# Flexible public transport in low density urban areas

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*Abstract:* A public transport system is of crucial importance to ensure an equitable and more sustainable mobility to all citizens of a region, since it allows the possibility to travel long distances instead of the use of private cars. However, conventional public transport systems have a rigid framework with routes where specific locations are predefined in order to have a regular service that serves as much population as possible. Well designed regular bus services are usually economically viable, but in low density areas the demand is not sufficient to ensure viability and the same service of central urban areas. Thus, it is necessary to introduce some flexibility in public transport service, to allow coverage of the entire population, without destroying the viability of the bus operator of low density areas. This approach is now being applied in a case study in low density areas of the municipality of Braga, where the bus service is poor and inadequate to ensure the mobility needs of its population. In this study, the implementation of a flexible public transport is preliminarily analysed, as a possible solution to this problem.

*Key-Words: Flexible transport, Demand Responsive Transit, Municipality of Braga, Bus transport*

## 1 Introduction

Public transport services can be considered sustainable mobility solutions when compared with private vehicles, since they are more efficient in terms of energy and space required to transport the same amount of people, while contributing to a more social equity among all citizens and to a reduction of noise and air pollution, mainly in high density urban areas.

Mobility management is of great complexity, especially in terms of interactions between different modes of transport, such as the public transports, which in a local (municipality) level are restricted to bus services.

In recent years, municipalities have made a strong investment on improving traffic infrastructure to promote good levels of accessibility and mobility in its territory, namely on roads and with the creation of public transportation services covering all resident population, such as public bus service.

However, low density and sprawled areas, mainly located in the outskirts of the municipalities or some urban areas, are characterized by a low bus demand, thus have a worse bus service than high density areas where this service is economically attractive and viable. In order to improve the service of the public transport in low density areas, the adoption of flexible transport services, as is already being used across many areas of European and North American municipalities, seems to be a suitable solution for the needs of those areas, namely by the implementation of the Demand Responsive Transport – DRT. In this paper, some examples of this solution will be presented, as well as a preliminary study of an application of DRT to the municipality of Braga, located in northern Portugal.

## 2 Flexible public transports (bus service)

Flexible transportation is characterized by providing a service that is not limited to traditional fixed routes and schedules. This is an alternative to the conventional regular bus system in areas of scarce demand, with an average quality of the service that fits well with the needs of local populations.

Unlike the regular public transport, which is carried out according to a pre-defined service, the Flexible Public Transport (FPT) is a concept that includes all public transportation services with flexible features that are partly, or fully, carried out by explicit requests from the users, which may include the use of technologies of information and communication [1].

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FTP can play an important role on mobility, especially with benefits for users (passengers) and bus operators, and the following objectives should be accomplished [1]:

- Provide a transport service in isolated and disperse rural areas;
- Ensure a shuttle in peri-urban areas, where population density does not justify the implementation of a regular service of public transport, complementing the existing bus network and setting the connection to regular public transport network;
- Satisfy the specific needs of the aging population and students in urban areas;
- Ensure the access to public equipments or other specific areas that do not generate the necessary demand to justify a regular bus service;
- Ensure the mobility for disabled people, which need a specifically suited proximity service;
- Respond to specific needs on evenings with a service that ensures connection between interfaces and homes;
- Increase bus supply and options for users;
- Enhance the use of public transport;
- Promote good practices and contribute to the improvement of environmental conditions and quality of life.

According to Transport Planning and Technology, flexible transport services should also provide the following benefits [2]:

- increase the potential protection of public transportation;
- integrate regular current fixed routes with FPT systems to get more holistic solutions in transportation;
- complement the existing transport through the increase of the additional capacity of the service;
- make public transport more attractive to all users in order to reduce car usage and its associated issues.

# 3 Types of the FPT services integrated in regular networks

There are several flexible public transport solutions, such as DRT, collective taxi, car-pooling and car-sharing, each of them with distinct characteristics, thus allowing to be adopted and adapted, according to the territory requirements set by the bus operators, users or the existing population. In this paper it will only be described and used as reference a type of FPT known as Demand Responsive Transport – DRT, which was previously assumed to be the most suitable service to be implemented in a low density area (case study) of the municipality of Braga.

Flexible transport services can be considered as part of the global public transport network as an interchange service, a network, a destination specific and/or as a substitute to conventional bus services [3].

The interchange solution of DRT is a public transport service with an existing fixed route where dwellings are scattered or when demand for traditional public transportation is scarce. It may be seen as an efficient way to increase penetration of the public transport system and to increase its use. Flexible transport services should operate at high frequencies, with integrated timetables, as well as with ensured connections in both directions. Driver training is of high importance to the success of this solution, as well as the interior of the vehicle that must have comfort and safety requirements for this specific use.

Flexible transport services as a network are used to extend the fixed route public transport or to replace it at certain parts of the regular network or periods of the days, when the volume of passengers in conventional bus services is low. Thus, the costs of the regular bus service will be high and unprofitable to the operator. Connections between the FPT and the regular bus service must be reliable mainly on arrivals and departures, as well as the specification of a formal interchange point between the two services, in order to promote confidence on the users of this service.

The destination-specific flexible service transport journeys are used when referring to a specific destination, such as a shopping center, instead of extending it to the fixed route of public transportation.

The substitute FPT service replaces the system of regular fixed routes, or part of it, and for that it has been called the "reinvention" of public transport. This can be considered a very flexible solution since it allows the development of a complete independent system that covers and serves a certain area.

# 4 Examples of projects of FPT solutions in Europe

## 4.1 The Agency for Flexible Mobility Services (FAMS)

Between April and October 2003, the Agency for Flexible Mobility Services (FAMS) has implemented two pilot projects, one in the region of

Florence, including its metropolitan area and the surrounding area of the city of Fiorentina Piana and another in the region of Angus, Scotland.

A DRT service named PersonalBus was introduced in 1997 in the city of Campi Bisenzio, located northwest of Florence, which covers an area of 28.62 km2 with 36000 inhabitants. This service covers the entire area of Campi Bisenzio with a network of 171 passenger collection points. Campi was the first European city with complete coverage of an on-demand bus service, from Monday to Saturday between 6:30 and 20:00.

The planning model was divided in two main components: physical infrastructures and an information system. In 2003, a new version of PersonalBus incorporated the development of a new webpage, which included all the necessary services related with operations of booking management and information to and feedback from users on how to use the service and travel. In particular, this included [4]:

- booking services oriented to specific categories of users (associations, groups, etc.).
- web services with storage capacity for personalized information (previous booking reservations, planned trips...).
- feedback services with booking confirmation and the possibility of requiring services from multiple booking methods (email, SMS, telephone).

FAMS has experienced significant improvements on the service in order to improve the accessibility for all users, with benefits for both users and service operators, resulting on the increase of its potential demand, as can be seen in Table 1, for the case study of Campi Bisenzio.

Table 1: Improvement in the area of Campi Bisenzio DRT service in accessibility to the service

| **Booking method** | **Before FAMS** | **After FAMS** |
|---|---|---|
| Telephone | 30 | 60 |
| Internet | - | 300 |
| Total | 30 | 360 |

In Table 2 some performance indicators are shown, such as the travelled kilometers, number of passengers, terms of booking, web booking and percentage of missed calls of the DRT service in Campi Bisenzio, from 1997 to 2003, i.e. from 1997 until the first year of FAMS. In general, the results show an increase on the usage of this service while the response capability has decreased. After the introduction of the FAMS improvements, it appears that the number of missing calls started to decrease, but further data is necessary to consolidate this conclusion.

Table 2: Demand evolution of DRT in Campi Bisenzio from 1997-2003

| Year | Km | Passengers | Terms of booking | Service users FAMS web | Percentage of missed calls |
|---|---|---|---|---|---|
| 1996 | 50728 | 7889 | - | - | - |
| 1997 | 70789 | 29573 | Telephone | - | 10,0 |
| 1998 | 120576 | 69565 | Telephone | - | 19,4 |
| 1999 | 229778 | 94547 | Telephone | - | 27,9 |
| 2000 | 286869 | 108062 | Telephone | - | 32,5 |
| 2001 | 321883 | 116305 | Telephone | - | 33,3 |
| 2002 | 310099 | 116544 | Telephone | - | 35,2 |
| 2003 | 321569 | 117058 | Telephone /Web | 26 | 33,1 |

## 4.2. The FLIPPER project in urban and rural European areas

Flexible transport service (FTS) platform and Information and Communication Technology (ICT) for Eco-Mobility in urban and rural areas of Europe, known as FLIPPER, is a project of the European Territorial Cooperation Programme funded under the EU Interreg IVC.

The principal goal of FLIPPER is the transfer of knowledge, experience and best practices on flexible transport services between different European regions in order to increase social inclusion of disadvantaged groups of citizens or areas, reducing energy consumption and environmental impacts, encouraging growth and social/ economic development. There is a consortium composed of 11 partners of nine European regions that represent different transport/ mobility environments. This provides an ideal backdrop for the exchange of experiences and good practices in accessibility mobility, environmentally friendly transport services and for the reduction of social exclusion of vulnerable groups of citizens. In this sense, flexible services aim to achieve some key targets: an increased mobility and new journeys; a reduction in the use and necessity of private vehicle; the provision of a local operator for conventional transport; a cost-effective mobility both for workers and for the unemployed.

In Figure 1 is presented the level of satisfaction obtained in the different European cities where pilot projects of FTS were implemented, where it is

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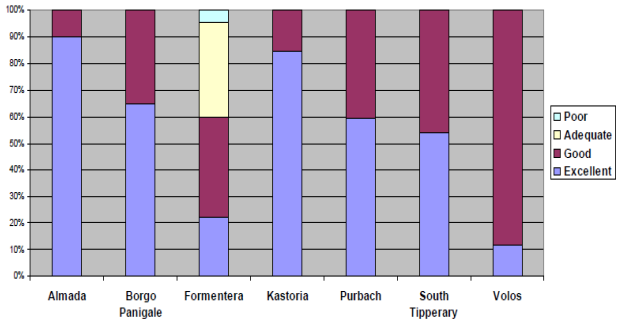
possible to conclude that most of users across these case-studies were satisfied with this service.

Fig.1 - Overall satisfaction with FTS in pilot sites through user surveys [5]




As can be seen in Fig. 1, the worst satisfaction results were verified in Formentera, mainly due to the maintenance of a fixed route, before and after the FLIPPER Project, for a Taxibus. In this case, FTS users need to previously make travel bookings, while in the past there was a fixed timetable. In addition, the taxi service often operates without passengers in some sections of the route, which favors taxi operators instead the users because the ticket price is calculated based on vehicle/km instead of passenger/km.

The political objective plays an important role in decision-making and there is a growing awareness that the costs need to be controlled, thus shared use of resources should be maximized. It also played a significant role in pilot concept projects of FLIPPER, for example, in Formentera, Borgo Panigale and Kastoria, where a multi-agency approach has been adopted to test the use of taxis to provide a FTS solution without the need of control centers, intelligent transport systems, additional vehicles and staff. [5]

# 5 Preliminary study of a proposal of FTS for the city of Braga

The city of Braga with a total area of 183.2 km is divided in 62 parishes and has a population density of 992.6 (inhab/km$^2$). The largest branches of activity are trading companies, hotels and restaurants, with 2594 companies [6]. The local public bus operator TUB (Transportes Urbanos de Braga) was founded in 1882, adapting itself over the years through a policy of innovation and development that allowed the assessment and monitoring of the needs and patterns of mobility of the resident population in the municipality of Braga. This operator provided some relevant indicators for the years 2010 and 2011, as indicated in Table 5[7].

Table 5 - Indicators of TUB 2010/2011

| | 2010 | 2011 |
|---|---|---|
| km network | 243.15 | 250.73 |
| Served area | 62 | 62 |
| Stops | 1789 | 1807 |
| Nr. of lines | 75 | 83 |
| Nr. of vehicles | 117 | 121 |
| Traveled km (million) | 5.557 | 5.439 |
| Passengers (million) | 10.275 | 10.781 |
| Staff | 330 | 319 |
| Capital (thousands of €) | 6.250 | 6.250 |

## 5.1 Preliminary study for the application of FPT in rural areas of Braga

In the context of the present research, a preliminary study for the application of FPT in rural areas of the municipality of Braga was carried out. As an example, in Figures 6, 7 and 8 are represented three bus lines (nr. 28, 29 and 73) that serve a suburban area of the municipality of Braga, which present very low values of demand that is reflected in the poor service provided by the TUB in this area. In short, the conventional bus service is almost economically unviable and residents are not well served and as a result avoid using it.

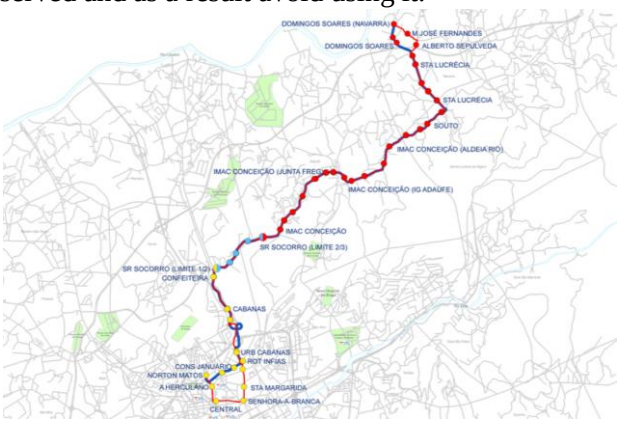


Fig.6 – Bus line nr. 28

Fig.7 – Bus line nr. 29

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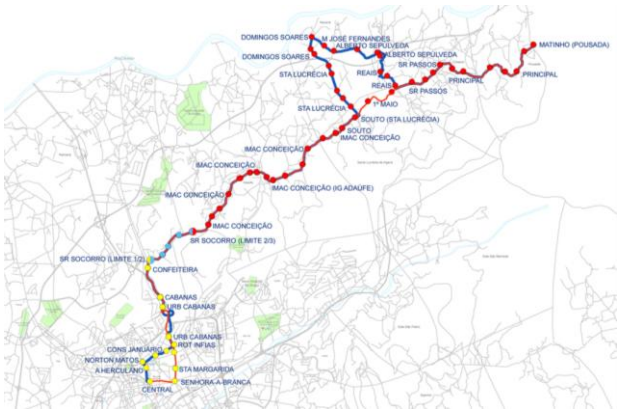


Fig.8 – Bus line nr. 73

Considering that a bus consumes 0.4 liters of fuel per kilometer, and its current price is of approximately 1.50€ per liter, the annual average daily savings with the suppression of these 3 bus lines are presented in Table 6. Therefore, there is a daily saving of 250€, resulting in annual savings of 62 960€.

Table 6 - Daily savings in the suppression of parts of networks

| Line Number | 28 | 29 | 73 |
|---|---|---|---|
| Number of Km travelled | 11.845 | 17.620 | 20.181 |
| Bus frequency | 6 | 7 | 11 |
| Number of Km traveled per day | 71.070 | 123.340 | 221.991 |
| Daily savings with the replacement of parts of line by FTS | 42.64 € | 74.00 € | 133.19 € |

Taking into account the economic and environmental benefits for the municipality, the bus operator may consider, in the future, the elimination of these bus lines and partly or fully replace this regular service with a FTS solution, or only with the suppression of the bus service in some periods of the day until a limit frequency of three buses per day (morning, afternoon and evening). In Table 7 are presented the savings according to the number of buses suppressed for line 73.

If the bus service in line 73 is reduced to a minimum of 3 buses per day, the bus operator can feasibly spend around 24 thousand euros in a FTS, such as a demand responsive transport – DRT, and with this measure provide a better service for the population of this low density area of the municipality of Braga.

Table 7 - Saving with decreasing frequency

| Nº of trips | Number of km traveled per day | Savings with suppression of trips (daily) | Savings with the elimination of travel (annual) |
|---|---|---|---|
| 11 | 221.991 | 0.00 | 0.00 |
| 10 | 201.810 | 12.11 | 3051.37 |
| 9 | 181.629 | 24.22 | 6102.73 |
| 8 | 161.448 | 36.33 | 9154.10 |
| 7 | 141.267 | 48.43 | 12205.47 |
| 6 | 121.086 | 60.54 | 15256.84 |
| 5 | 100.905 | 72.65 | 18308.20 |
| 4 | 80.724 | 84.76 | 21359.57 |
| 3 | 60.543 | 96.87 | 24410.94 |

This exercise was only made for a small part of TUB network so it is mandatory to extend this analysis for the entire network, especially for zone 3 of the bus service, since it corresponds mainly to low density areas with similar problems of the example of the area covered by lines 28, 29 and 73.

## 6 Conclusions

Flexible transport services can provide higher levels of accessibility and mobility to populations that live in low density areas, in order to avoid social exclusion, and to reduce travel costs for public transport operators and for the municipalities. FTS can be more efficient and attractive due to its great flexibility, mainly based on a door-to-door service.

In a low density area of the municipality of Braga, in northern Portugal, a preliminary study is being undertaken to implement a FTS integrated with the regular public transport (bus) network, based on a partial or full replacement of certain parts of the bus network in the outskirts of the municipality. The main objective of this action is to promote a modal shift from private vehicles to more sustainable ways of travelling, such as the bus service. In this paper, a small economic exercise was carried out to verify whether a small reduction on the regular bus service could provide a financial support of around 60 thousand euros per year, for an introduction of FTS on an area covered by bus line with an average extension of 17 km. In future developments of this work, the global costs of FTS based on DRT service will be assessed for this and other areas of the municipality in order to evaluate the economic viability of this type of solutions, as well as the social and environmental benefits for local populations.

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