Enhancement of the forest road network accessibility using Information Systems

Christos Liotiris [1]

A B S T R A C T

Accessibility of the forest road network is one of the most important factors in the sustainable management of forests. This study presents the development of an information system which enhances the accessibility of the forest road network. This project uses HTML5 and CSS3 for the frontend and WAMP Server with MySQL database as backend. End users will be able to receive the necessary information and coordinates via notifications on their Android smartphone using an application. This Android application uses the Google Maps app to display the route that should be followed. Forwarding information to users is operated through Firebase Cloud Messaging. Last but not least, it should be highlighted that free and open source software was used to implement the aforementioned system.

1. Introduction

One quarter of the total landmass of Greece is covered by forests, ranking it fourth among the European countries. Forest fires are considered to be one of the most decisive factors affecting forest resources throughout the world and, in particular, Mediterranean countries (i.e., France, Greece, Italy, Portugal, Spain, and Turkey) due to their climate and other factors (Demir et al. 2009). In addition, changes in forest landscapes resulting from road construction, have increased remarkably in recent years. Roads are essential structures to provide access to the forest from the establishment phase to the harvesting stage. Consequently, it is important that roads are properly planned in order to ensure the transportation of forest products as well as the safety, comfort and economy of vehicle operations. The complex structure of the forest road network makes it necessary to use navigation technologies to facilitate the movement of vehicles, citizens and employees working in it. The sustainable management of forest resources can only be achieved through a well-organized road network (Athanasiadis & Andreopoulou 2015).

Global Positioning System (GPS) technology has been increasingly used in many forestry applications such as forest operations, forest transportation, forest fires, etc. Furthermore, it enhances the ability of firefighting vehicles and staff to reach a fire area as quick as possible. Most of those technologies are based on GPS navigation devices or GPS navigation applications for smartphones. Land navigation methods and tools such as Compass with adjustment for magnetic declination, Clinometer, Topographic maps etc., have been used widely so far but their accuracy can be improved by the Information Technologies and the Internet (Wing et al. 2005).

There are many reasons given for the growth of the Internet usage (not specifically retailing) over recent times, including for example, its size as a source of information, increasingly becoming much more accessible and less expensive (Bonn et al. 1999). Especially the latter one, is the main reason why people can access Internet via their smartphones, tablets, laptops etc. mainly for work and entertainment, in daily basis. The purpose of this paper is the development of an Information System which combines different open source technologies and it will be running on Windows machines and Android devices. It aims to facilitate the movement of vehicles and citizens, reducing the unnecessary shifts and providing the fastest and most reliable path.

---

[1] Christos Liotiris
Aristotle University of Thessaloniki
cliotiris@for.auth.gr

Christos Liotiris: Enhancement of the forest road network accessibility using Information Systems

2. Materials and Methods

This Information System uses HTML5 and CSS3 for the frontend and WAMP Server with MySQL database as backend. In order to achieve the best performance, users should install Windows 7 or newer edition. It should be pointed out that WAMP Server 2.5 is not compatible with Windows XP, neither with SP3, nor Windows Server 2003. The programming languages and the technologies which were used for the development of this Information System, will be presented below.

WAMP Server refers to a software stack for the Microsoft Windows operating system and consisting of the Apache web server, OpenSSL for SSL support, MySQL database and PHP programming language. The most important part of the WAMP package is Apache (or "Apache HTTP Server") which is used run the web server within Windows. By running a local Apache web server on a Windows machine, a web developer can test webpages in a web browser without publishing them live on the Internet (Bourdon 2012).
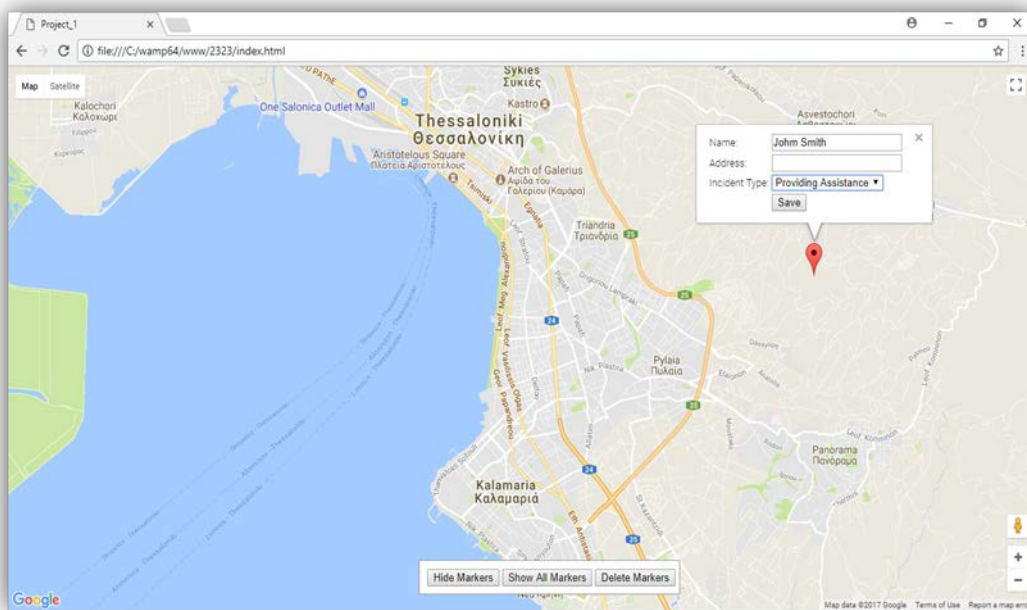

Figure 1. Website with Google Maps

PHP (Personal Home Page or Hypertext Preprocessor) is a server-side scripting language designed primarily for web development but also used as a general-purpose programming language. PHP code may be embedded into HTML or HTML5 markup, or it can be used in combination with various web template systems, web content management systems and web frameworks (Lerdorf 2007).

HTML is the World Wide Web's core markup language. Originally, HTML was primarily designed as a language for semantically describing scientific documents. Its general design, however, has enabled it to be adapted, over the subsequent years, to describe a number of other types of documents and even applications. HTML5 includes detailed processing models to encourage more interoperable implementations. It extends, improves and rationalizes the markup available for documents and introduces markup and application programming interfaces (APIs) for complex web applications. (W3C 2017)

CSS3 (Cascading Style Sheets) is a style sheet language used for describing the presentation of a document written in a markup language. Although most often used to set the visual style of web pages and user interfaces written in HTML. Along with HTML and JavaScript, CSS is a cornerstone technology used by most websites to create visually engaging webpages, user interfaces for web

applications, and user interfaces for many mobile applications (Clark 2014). CSS3 has been split into "modules". It contains the "old CSS specification" (which has been split into smaller pieces). In addition, new modules are added. Some of the most important CSS3 modules are: Selectors, Box Model, Backgrounds and Borders, Image Values and Replaced Content, Text Effects, 2D/3D Transformations, Animations, Multiple Column Layout and User Interface (Lazaris 2010).

MySQL is an open source relational database management system (RDBMS). Its name is a combination of "My", the name of co-founder Michael Widenius's daughter, and "SQL", the abbreviation for Structured Query Language (MySQL, 1995).
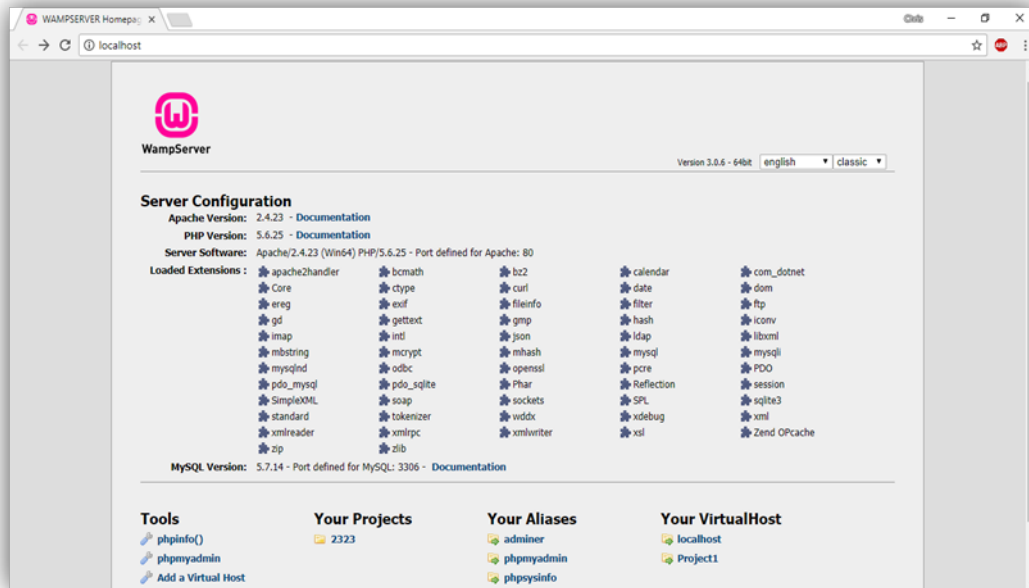

Figure 2. WAMPSERVER Homepage

Firebase is a mobile and web application development platform, has grown inside Google and expanded their services to become a unified platform for mobile developers. Firebase now integrates with various other Google services to offer broader products and scale for developers (Firebase 2011).

Google Maps is a web mapping service developed by Google. It offers satellite imagery, street maps, 360° panoramic views of streets (Street View), real-time traffic conditions (Google Traffic), and route planning for traveling by foot, car, bicycle (in beta), or public transportation. Google developed Google Maps App (mapping mobile app) for the Android and iOS mobile operating systems and it uses Google Maps for its information. The Google Maps apps on Android and iOS have many features in common, including turn-by-turn navigation, street view, and public transit information (Google 2017).

Postman is a powerful GUI (Graphical user interface) platform to make your API development faster & easier, from building API requests through testing, documentation and sharing. It was designed from the group up, to support all aspects of API development. Postman's apps are built on a single underlying layer, ensuring consistent performance and user experience. Postman has features for every API developer: request building, test and pre-request scripts, variables, environments, and request descriptions, designed to work seamlessly together. It supports Mac/Windows/Linux Apps, individual and team options, and multiple integrations, including support for Swagger and RAML formats (Postman 2012).

Android Studio is the official integrated development environment (IDE) for Google's Android operating system, built based on JetBrains' IntelliJ IDEA software and designed specifically for

Android development. It is available for download on Windows, macOS and Linux based operating systems (Android Studio 2013). It is a replacement for the Eclipse Android Development Tools (ADT) as primary IDE for native Android application development.
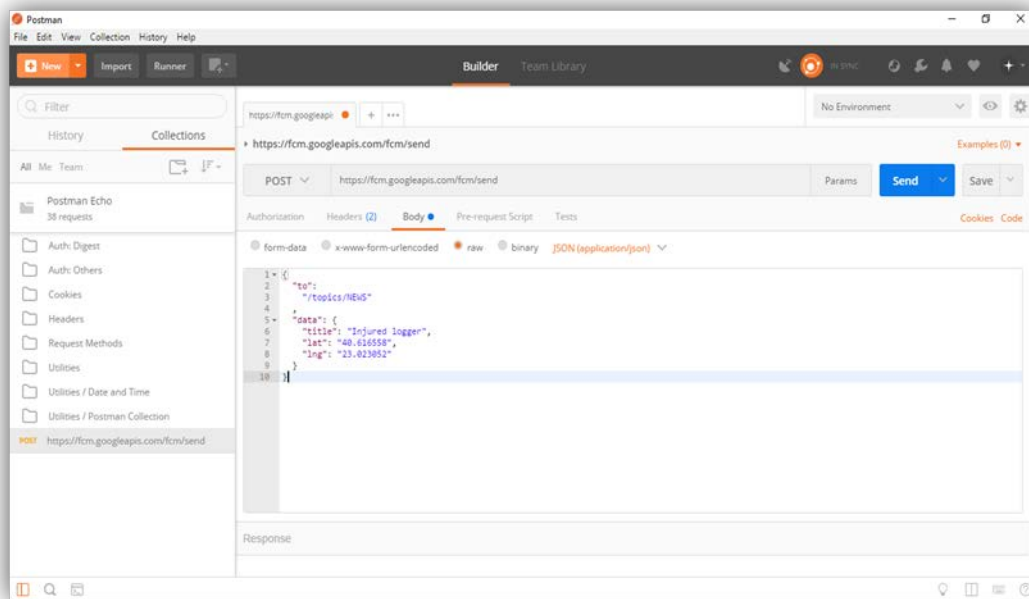

Figure 3. Postman GUI

3. Results

The project (information system) of this paper consists of a website using WAMP server, MySQL Database (phpMyAdmin), Google Maps, Postman (GUI), Firebase Cloud Messaging and an Android Application which triggers Google Maps application (Figure 4).
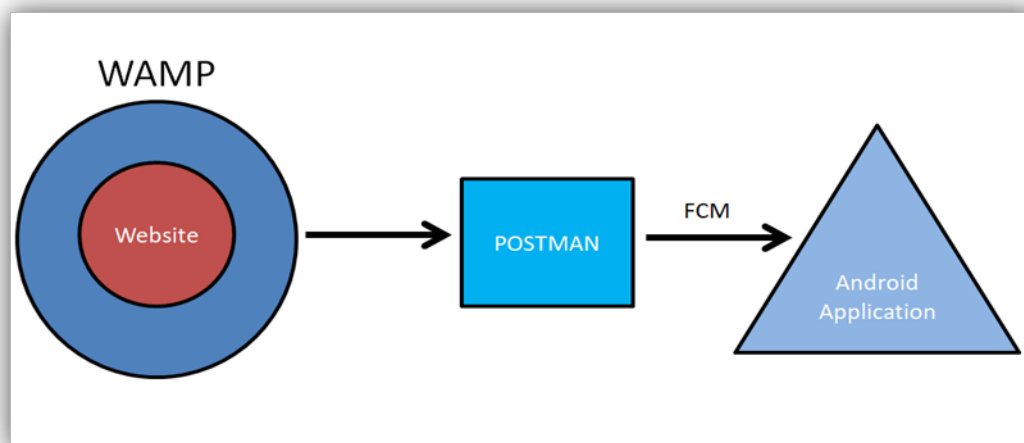

Figure 4. Information System structure

In order to describe this Information System step by step, we are going to use a hypothetical scenario. Furthermore, by using this we will be able to comprehend how the Information System interacts with the users so as to store the necessary data and send a notification or more, with the coordinates and other useful information. The scenario says that a logger got injured in the woods and we have to guide a rescue team using the shortest route. So, all we need to do is to send logger's location to the leader of the rescue team. According to our hypothetical scenario, the Information

System requires at least two end users, User_A and User_B, with very distinct roles in order the system to be functional. User_A creates the marker(s), stores the data and transmits the information. User_B receives the information in his/her Android smartphone.

Initially User_A requests the html page from the server by selecting the file Project1 from the "Your VirtualHost" tab of WampServer's Home page (Figure 2) and Google Maps is loaded. Then, User_A can click anywhere to the map creating a marker. By clicking on the marker, a pop-up window shows up with empty fields to fill in (Figure 1). All the data inserted by User_A and the coordinates are stored automatically in the database (Figure 7). Afterwards, the selected data from the database are aggregated by using the Postman GUI (Figure 3) in order to create the message which will be sent as notification. User_B receives the notification on his/her Android smartphone (Figure 5). Finally, the delivered notification triggers the Google Maps application (Android) showing the route that should be followed (Figure 6).
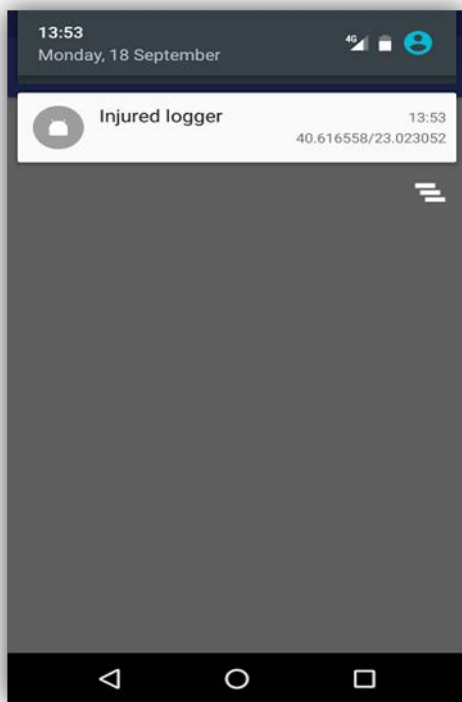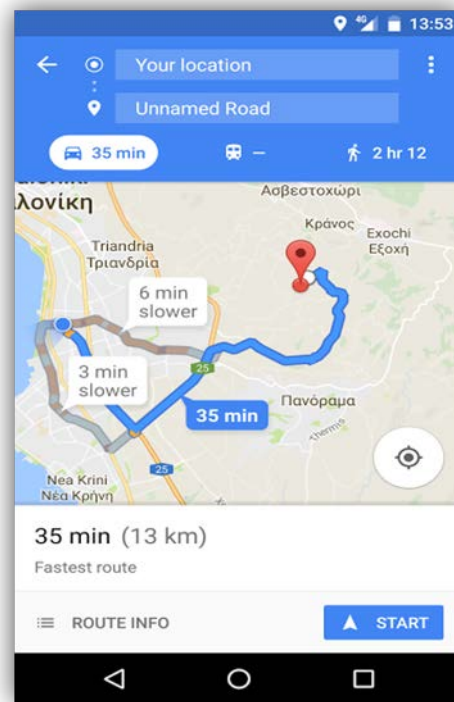

Figure 5. Notification   **Figure 6.** Google Maps (Android)

4. Discussion-Conclusions

Information systems (IS) and information technology (IT) are often considered synonymous. In reality, information technology is a subset of information systems. The perception that these terms can be used interchangeably can cause confusion for individuals interested in pursuing a technology-related career. Although both these fields deal with computers, they have distinct characteristics and specific career paths that require different education and training.

Information Systems is an academic study of systems with a specific reference to information and the complementary networks of hardware and software that people and organizations use to collect, filter, process, create and also distribute data. An emphasis is placed on an information system having a definitive boundary, users, processors, storage, inputs, outputs and the aforementioned communication networks (Jessup & Valacich 2007).

Information Technology is considered a subset of information and communications technology (ICT). An ICT hierarchy was proposed where each hierarchy level "contains some degree

of commonality in that they are related to technologies that facilitate the transfer of information and various types of electronically mediated communications" (Zuppo 2012).
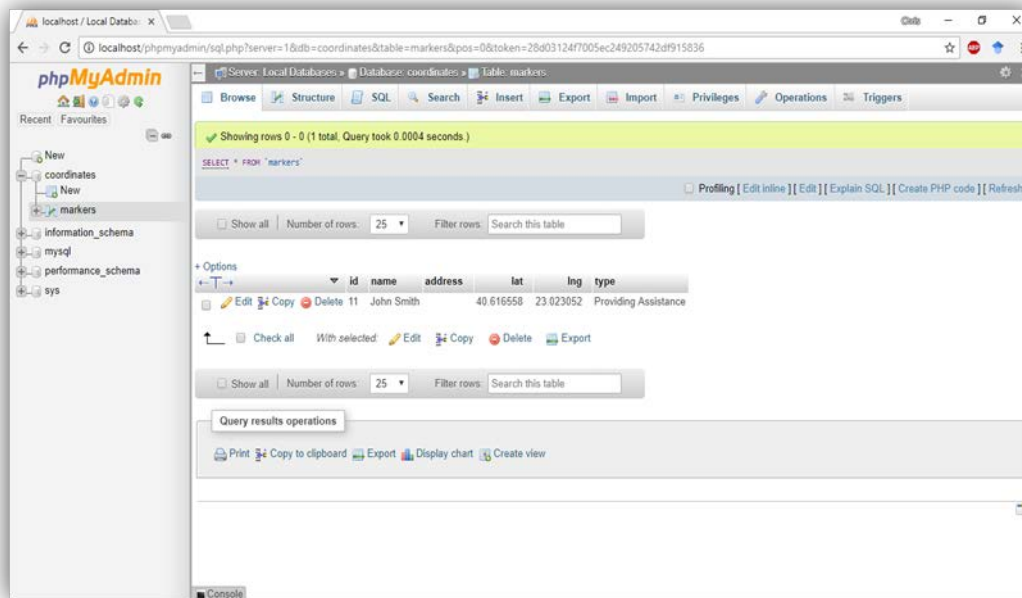

Figure 7. Database

Information and Communication Technologies can play a key role in the environmental protection, the environmental sustainability, the environmental education and the rural sustainable development (Andreopoulou 2014).

As previously stated, the forest road network accessibility plays a significant role in the sustainable forest management. Further, enhances forest's socio-economic development apart from providing a safe and suitable mode of transport. In order to succeed this, an Information System was successfully developed reducing the unnecessary vehicle shifts and ensures the shortest route. Furthermore, it could be used as a guide system for hikers, employees of the Forest Service – Police and Fire Department or even for transporting injured persons. Finally, it should be highlighted that free and open source software was used to implement this system.

5. Acknowledgements

References

Andreopoulou, S. Z., 2014. Green Informatics: ICT for Green and Sustainability. *Agricultural Informatics,* vol. 3, no. 2, pp. 1 – 8, ISSN 2061-862X http://www.magisz.org/journal

Android Studio, 2013. *Android Studio - The Official IDE for Android.* [Online]. Available at: https://developer.android.com/studio/index.html [Accessed 28 December 2017].

Athanasiadis, A. & Andreopoulou, Z., 2015. A DSS for the identification of forest land types by the Greek Forest Service. *International Journal of Sustainable Agricultural management and Informatics,* vol. 1, no. 1, pp. 76-88, https://doi.org/10.1504/IJSAMI.2015.069053

Bonn, M. A., Furr, H. L. & Susskind, A. M., 1999. Predicting a Behavioral Profile for Pleasure Travelers on the Basis of Internet Use Segmentation. *Journal of Travel Research,* vol. 37, no. 4, pp. 333 - 340. https://doi.org/10.1177/004728759903700403

Bourdon, R., 2012. *WAMPSERVER, a Windows web development environment.* [Online]. Available at: http://www.wampserver.com/en/ [Accessed 28 December 2017].

Clark, S., 2014. *Web-based Mobile Apps of the Future Using HTML 5, CSS and JavaScript.* [Online]. Available at: http://www.htmlgoodies.com/beyond/article.php/3893911/Web-based-Mobile-Apps-of-the-Future-Using-HTML-5-CSS-and-JavaScript.htm [Accessed 28 December 2017].

Demir, M. et al., 2009. Assessment of forest roads and firebreaks in Turkey. *African Journal of Biotechnology,* vol. 8, no. 18, pp. 4553 – 4561, ISSN 1684–5315 © 2009 Academic Journals

Firebase, 2011. *Firebase.* [Online]. Available at: https://firebase.google.com/ [Accessed 28 December 2017].

Google, 2017. *Google Maps.* [Online]. Available at: https://www.google.com/maps/about/ [Accessed 28 December 2017].

Jessup, L. & Valacich, J., 2007. *Information Systems Today: Managing in the Digital World.* 3rd ed., Prentice Hall Press Upper Saddle River, NJ, USA ©2007.

Lazaris, L., 2010. *CSS3 Solutions for Internet Explorer.* [Online]. Available at:https://www.smashingmagazine.com/2010/04/css3-solutions-for-internet-explorer/ [Accessed 28 December 2017].

Lerdorf, R., 2007. *PHP on Hormones – history of PHP presentation by Rasmus Lerdorf given at the MySQL Conference in Santa Clara, California.* [Online]. Available at: http://web.archive.org/web/20130729204354id_/http://itc.conversationsnetwork.org/shows/detail3298.html [Accessed 28 December 2017].

MySQL, 1995. *History of MySQL.* [Online]. Available at: https://dev.mysql.com/doc/refman/5.7/en/history.html [Accessed 28 December 2017].

Postman, 2012. *Postman is the most complete API Development Environment.* [Online]. Available at: https://www.getpostman.com/postman [Accessed 28 December 2017].

W3C, 2017. *HTML 5.2.* [Online]. Available at: https://www.w3.org/TR/html52/ [Accessed 28 December 2017].

Wing, M. G., Eklund, A. & Kellogg, L. D., 2005. Consumer-Grade Global Positioning System (GPS) Accuracy and Reliability. *Journal of Forestry,* June, vol. 103, no. 4, pp. 169 - 173.

Zuppo, C. M., 2012. DEFINING ICT IN A BOUNDARYLESS WORLD: THE DEVELOPMENT OF A WORKING HIERARCHY. *International Journal of Managing Information Technology,* vol. 4, no. 3, pp. 19, doi: 10.5121/ijmit.2012.4302. https://doi.org/10.5121/ijmit.2012.4302