Design and development of an interactive mobile-based decision support system for selecting higher education studies

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ABSTRACT

This work is an attempt to contribute to the knowledge and guidance of young people (lyceum graduates, higher education students and recent graduates) regarding important issues related to their career and vocational prospects. These issues are related to major relevant questions such as 'what' and 'where' to study, as well as the contents and the prospects of all provided specializations by the departments of Greek institutes of higher education. This article focuses on the analysis and the design of a mobile-based decision support system (DSS) to assist its users in getting thoroughly informed about HE studies in Greece, and eventually in choosing their vocational prospects. An extensive literature and applications review has revealed that there are no such DDS systems, giving to this work an innovative character. The article contains all main elements of system's architecture and design including the essential technical information, presents the main features and representative screenshots of the mobile-based application and comes to conclusions and future suggested work.

Keywords: Decision support system, higher education, mobile-based application, vocational orientation.

1. INTRODUCTION

The vocational orientation of lyceum graduates, higher education (HE) students and fresh university graduates, as well as linking higher education with labor market are two research areas that have not been investigated extensively, especially in Balkan countries. Nevertheless, these areas present significant scientific interest, so as their practical implications, because they are directly connected with the vocational orientation of the youngsters, and the desired decrease of unemployment rates in European Union and every single member country.

Among the tools used in vocational orientation, career planning and development, are the job profiles or occupational profiles. They constitute a basic or detailed description of the different professions in a standardized way, in most cases recorded in digital data bases, accessed easily and freely through computer applications. More analytically, job profile is a term used to describe any type of information that defines the inputs, process and outputs of any job. The usefulness of job profiles is apparent as the professions of each broader specialty mirror the current situation of the corresponding labor market (Field, 1996). HE jobs profiles have been established in many countries
and are used extensively by two main categories of users: a) lyceum graduates who are called to choose the field of their further studies and future profession, and b) HE students or graduates wishing to know better the vocational and academic prospects of their specialization.

This paper is a further work of a research project titled “Digital map of higher technological education professions - Diguiupro” that concerned the analysis and design of a digital guide, a web-based decision support system aiming to support youngsters who are about to enter, study, or have graduated at HE institutions (Kostoglou et al., 2013 and 2014). The present work focuses in the development and user-friendly design of an interactive platform which is based on a mobile application aiming to provide all Diguiupro functionalities to the user. We chose the mobile application spectrum because nowadays students are using their mobiles significantly more than desktops or laptops. Additionally, the more enjoyable the application looks the more usable it becomes. Companies have turned their attention to mobile applications and tend to convert them from web-based to mobile-based for two additional reasons: mobile devices are more popular today in comparison to web-based applications, and provide to their users more security. The interaction with a mobile-based application has to be very clear and easy to grasp by all ages; the complexity is a very important issue as if a user cannot find what he is looking for he will probably leave it.

A literature review in different time periods, before the Diguiupro project as well as very recently, revealed that there are no published mobile-based approaches focusing on informing and supporting users on higher education studies. This fact gives to this work a clear innovative character.

A key aspect to enhance the usability of the proposed DSS is the design of user-friendly interfaces. Simple interfaces are designed and implemented. This mobile design approach assists users to easily read and navigate through the DSS with a minimum of resizing and scrolling. Geographical Information Systems (GIS) have been utilized in order to assist users to visualize the location of the HE departments. Google Maps API has been used as a promising technology to implement mobile-based DSS with geographical data. Selected screenshots are presented in order to provide the key features of the system.

Regarding the structure of this article next section deals with the main elements of system’s analysis and design, such as the requirements analysis, the architecture of the system, the user interface and the tools used for the creation of the whole DSS. Section 3 includes a short presentation of the mobile-based application including its main features and a few representative screenshots. In the last section, some conclusions are drawn and future work issues are discussed.

2. ELEMENTS OF ANALYSIS AND DESIGN

2.1. Object-Oriented Requirement Analysis

An object-oriented approach with Unified Modeling Language (UML) has been adopted in the analysis and the design of the proposed mobile-based DSS. UML is the standard language for modeling large-scale software systems. Users can display the map of Higher Education Institutions (HEIs), display the departments of a specific HEI and view department details, such as the curriculum and employment prospects.

Figure 1 presents the class diagram in the Unified Modeling Language, the class diagram is a type of static structure diagram that describes the structure of a system by showing the system's classes, their attributes, operations, methods, and the relationships among objects (Bloch, 1996).
2.2. System Architecture

The basic system architecture is illustrated in Figure 2. Blue rectangles and names designate machines, black rectangles and names designate software/system components, red arrows lines designate physical communication channels of machines, green arrows and lines designate logical communication between components belonging to separate machines, while black arrows and lines designate logical communication between components within the same machine. The middle tier (application server machine) consists of a web server (e.g. Apache) that communicates with the mobile applications at end user machines providing them with dynamic content (JSON). Queries, appropriately restructured are forwarded by the data access component to the Database Management System (DBMS), residing on the data tier (database server machine). The Database Server, the Application Server and the Administrator's PC are interconnected through a high speed Local Area Network. The Administrator's PC runs administrative utilities that communicate with the DBMS and enable performing administrative tasks and updates of the DSS database.
2.3. User Interface / Human System Interaction

A key issue for the successful “pumping” of information from the job profiles database is a powerful yet simple User Interface (UI) to the DSS that help the end user expressing complex powerful queries. The design of the UI is based on forms providing the following capabilities:

- Fields referring to limited numbers of items are filled by allowing the user to select an item from a scrollable list. In case the number of items is fixed but too long to be handled through a list, typing any part of the item narrows and displays the corresponding list.
- For fields that are numerical of date / year type, is provided the ability to enter ranges of values.
- The selections made by the end user are displayed along with the result, so that the user can alter some of these selections and directly see the change of the results.
- Since a key characteristic of HE departments and institutions is their position on the map, fields related to geography (like regions where the end user would prefer to study) can be filled by tapping on smartphones and tablets and / or dragging on a map. The search results are also presented on a map.
- For text fields, the ability to enter wild cards or regular expressions or keywords is provided.
- Search conditions and results are saved for inspection, or reference at any future time point.
- The ability to enter conjunctions, or disjunctions of search conditions are provided (for example, search for all departments (related to “informatics” OR “information”) AND (situated in the region of “Western Greece”).
- The ability to present a comparison between the conditions of searches and the results returned are provided. This is done by displaying each group of conditions and related results in a column, followed by a column for another group etc., taking into account the width of the screen.
2.4. Tools and Technology Environment Used

A series of tools have been used for the design and development of the mobile-based decision
support system; the most important being:

- **Android visual studio** is the official Integrated Development Environment (IDE) for Android
  app development, based on IntelliJ IDEA. On top of IntelliJ's powerful code editor and
  developer tools, Android Studio offers even more features that enhance your productivity when
  building Android apps (Griffiths, 1996).
- **Android device emulator**, a virtual device that runs on your computer. The Android Emulator
  lets you develop and test Android apps without using a physical device.
- **Apache** is the most widely used web server software. Developed and maintained by Apache
  Software Foundation, Apache is an open source software available for free. It runs on 67% of
  all webservers in the world. It is fast, reliable, and secure. It can be highly customized to meet
  the needs of many different environments by using extensions and modules.
- **MySQL Server** was originally developed to handle large databases much faster than existing
  solutions and has been successfully used in highly demanding production environments for
  several years. Although under constant development, MySQL Server today offers a rich and
  useful set of functions. Its connectivity, speed, and security make MySQL Server highly suited
  for accessing databases on the Internet.
- **PHP** is a widely-used open source general-purpose scripting language that is especially suited
  for web development and can be embedded into HTML.
- **Volley** is a networking library developed by Google and introduced during Google I/O 2013. It
  was developed because of the absence, in the Android SDK, of a networking class capable of
  working without interfering with the user experience.
- **Google maps** is a mapping mobile app developed by Google for the Android and iOS mobile
  operating systems; 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.
- **Version control systems** are a category of software tools that help a software team manage
  changes to source code over time. Version control software keeps track of every modification
  to the code in a special kind of database. If a mistake is made, developers can turn back the
  clock and compare earlier versions of the code to help fix the mistake while minimizing
  disruption to all team members.

3. PRESENTATION OF THE MOBILE-BASED APPLICATION

The main features of the mobile application are the following:

- **Google map** including all Technological Educational Institutions (TEI) of Greece. The user
  can select a Marker to receive information about each individual department
- **Map for searching for TEIs and departments using complex search criteria including city of
  origin and maximum desired distance for HE studies.**
- **Function to search for department using regular expressions such as words or key phrases
  contained in a desired specialty or department.**
- **Communication and technical support** allowing users to communicate with the application
  manager to report any problem they encountered while browsing the application. The problem
  may be either a technical or content problem, for example incomplete data or information
  requiring restoration and updating.
- **DSS Manual.** Contains a complete user guide enabling the user to browse to any function with
  the use of both instructions and photos. The guide has been designed to address to users of any
  age and background.
A good picture of the mobile-based DSS and corresponding application can be provided by a few representative figures. Figure 3 presents the main menu of the mobile-based application; it is the starting point which the user can start the interaction with the application.

![Main menu of the mobile-based application](image)

**Figure 3: Main menu of the mobile-based application**

Figure 4 presents the interactive map of the Greek TEI with which the user can preview the geographical information of each TEI and access the departments of a specific TEI. The user can change the view of the map between hybrid and satellite mode; it also gives the ability to zoom in and zoom out to a specific location.

Figure 5 shows the visualization that the application offers for the search results, so that the user can alter some of these selections and directly see the change of the results on the map. A user can fill the department's name and / or the TEI's name and / or the city's name by entering wild cards and find the location of the departments that fulfill the specified criteria.
Figure 4: Interactive map of Greek Technological Educational Institutions

Figure 5: Geographical visualization of search showing all informatics engineering departments
Figure 6 shows all the available departments of the selected higher education institutions. The user can navigate to this module from different starting points, for example by selecting a particular marker within the map module that represents an individual TEI or by searching all the departments using wildcards and regular expressions.

![Figure 6: Search results of all the departments of a particular institution](image)

4. CONCLUSIONS AND FUTURE WORK

A mobile-based decision support system aiming to support youngsters who are about to enter HE studies or have recently graduated has been presented in this paper. The proposed DSS informs its users about the available departments and their vocational prospects, and finally assists them to choose HE studies in Greece. The system provides the end user with the ability to search for information related to job profiles and their relation to higher education studies by giving numerous search criteria and possibilities to combine them in an easy to fill / reuse / compare way. The information “pumped out” of the database of job profiles could serve as an advisor in the decision making of a youngster, who seeks information about the provided studies and the vocational rehabilitation they lead to. Furthermore, GIS technologies through Google Maps API have been used in order to assist users to visualize the location of the HE departments.

Based on users' functional requirements, fundamental software elements of the DSS have been introduced using UML notation. More specifically, the Class diagram and System Architecture have been presented as well as the selected screenshots. A typical 3-tier architecture was used in order to logically separate the presentation layer, the business logic layer, and the database layer.

As future work, we aim to provide some additional functionality to the proposed DSS in order to assist youngsters in the decision making of their HE studies. These enhancements can be summarized as follows: i) database historical data could be useful to answer aggregate questions (this would require dimensional modeling and creating a Data Warehouse (Golfarelli and Rizzi, [2022]).
2009), ii) data related to the placement of graduates of each higher education specialty in the labor market would give an overview of each specialty's vocational prospects, and iii) personalization and recommendation tools will further support youngsters to make their decisions.

Finally, this mobile-based DSS can be easily adapted and used for any other country and/or level or field of studies with the only provision the availability of relevant information.

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