The Valletta Travel Information Service

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Abstract: This is an invited summary of the Valletta Travel Information Service (VaTIS) position paper (DINGLI & ATTARD 2016). In this paper, we highlight the main concepts behind the Travel Information Service currently being deployed in Valletta, the Capital City of Malta. The VaTIS system is capable of harvesting data from an existing road pricing system using automatic number plate recognition (ANPR) technology and beacons installed in all the streets of the city, thus creating a digital landscape of the City in which to process travel related information. The data is harvested from the various sensors via user smart phones and fed into modelling and simulation software, which is capable of predicting movement of cars around the city's road network. The information is then used to calculate the free parking spaces around the city thus helping commuters reduce the cruising time spent searching for parking. Furthermore, users approaching the city can receive information in real-time thus providing them with invaluable information about the real state of traffic within the city which can be used to take informed decisions. They can opt to park outside the city if the parking spaces within the city walls are saturated or they can choose the entry point to the city, which will give them the highest probability of finding a parking space. The Geodesign and architecture at the heart of VaTIS is low cost thus making the same model easily replicable in other cities with minimal changes. In this paper, we will describe how the different components of VaTIS work and integrate together. We will also report on the first phase which has been running successfully for a number of years and which will be integrated with our system. Overall, the project aims to create a sustainable mobility model throughout the entire city by providing effective travel information with the help of crowd sourcing initiatives.

Keywords: Transport, beacons, crowd sourcing, digital landscape, intelligent information services, road pricing

1 Introduction

In 2002 Margot Wallstrom, the European Commissioner for the Environment, established Car Free Day as a European initiative for the new millennium, which eventually led to what is known as the European Mobility Week (http://www.mobilityweek.eu). This initiative involves hundreds of European cities and is held between the 16th and 22nd of September.

As part of this initiative, the Valletta Local Council together with the Institute for Climate Change and Sustainable Development of the University of Malta developed a Sustainable Urban Mobility Plan (SUMP) for the City. As part of this SUMP, 15 projects were identified around the city to encouraged sustainable mobility. Out of these measures, the Valletta Travel Information Service (VaTIS) Project was identified as a significant contributor to sustainable mobility. Eventually, Transport Malta (TM)[1] awarded funding to the Valletta Local Council in a national competition amongst all 68 localities that were competing.

[1] Transport Malta is the Maltese Authority whose aim is to promote and develop the transport sector in Malta by means of proper regulation and by the promotion and development of related services, businesses and other interests both locally and internationally.

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The VaTIS project will make use of wireless and mobile technologies to create a network of sensors, which is constantly collecting and collating traffic information from around the city. A traffic and transport digital landscape will be provided and presented to the user in real-time via an app. The aim is that such a system will help drivers decide whether to use a car or public transport, find easier routes, find parking spaces, reduce cruising time, and ultimately contribute to reducing the environmental impact of transport on the City. A website with real-time travel information will also compliment the app and encourage drivers to use other means of transport to the City, especially when congestion is high. This project will be the first to use data from the various sensors around the city and provide useful information for users in digital form.

The project will be divided into three main phases.

Phase 1 uses the information obtained from the Controlled Vehicular Access (CVA) system (Valletta's road pricing system), in order to get real-time information about the number of vehicles entering and exiting the city.

Phase 2 will use the beacons, deployed throughout the entire city, which will provide fine grade information about users.

Phase 3 will use the crowdsourcing platform via the app and website in order to collect and share more information.

This paper will give an overview of the various phases whilst focusing on the evaluation of the first phase (which has already been implemented and tested). The next section will provide a background for our work as well as review relevant literature supporting the project. Section 3 will go into the various phases of the project. Section 4 will describe the evaluation of Phase 1. Finally, we will conclude this paper by looking at the future work involved in this project.

2 Background to the Case Study

In 2005 a strategy was published by the Maltese Government to implement measures aimed at improving accessibility to the city of Valletta (CABINET COMMITTEE FOR NATIONAL PROJECTS 2005) and it included the development of a number of projects such as the road-pricing scheme to access the city. The proposed scheme was envisaged to also introduce the polluter-pays principle in the management of limited road and parking infrastructure in the City (ATTARD & ISON 2010).

When implementing such a scheme, a number of critical issues affecting the implementation have been identified by ATTARD & ISON (2010) and point primarily to:

- political and public acceptability,
- clear purpose and objectives,
- a scheme which is simple and fair,
- easy to understand and to manage.

These issues are evident throughout the successful schemes (as can be seen in WILLOUGHBY 2000, SANTOS 2005, DE PALMA 2007, BUTTON & VEGA 2008, KOH 2003) and (STOCKHOLMFORSÖKET 2006) despite the uniqueness, which exists between the cities.

Notwithstanding this, technologies supporting such schemes tend to be expensive so they are mainly located in the periphery of the interested zone. More recently, a new low cost technology emerged which can be used to take this concept further by offering a greater granularity than is currently possible. These sensors are normally referred to as Beacons (GAST 2014, GILCHRIST 2014). These small devices, some of which the size of a flat sticker provide location-based information services to mobile devices by implementing the Bluetooth low-energy (BLE) wireless technology (GOMEZ et al. 2012).

Beacons are small, cheap Bluetooth transmitters that send a small signal which is caught by an app installed on a mobile device as soon as the device gets within the beacon's range. The beacon normally transmits a unique Id and that Id is then interpreted by the app to provide a context. Essentially, every time the beacon interprets an Id location the app loads the context associated with that location. This is obviously just one of the possible applications. Beacons have been used in shops (DI RIENZO et al. 2015), in airports (REED 2015), in location-based games (CHANG et al. 2014), libraries (PUJAR & SATYANARAYANA 2015) and many more applications. However, it seems that such a system has been seldom used for traffic management and for the creation of digital landscapes able to communicate information.

HOBI (2015) explores similar issues by looking at beacons combined with crowd sourcing applications. The idea of using crowd sourcing applications has been widely explored within the context of parking as can be seen in (HOH et al. 2012), (KOPECK & DOMINGUE 2012), (YAN et al. 2011) and (SATHYARAJA 2015). Most of these systems look into the issue of cruising for parking. This search is typically time consuming and costly (in terms of fuel costs) since the driver would be wandering aimlessly looking for a parking space. This also creates further traffic whilst also impacting negatively on the environment at large. Because of this, modern systems are combining low cost sensors such as beacons (whose cost make it possible to have a higher penetration in cities) together with crowd sourced parking information, which helps to increase the granularity of information within the system.

To our knowledge, our study will be a first of its kind since it will implement and test such technologies using the entire Capital City as case study.

3 Methodology

This chapter will now explore the different phases of the project. The first phase will make use of a camera system using ANPR technology installed in Valletta, which is normally referred to as the Controlled Vehicular Access (CVA) system. The system will provide real-time information about the entry and exit points in the city. The second phase will see the deployment of beacons throughout the city, which will provide fine grade information for each and every junction in the city. The digital map of the city will provide critical information for travellers. The third phase will focus on the deployment of crowd sourcing information through the use of GPS and other sensors.

3.1 Phase 1

The CVA system makes use of Automatic Number Plate Reading (ANPR) technology and a dedicated camera system to monitor and photograph vehicles entering and exiting the CVA boundary. The city of Valletta has eight entry points and eight exit points as can be seen in Figure 1.

Fig. 1: Map of Valletta showing the entry and exit points of the city. The green dots represent the entry points; the blue dots represent the exit points whilst the yellow dots represent two-way roads (entry and exit). The red dots represent the location of around 80 beacons practically in each and every junction in the city (drawn up by author using https://www.openstreetmap.org).

The system then automatically calculates the total amount of time which the vehicle spends within the controlled zone and finally computes the fees due for access and parking based on the tariffs issued by the national authority Transport Malta (see http://www.cva.gov.mt for details of tariffs and regulation). For the VaTIS project, a new server was added to the CVA system in order to send live feeds to the VaTIS centralized server.

3.2 Phase 2

The second phase of this project involves the installation of beacons throughout the city in pre-defined locations (see Figure 1). A beacon is a small device capable of emitting some data (normally a unique ID) to the environment using Bluetooth technology. They come in all sorts of shapes from stone like casings to flat stickers. A Bluetooth Low Energy (BLE) supported device is capable of reading this data without any necessity to secure-pairing. The maximum range of a beacon is around 65 to 70m which makes it idea for the narrow roads of Valletta since the widest road in the city is less than 15m. Some of these beacons are also waterproof thus making them perfect for outdoor use. The cost of a beacon is around €20 making it a cheap alternative to other more expensive sensors.

This technology will support the creation of digital environments and landscapes able to receive information, as well as process information into useful feedback for users in the system. Such technologies allow the processing of digital information almost in real time.

3.3 Phase 3

The final phase, the crowd sourcing platform and website consolidates the technologies and systems developed in Phase 1 and 2 of this project. The beacons provide a context so unless a good number of users are engaged with the system, there is very little meaningful information, which can be attached and used in that context. This leads to what is normally referred to as the cold start problem where the system does not have sufficient information to give meaningful predictions. In order to compensate for this lack of information at the start, but also throughout the project, the system will tap into the CVA data to provide for the initial predictions. Although this information is not detailed enough, yet in its basic form, it is valuable for the drivers approaching or exiting the city since such information can allow drivers to select least used entry/exit points, thus reducing the traffic at particular junctions, avoid entry/exit points that have most traffic and identify the parts of the city which, through historic data and prediction algorithms suggest traffic congestion and delays. This information will get users to download the app in order to access this real-time information provided by the CVA system initially. Once they load the app, the system (with their consent) will:

- Keep track of where they are going in the city (by using the beacons or GPS position);
- Keep track of where they park;
- Harvest this information, analyse it and update a dashboard on the app with information highlighting a detailed picture of the traffic situation in the city.

GPS positioning information is only being proposed for redundancy purposes in order to confirm the readings obtained from the beacons. SHEN & WYNTER (2015) claim that some of the information provided by GPS systems is not always very accurate and should not be used for traffic estimation and/or prediction without an understanding of error. This was also noted in our tests, performed in previous projects where GPS sensors showed to be unreliable in cities with narrow roads and tall buildings. This was also the reason why this study is looking at a mix of technologies to support real time location information for the creation of digital data, and subsequent traffic estimations and predictions.

This system, is hoped, will engage users who will access the app or the website to interact in a digital landscape and to check the travel information available in and around the City, plan their journey accordingly and contribute with their data once they approach the city or driving through it. The more people using the system, the more accurate the system will become and as such, more users will engage. This follows most of the Web 2.0 patterns of use as defined by O'REILLY (2007) in particular the data and collective intelligence, which are two pillars of these types of applications. Websites such as Google, Facebook and eBay all manage large databases so the shift in value has moved from the software towards the information that these websites accumulate. These are now being referred to as info-ware. Collective intelligence is achieved by not only allowing users to access the valuable information provided by the app, but by also allowing them to contribute to the provision of data in a transparent way (but always with their permission). This allows the app to improve its predictions thus providing a better service each and every time it is used.

4 Initial Evaluation

The evaluation of such a system is still in its initial phases and in this paper, we report about the results obtained in Phase 1, the introduction of the CVA system. When the system was originally implemented, it recorded an initial decline in the number of vehicles entering the charging zone with seasonal patterns repeating themselves over the years with the highest access registered always towards the end of every year. These seasonal patterns reflect reduced activity during the summer months and the Christmas shopping during December. The number of vehicles entering the charging zone peaked in December 2009 where a 20 per cent increase over the initial numbers was recorded. This however did not persist with the numbers declining once again to 2008 levels by 2010 (ATTARD & MUSCAT 2014). Vehicular access declined even further in 2011 with the start of major infrastructural and regeneration projects in Valletta, limiting further the circulation of vehicles in the city.

A hypothesis for the increase in the third year of operation could well be increased activity by car in and around the city and a wearing-off of the effects of the charge. On average 10,000 vehicles accessed the charging zone on a daily basis in the period under review. It is interesting to note however, that 54 per cent of all entries represent vehicles staying 30 minutes or less in the charging zone. This represents a significant number of entries that can be reduced if the free 30 minutes, which are currently provided by the system, are removed or at least reduced.

The apprehension by many that the effects of the charges would attenuate over time were made public in 2010 when the then Minister for Transport was quoted saying that the CVA and Park and Ride are "too cheap" and are attracting too many cars to the city (SCHEMBRI 2010). The article quotes the Minister saying that "this is a reflection of the pricing structure put in place in the peninsula." References here were made to the free Park and Ride, relatively low charge and a free drop-off concession of 30 minutes, which was too long. This speech, delivered at a local Valletta conference was also pre-empting the introduction of a charge for the use of the Park and Ride which came into force later in July 2011. In addition to this, morning peak hour traffic was monitored outside the city in the main road leading to Valletta with surveys carried out during a typical weekday in 2003, 2004, 2007, 2008, 2010 and 2013. A comparison of the recorded traffic volumes shows an initial decline of 25 per cent in traffic. The last recorded survey however, carried out in 2013, shows peak hour traffic in the same section of road increasing back to 2004 levels after a drop of over 43 % in 2010 (ATTARD & ISON 2015).

The 2010 drop in traffic was aided by the extensive regeneration works in Valletta which included the closure of a main road, limiting the traffic circulation further in the city. Whilst the increase in traffic recorded later in 2013 is partly due to the opening of a large parking area just outside the city walls in 2011. This might have attracted back all the vehicles which over the years since the implementation of the CVA shifted to other modes (see also ATTARD

& ISON 2015). The charges in the case of Valletta did not change until 2013 therefore factors such as inflation would have automatically changed the real cost of the charge over time. According to (BÖRJESSON et al. 2012) the acclimatization effect is important because it might affect travel choices based on the fact that people find it less difficult to pay the extra cost as it decreases over time.

There are of course, other external factors that affect the impact of charges over time. An immediate secondary impact of the scheme and the changes to traffic was also reported in the media in January 2008 with the Communications Coordinator at the Ministry for Urban Development and Roads claiming that the fixed air quality monitoring station located just outside the peninsula reported a decline in the values for Nitrogen Oxides (NOx), Carbon Monoxide (CO) and Benzene between the period March and July 2007. No evidence of this decline in the long term however is available to claim environmental benefits brought about by the CVA. It is also difficult to attribute changes to air quality in the inner harbor region to transport alone due to the influence of various polluting activities in the harbor (including energy generation) and the effects of wind and the sea.

In addition to the trends noted by the CVA system in terms of traffic entering the charging zone, there are other significant impacts, which have been recorded and do show a positive change in the travel behavior to and from Valletta. The National Household Travel Surveys, carried out in Malta in 1989, 1998 and 2010 provide a good indication of the population travel behavior over time, particularly with the introduction of the CVA in 2007. On a national level the private car is still the primary mode of travel, increasing from 54.7 % in 1989, to 70.2 % in 1998 and 74.6 per cent of all trips in 2010. Public transport use fell from 24.3 % in 1989 to 11.4 % in 1998 and 11.3 % in 2010 according to Transport Malta. This pattern however is not reflected in the trends observed for trips to Valletta. Trips by car as driver and passenger have declined by 10 % whilst public transport trips, including those carried out by private public transport services have increased by 10 %. Other modes including trips by motorcycle and on foot have decreased slightly (TRANSPORT MALTA 2011).

The decline in the use of motorcycles is relevant to note since these were exempt from the charge in an effort to increase their use. In contrast to this decline in mode choice for trips to Valletta, the period 2007 and 2008 registered an increase in 12 per cent in the number of motorcycles in the islands, the highest increase recorded over the period 2005-2010. It would have been interesting to note an increase in the use of motorcycles given this national increase in the fleet and the exemption from the charge. Also, unlike Stockholm (and as reported in BÖRJESSON et al. 2012), the exemption for electric vehicles did not encourage their sale and use, with registrations of electric vehicles remaining very low (0.013 % of the total passenger car fleet) in the islands between the period 2008 and 2010. Despite all this, the shift from private to public transport modes for trips to Valletta as captured by the Household Travel Surveys is substantial and very positive. How much can these be attributed to the CVA or the reduction of circulation and parking space in the city or the overall rise of congestion in and around the city is more difficult to ascertain. Another important indicator, which was recorded in surveys before and after the implementation of the CVA, was the reduction in the number of cars parked in the charging zone between the hours of 6:00am and 9:00pm, which reduced by 25 per cent over the period October 2006 and October 2007. In the same surveys, the duration of parking within the parking spaces (within the city) went down from an average of 3.5 hours in May 2007 to 2.58 hours by December 2008 (INFORMA 2008).

5 Future Research

It is clear from an evaluation of the CVA scheme that the system has managed to reach most of the intended objectives since its implementation. Infrastructure projects, political decisions, changes to parking infrastructure and other factors have influenced significantly the overall performance of the system and there is certainly value in understanding the relationship of these events and factors with the sustainability or otherwise of road pricing schemes. However the VaTIS Project will attempt to take the scheme and its potential further by implementing Phase 2 and 3 as described earlier in this paper. Even though the CVA provides better access to the city through better management of road use, it does not empower the users, through direct access to digital information, to take informed decisions with regard to travel options and parking within the City. The current CVA is invisible to the user and apart from the monthly bills issued by the system there is very little feedback to the user in trying to engage and modify travel behaviour.

The next two phases will ensure that the system starts providing important digital information to the users regarding their travels to the City. Amongst the information that the VaTIS Project will provide, there will be some which will help travellers decide upon:

- whether they should enter Valletta or else, find a parking space outside of the walls of the city, thus reducing the parking problem in the city;
- which route to access the city from, thus reducing the pressure on the limited infrastructure available through the City fortifications and roads;
- the correct combination of roads leading to the most available parking space or area, thus reducing the cruising time for parking;
- which area to explore while cruising for parking based upon the information from cars leaving the city;
- which roads to take when leaving the city to avoid traffic congestion;
- when to leave the city by using real-time information provided to the user.

The granularity of the information VaTIS will provide will ensure better planning especially with regard to parking management and potentially charging policies. Despite its size, Valletta has distinct zones which are defined by different land uses and functions. This might suggest different charging structures for the different zones. The movement of people within the city might also shed some light on the movement of traffic and the efficient (or not so efficient) use of the road infrastructure. Further still, the information obtained might also have commercial considerations, which still need to be explored. Apart from this, the reduction in cruising time which is a main aim of this project will impact the level of pollution in the city thus improving the quality of life of residents, workers and visitors alike. This however is another interesting study following the full implementation of the VaTIS Project.

Future projects can also explore gamification. DETERDING et al. (2011) defines gamification as the idea of applying game mechanics and game design features in order to get more people to engage with a particular task or to motivate them to achieve specific goals. It also taps into the idea of human desires and needs, which drives personal impulses in order to get people to achieve status and achievements. Within the context of the VaTIS project, the idea would entail the addition of gamification elements to the app or website in order to reward people who use the system. As an example, the system can reward people who make arrangements to leave the city before or after rush hour thus reducing the load on the road network, or to shift to alternative, more environmentally friendly modes. There are various ways in which gamification systems can help the VaTIS Project to succeed and remain sustainable.

6 Conclusion

This paper has introduced the concepts and rationale behind the VaTIS project and the potential of digital landscapes in the field of urban transport. We explained how technology and intelligent information systems can be used to harvest information from existing systems, in this case the CVA system currently in place in Valletta, Malta, and combine it with information obtained by users through a specific app and website. The system is being designed to make use of low cost sensors installed throughout the city and locating vehicles as they move and park within the space. This information is then processed and predictions about traffic behaviour are performed using specialized software. The system will be capable of tracking the location of cars within the city and use it to locate free road space and parking areas. This information is then relayed back to the users approaching the city in real-time, providing them with precious information about their commute to the city.

The evaluation of Phase 1 has also shown the importance of schemes such as road pricing schemes in managing limited road infrastructure. Further still, this is one of the few systems in operation globally and the next phases will help create the next generation of such systems and show how they can contribute to modify behaviour and improve transport systems in cities. The system that is proposed in this paper is low cost and has a high potential for transfer to other similar cities minimal changes and costs.

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