4.3. ICTs and public transport in the dispersed city

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Introduction

Urban mobility represents a fundamental right of citizens: the higher the mobility (the ability of citizens to move from one place to another in a given time span - e.g. one day) the higher the chances for citizens to make more trips per day to access jobs, leisure activities, education and in general to enjoy the city they live in. On the contrary, a reduced mobility is a hindrance to the ability of citizens to access the desired destinations. Public transport plays a crucial role in guaranteeing a high mobility to those categories of citizens that for several reasons cannot afford a private means of transportation (seniors, students, immigrants) and in reaching sustainable development objectives. In this regard, a more sustainable urban mobility represents a policy objective both at the local level and for international bodies such as the European Union (2007 and 2011) and the United Nations (UN Habitat, 2011 and 2013). An efficient, accessible, frequent and sustainable local public transport system is therefore crucial to guarantee both a high mobility of weaker social categories and a sustainable urban environment.

Furthermore, mobility in its smart component is recognized as one of the fundamental pillars of smart cities, together with environment, people, economy, governance, and living (Giffinger and Gudrun, 2010; Albino et al., 2015; Estevez et al., 2015). This definition of smart cities consisting of six different pillars is particularly relevant in our case since it is also used by the Osservatorio Nazionale Smart City (ONSC) (*Italian National Smart City Observatory)*. A fundamental role within smart mobility is played by the technological component (e.g. GPS devises, online timetables and routes, mobile app-based trip planners, trip duration and constant updates on delays, and so on).

In this perspective, the context of post-earthquake L'Aquila is highly interesting. Located in a mountainous region and characterized by a dispersed settlement structure - approximately 70,000 residents spread over an area of 474 km^2 – the city presents challenging conditions for the development of an efficient public transportation system. The public transit system in L'Aquila is in need of substantial investments, both in regard to

the infrastructure – see the case of the bus terminal Collemaggio - and to the bus fleet.

Regarding "smartness" L'Aquila - according to the ONSC - ranks 91st out of 116 provincial capital cities. (Ernst and Young, 2016: 15). This is consequence to some extent of the 2009 earthquake and the enormous impact it had on the city.

However, L'Aquila was awarded the SMAU "Smart Communities Milano 2015" award for the project 'L'Aquila Smart City: rete elettrica intelligente e mobilità verde' (*Smart electric grid and green mobility*). The details of the project (SMAU, 2015) confirm the great investment and amount of financial resources in infrastructure improvements, especially for the smart electric grid, which will provide charging stations for electric car sharing (the latter represents the green mobility component of the overall intervention). The project cost is estimated to be around 16 million euros and is entirely financed by the national government. Even though the role of reliable and real-time information and communication network play a very critical role in the smart grid operation and management, we believe, however, that much improvement can be achieved through the application of Information and Communication Technologies to the public transportation and mobility system of the city of L'Aquila, with significantly lower costs when compared to those foreseen in L'Aquila Smart City project (SMAU, 2015). Indeed, we based our work on the *infostructure* approach, defined as targeted small interventions[1] that rely on digital and information technologies to improve the flow of information and data available to citizens (Tomitsch and Haeusler, 2015). Specifically, this work has sought to achieve three main aims: i) increasing the quality and amount of information relatively to local public transport (e.g. routes and scheduling) by digitalizing existing information and producing new one where feasible; ii) increasing the level of accessibility and usability of local public transport information; iii) producing new computer and web applications and open data that can be used by and shared with the citizenry and the community of open-source developers. The application of ICTs to the challenging context of post-earthquake L'Aquila, Italy, is generally intended for the benefit of citizens and city users by contributing to an improvement in the availability, accessibility and management of public transport information and data.

This work has delivered four main by-products until now:

- geo-referenced database of all bus stops and bus lines in L'Aquila; the database is the starting point for any analysis and software development we did and we will do within this project;
- the development of a new open-source application to manage and produce GTFS (General Transit Feed Specification) data;
- a sample GTFS data for the two routes of the local public transport system of L'Aquila. This constitutes the starting point for the interested mobility stakeholder to produce a full GTFS dataset;
- a web-based trip planner application for the city of L'Aquila.

1 The cost of the application described in this work is about 50,000 euros.

The next sections of this chapter will briefly discuss the current state of public transport use and modal share in the city of L'Aquila, provide more details on the different phases and by-products of our research, and draw some conclusions.

A city of cars. Current state of public transport, modal share data, plans and projects of the city of L'Aquila.

When discussing the possibilities for smart and sustainable mobility in L'Aquila, it needs to be clarified first that the population of the city is strongly dependent upon the automobile. Already before the earthquake, a vast share of all commutes in L'Aquila had been effectuated by cars (Figure 4.3.1).

In the aftermath of the disaster, the share of car commutes has increased, while the share of bicycle and pedestrian trips has declined. This fact could be possibly linked to the spatial dispersion of the resident population engendered by "new town" public housing projects like C.A.S.E. and MAP. The share of public transportation remained virtually unchanged, despite the extension of the bus network to the C.A.S.E. and MAP projects. Other measures, like the introduction of free public transportation for the post-earthquake period, also did not bring durable effects in terms of increased passenger numbers. It should be noted that in the case of commutes to work, public transportation only plays a marginal role while in the case of commutes for study purposes its importance is significantly higher.

As of October 2016, the public transportation system of L'Aquila consisted of 18 principal bus lines, which generally did not operate in regular intervals. The frequency of services was greatly differentiated, with more distant settlements (hamlets) being served only several times a day (example of a bus line is provided in Figure 4.3.2). Even on the main routes, particularly in out of peak hours as well as on Sundays and holidays the number of connections was much more limited.

Therefore, even though the subject surely would deserve a more detailed investigation, it could be hypothesized that the spatio-temporal structure of the bus network did not enhance the attractiveness of the public transportation against other means of transportation, especially automobiles.

Possible improvements of the public transportation system of L'Aquila could be sought both in "hard" and "soft" measures. Hard projects include investments like the modernization of the bus fleet, the upgrade of passenger infrastructure and the construction of new systems such the commuter rail mentioned in the local mobility plan.

Indeed, in 2012 the city of L'Aquila updated its urban mobility plan (Piano Urbano Mobilità, P.U.M). The previous version of the plan went back to 2008, but after the earthquake many revisions were necessary. According to this document, the future system of public transportation in L'Aquila should have been based upon three main elements: (1) suburban railway, (2) bus rapid transit, called "Metrobus", (3) electric buses in the area of the historical core (Piano Urbano Mobilità, P.U.M). The suburban railway should connect

Means of transport	Commutes by purpose			
	Work		Study	
	2001	2011	2001	2011
Automobile - total	79,5%	91,9%	56,2%	68,8%
Automobile - driver	-	86,6%	-	13,4%
Automobile - passenger	-	5,3%	-	55,4%
Motorcycle/motor scooter	1,0%	0,5%	3,4%	0,8%
Train	0,0%	0,1%	0,0%	0,0%
Bus	3,5%	3,2%	24,4%	26,3%
Bicycle/pedestrian/not declared	16,0%	-	16,0%	-
Bicycle	-	0,1%	-	0,1%
Pedestrian	-	3,9%	-	4,0%
Other	-	0,2%	-	0,1%

Figure 4.3.1 Modal split of tips to work and study in L'Aquila, before and after the earthquake (2001 and 2011). Source: Comune dell'Aquila (2012) and Istat (2016).

ama s.p.a.	azienda della mobilità aquilana	11-M11R-11T
orario feriale in vigore dal	9 aprile 2015	linea n°

Itinerario 11	**terminalbus**- crispi -mausonia-ctr.Bernardi- roio colle- s.rufina- roio piano- roio poggio e viceversa
Itinerario 11T	**terminalbus**- tunnel- acquasanta- f.luminosa- croce rossa- viale XXV aprile- stazione e viceversa
Itinerario M11R	**terminalbus**- XX settembre- stazione F.S.-ctr. Bernardi - roio colle- roio piano- CASE roio 2- roio poggio- CASE roio 1- ingegneria monteluco - roio poggio-CASE roio 1- roio piano-CASE roio 2- s.rufina- roio colle- genzano- **aquilone**- optimes e viceversa

note	linea	terminalbus	XX settembre	stazione	roio colle	roio piano	roio poggio	ingegneria monteluco	roio poggio	roio piano	roio colle	genzano	via saragat	aquilone
	11T	06.00	c.rossa	06.05										
SA	11L						bagno-pianola		07.20	07.23	07.28	07.35	optimes-mazzini-collugno-patini-cerwetale	
N	11R								07.20	07.23	07.28	07.35	optimes-s.s.17-c.rossa-terminal	
	11T	07.35	c.rossa	07.52										
	M11T	07.40	07.38	07.50										
SB	11R							08.40	08.43	08.45	08.48	08.50	08.55	optimes
	M11R	08.10	08.13	08.18	08.28	08.35	08.40	08.45	08.48	08.50	08.53	08.55	09.00	09.10
	11T	08.30	c.rossa	08.45										
	11T	08.50	c.rossa	09.05										
	M11R	10.20	10.23	10.28	10.38	10.45	10.50	10.55	10.58	11.00	11.03	11.05	11.10	11.20
S	11T	10.30	c.rossa	10.45										
	M11R	12.35	12.38	12.43	S.S. 615		13.05	13.10	13.13	13.15	13.18	13.20	13.25	13.35
	11T	12.25	c.rossa	12.35										
C	11	13.05	mausonia-ctr.bernardi						13.20	13.23	13.28	13.35		

Figure 4.3.2. Extract of a bus line's schedule and frequency

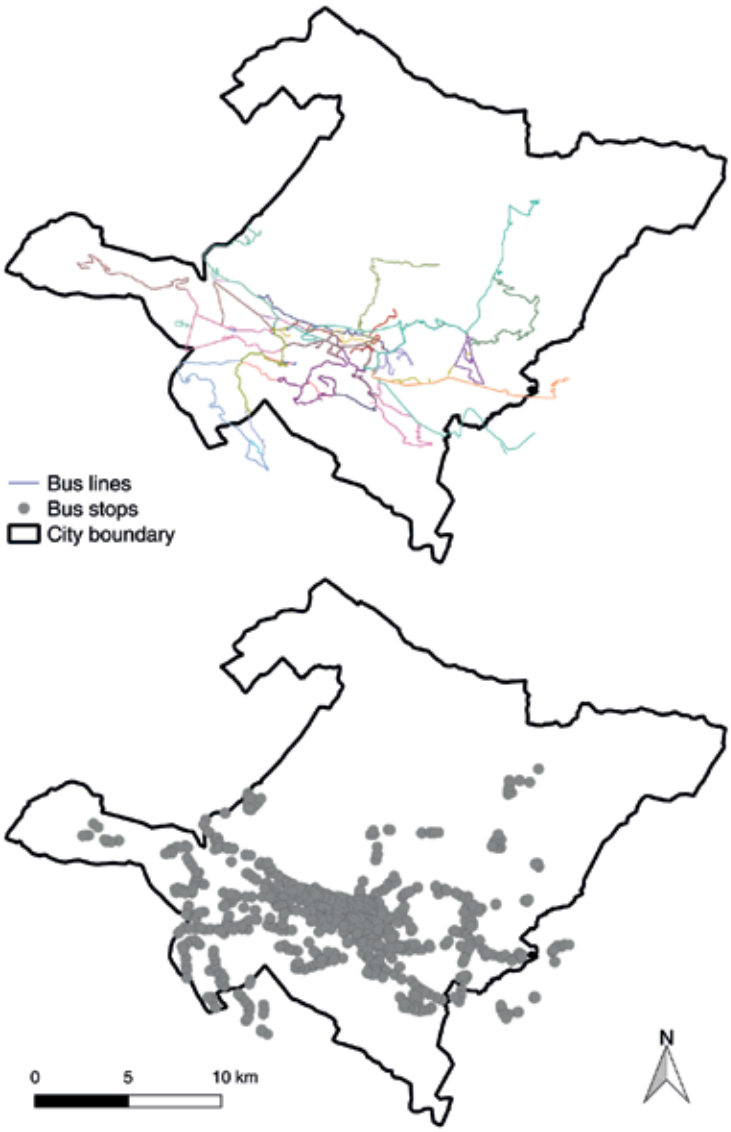

Figure 4.3.3. Georeferenced bus stops in L'Aquila

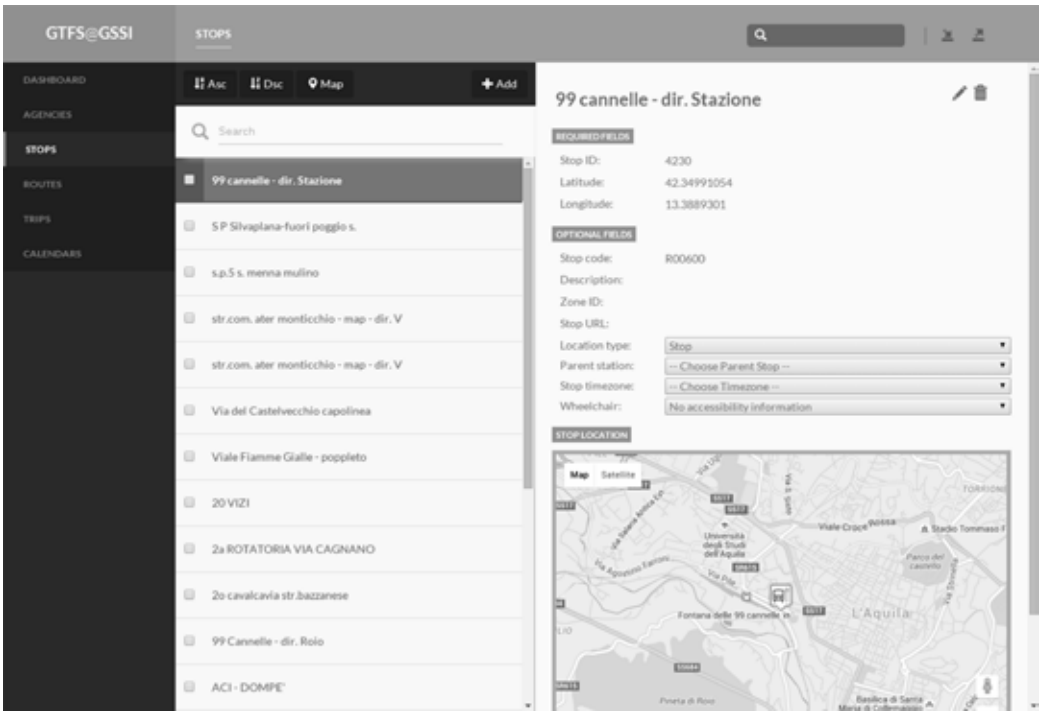

Figure 4.3.4. GTFS editor. Stops screenshot.

peripheral districts located to the west and to the east with the core of the city, using the already existing regional railway corridor. Bus rapid transit is intended to complement the railway system, including two lines running also from west to east, but serving districts more distant from the railway corridor. In part, it would follow the route of an abandoned previous project of a monorail connection (Translohr, see below). The urban mobility plan also foresees the construction of a cable car between the historical core and the university campus.

Looking at the vision of the future of the urban mobility plan, it is hard to avoid the impression of a very high discrepancy between the present situation and the desired state. Both the suburban railway project and the bus rapid transit system would require substantial infrastructural investments, and therefore they are strongly dependent upon the availability of external funding.

However, in this context the negative experience of the failed Translohr project (*Tramvia su gomma*) should be remembered. Indeed, it was planned a line connecting the hamlet of Coppito with the Terminal Bus Collemaggio passing through the historical center, for a length of 7.5 km, served by 7 cars (150 people), some of which had already been purchased. The work was blocked twice: firstly for problems with the government office of cultural heritage, and secondly due to an infringement procedure initiated by the European Union. After the construction of the cars deposit, the set in place of the rail along the route, the construction of the electric power line and the bus shelters along most of the route, the project was blocked due to financial problems and for design changes to the original project. After the earthquake of 2009, the project was abandoned and in 2013 the dismantlement of what had been already built was started.

Soft measures generally require substantially lower financial outlays, while offering potentially significant outcomes in terms of the attractiveness of the public transportation. Such measures could be based on the info structures approach, which utilizes ICT and georeferenced data. Moreover, as described in the P.U.M document, there is a proposal to set up a bike sharing service within the historic center by pedal-assisted bicycles which, by facilitating the overcoming of small distances and gaps, can be a real alternative to the use of private cars, even in a context apparently seldom conducive to cycling.

However, some steps towards sustainable and smart mobility in L'Aquila could be made even without large infrastructural spending. The recent turn towards "infostructures" deserves particular attention here.

Geo-referencing, General transit Feed Specifications and Bus on Air: experimenting with soft investments in mobility policy

Our project consisted of three main stages: georeferencing spatial data of all bus stops; production of a sample General Transit Feed Specification (GTFS) and development of a GTFS editor; development of a web-based app for trip planning purposes (bus on air). We describe all three of them below.

Georeferencing

Georeferenced data (i.e. data that are linked to geographical location) are being increasingly used in many contexts. Within the context of our project, we aimed at creating a database containing all the bus stops and the routes of all the lines served by the municipal public transport company (Azienda Mobilità Aquilana, AMA). This was achieved using data drawn from the company's website, and updating them on the basis of field work where necessary[2] (Figure 4.3.3).

The database that was created using QGIS software can thus be used in any common geographical information systems (GIS) software. It can be also further developed and applied both for analytical purposes (accessibility analysis), and for web-based applications (trip planners).

General Transit Feed Specification (GTFS) editor and data

Within the framework of the project, the production of a General Transit Feed Specification (GTFS) for L'Aquila was initiated. The GTFS is a widely accepted standard of data for the purpose of trip planning. Many cities and towns worldwide use such format for trip planning purposes[3]. Until now, such data was not available for the city of L'Aquila and we have produced a first example for two bus lines.

Moreover, we have developed a GTFS editor that should facilitate the creation of a GTFS. Our editor is a new open-source application to manage and produce GTFS (General Transit Feed Specification) data; after a careful analysis of existing software for managing GTFS data, so far our application is the only stable open-source product for managing GTFS data available as web application; our GTFS editor (Figure 4.3.4) has been developed using the latest web technologies of the open-source development state of the art such as HTML5, CSS3, JavaScript, AngularJS.

Bus on Air

BusOnAir (Figure 4.3.5) is the first web platform built on the geo-referenced database of all bus stops and bus lines of L'Aquila (i.e. the first by-product of our activities), it has been developed as a cross-platform web application, which supports both mobile and desktop users by following the responsive web development paradigm.

BusOnAir is a project developed in collaboration with the University of L'Aquila (Italy). Figure below shows an overview of the various functionalities of BusOnAir. The main idea behind BusOnAir is the ability of the system

2 After the earthquake, L'Aquila's traffic has suffered continuous and numerous variations, due to demolition of buildings, renovation of damaged buildings, road resurfacing. Changes, of course, also involved bus routes and their stops which often diverged greatly from the original ones. Field work was therefore necessary in some instances to verify the exact location of bus stops, especially in more remote areas.
3 See e.g. GTFS data exchange website http://www.gtfs-data-exchange.com/

Figure 4.3.5. Bus On Air Trip Planner.

to track in real-time the position of each bus within the city. When a potential traveller needs to go to a specific destination, it fires up a mobile application that allows him to calculate the nearest bus stop to go there. Also, given a specific bus stop, the mobile application allows the user to get the (actual) arrival time of all next buses stopping there.

Interestingly, the BusOnAir server-side application manages all the data coming from the buses in the streets, and updates the information on a dedicated website and on its mobile application. Logging and statistical analysis are also part of the tasks performed in the BusOnAir server. It is important to note that the BusOnAir software is generic and independent from the transit agency being served. That is, our system scales well when serving a large number of transit agencies. Indeed, when adding a new transit agency X, the only input that we need is a GTFS specification describing the various bus routes of X and containing some other additional parameters. The software running in our BusOnAir server manages autonomously the new transit agency and configures itself in accordance with the routes and parameters specified in the GTFS specification.

Conclusions: promoting soft-investments for a more sustainable city

This contribution has looked at the application of the ICT and digital technologies in relation to the case of public transportation and mobility in the city of L'Aquila.

We believe that the application of the ICT could bring substantial benefits to the city of L'Aquila, and particularly for its public transportation system. The 2009 earthquake has attracted much attention, and for sure it will greatly affect the city's governance over the following years. However, some problems of the city, like the underinvestment in public transportation, date back more into the past. If the public transportation is going to become a feasible alternative in this currently strongly automobile-dependent city and if the city administration aims at delivering a more sustainable, smart and user friendly public transportation system, a number of changes are needed. In our view, such changes should not be only physical and infrastructure-related investments, but also measures based on the application of digital technologies which could deliver substantial improvements with little investment. In fact, the latter do not require substantial financial support and investment.

What is actually needed to develop a smarter public transportation system is geospatial data and software able to generate, elaborate, and make the data available to the users. Thanks to the work done in this project, a substantial progress has been achieved. Starting from a position of very low availability of geospatial data, a dataset has been created for the public transportation system (bus stops, bus connections) that can be used in the future. However, we think that it is highly recommendable to continue working on the creation of data, particularly towards the creation of a full general transit feed specification (GTFS). With regard to software develop-

ment, the presented software architecture is based on BusOnAir, an open-source project developed in collaboration with the University of L'Aquila, the Gran Sasso Science Institute, and the Vrije Universiteit Amsterdam.

The three main drivers of the proposed architecture can be summarized as: (i) to efficiently manage static and real-time information about public transportation systems, (ii) to make public transport information available to the users by means of a responsive web app, and (iii) to provide such information to third-party developers as open data in order to encourage the development of new applications based on it. For future research we are planning to extend the experiment including also private transportation companies in our system and performing a public transportation accessibility analysis of major points of interests in the city L'Aquila, such as new CASE and MAP settlements and public services (e.g. hospital, university, schools, and so on).

The applications and data produced have been already presented to the municipality, the mayor and citizens in the public forum "L'Aquila del Futuro" organized by the GSSI in December 2015. However, currently, due to an internal management restructuring of the public bus company AMA to improve its efficiency, it has not yet been possible to start a formal collaboration that will be sought at a later stage.

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