belonging to the French national carrier Kéolis) within the French Research Program on Transportation PREDIT, has provided a DRT in the town of Besançon.

This applied research followed a three stages process:

- a feasibility study (What will be the effective demand ? Where will it be located ? How could be the consequent flows ? What is the profile of the user ? What is the profile of the service ?),
- a local and time limited implementation for evaluation, where the service worked without any advertising, only by relationship between clients,
- the final service, including dedicated softwares and designed to the real needs of the population.

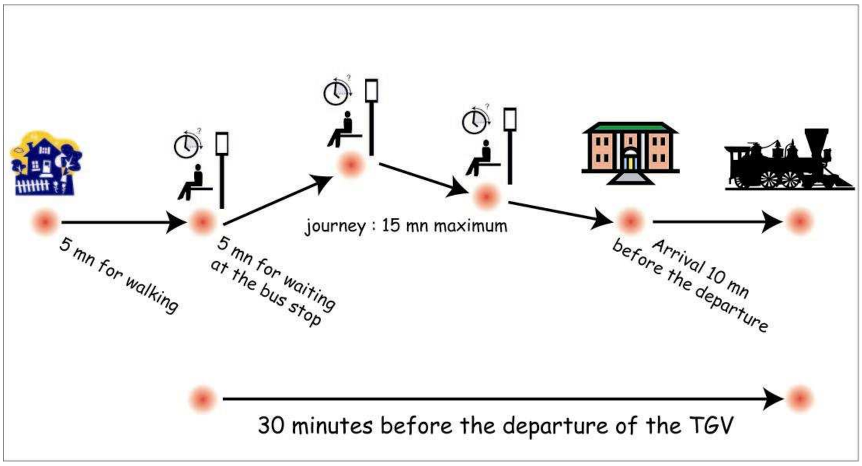
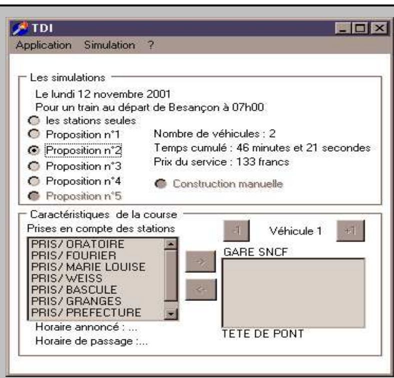



**Figure 2 - The travel chain organisation of an Evolis service**

The objective for Evolis DRT is to serve the total population in Besançon in providing an efficient and cheap access to the early high speed trains (TGV) at the trains station. We ensure that customers surely get their train and that it takes no more time than half an hour for each trip. According to the private firm and the customers wishes, we defined the travel chain as showed in figure 2.

Another goal is to optimise the routes so that the maximum of people is moved in the same vehicle. For doing this, we implemented a software (©ReSAD2) whose role is to bring together the customers for each round, depending on the vehicles availability and capacity. For each day and each train, the carrier gets a route map which indicates the customers locations, the services times and the routes associated to vehicles. This is summarised in figure 3.

1.The booking of services is saved in several files according to the date and the timetable.
2. From these files, the interface calculates automatically a maximum of 5 solutions according to parameters defined before by the user
3. Then the solution can be analysed with the following graphic interface. The trip cost and the itinerary help the analyst to determine the best solution.



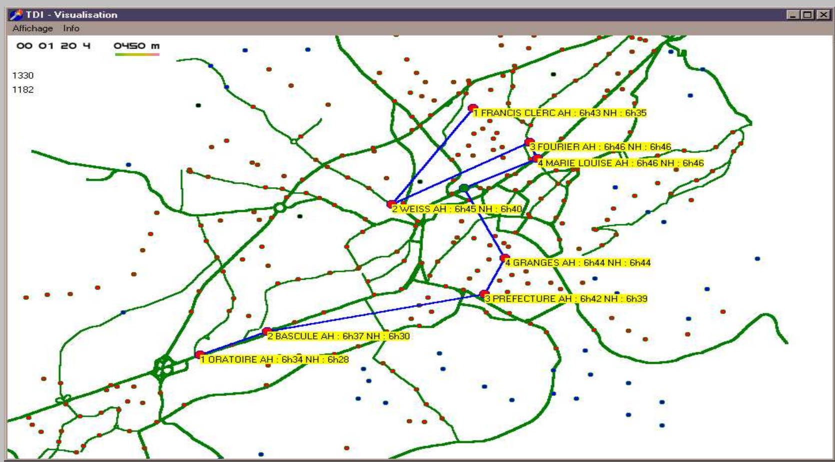




**Figure 3 - The 3 steps for generating an Evolis service**

## Conclusion and perspectives

Finally, the originality of the Demand Responsive Transport Evolis:

- it is a user-designed service, based on an important feasibility study and the concrete knowledge of the associated carrier,
- even if a topological GIS is required for paths and matrices calculations, the system is very quick and very efficient and necessitated new spatial optimisation heuristics and tools,
- it is potentially extendable to any central point(s) serving in an intermodal context. This will be the case around the town of Besançon in 2002.

Since October 2000, Evolis is working. Actually, about 2000 trips have been provided. This is the result of a three years applied research program. But, some modifications may be provided to improve the economical and social purposes. They are related to quite consequent questions:

- how to deeper integrate the Information and Communication Technologies in this kind of services, despite restrictive customers needs (for Evolis : they need to be certain they get their train) ?
- which kinds of new pricing may we implement in order to make more flexible and attractive the service, in a reliable economical yield ?
- do we need a more territorial approach of the supply (by predefined potential areas, for example) ?
- are we able to exceed a simple vehicle management to look forward new systems where vehicles would be endowed with new intelligent capabilities (for example, to predict a potential demand) ?
- are all these technological and market supply evolutions coherent with the customer habits and practices in Europe and in countries ?

If we just conclude on perspectives, let's say that a comparison between local demands or DRT in different countries would be welcome. How can we assess the demand and the mobility in several sites ? What may be the differences and the shared aspects of the transport demand ? Which tools, especially ICT, may be used and developed ? What is the degree of acceptability for these new technologies in a social context of public transport ? Is there a european model for Demand Responsive Transport ?

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