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ANALYSIS AND DESIGN OF A WEB-BASED DECISION SUPPORT SYSTEM FOR CHOOSING HIGHER EDUCATION STUDIES

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Abstract: The vocational orientation of the youngsters who are about to enter, study, or have recently graduated at higher education (HE) institutions, and linking HE with labor market are two research areas which have not been investigated extensively in Balkan countries. Job (or occupational) profiles,among other tools used in vocational orientation, provide standardized and digitized descriptions of different professions. This article focuses on the analysis and the design of a web-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. Apart from reviewingthe related previous research work and relevant web-based systems, we present the main elements of the system's analysis and its design, the extensions that could lead to even more powerful systems, and conclusions about the advantages, limitations and practical application of the DSS.

Keywords: Computer assisted studies guide, Vocational orientation, Highereducation, Specialty of studies, Decision support system, System analysis and design.

MSC: 68U35, 91B06.

1. INTRODUCTION

The vocational orientation of lyceum (3-year upper secondary education) 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 are of exceptional scientific interest,so as their practical implications, because they are directly connected with the vocational orientation and socialization of the youngsters, and the desired decrease of the unemployment rate. Especially nowadays, these issues are of top priority as they are directly related to the efforts to decrease unemployment, which in the European South records unprecedented rates exceeding 20% of the active population and 50% of the persons aged less than 25 years [1].

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. This may include things like purpose statements, grades, roles & responsibilities, expected results, priorities, reporting structures, required skills & qualifications, experience, etc. associated with the job or the person doing the job. The usefulness of job profiles is apparent: the professions of each broader specialty mirror the current situation of the corresponding labor market [2].

This article focuses on the analysis and the design of a digital guide, a web-based Decision Support System (DSS), aiming to assist its users in getting thoroughly informed about HE studies, and eventually in choosing the most appropriate HE studies[1]. The digital guide has a twofold goal: i) support youngsters in their decision making, and (ii) inform students or graduates about their department's vocational prospects. The digital guide presents the HE departments in Greece; these departments are categorized according to their specialty, their vocational prospects, and HE institutions. These categories offer the users the opportunity to search the DSS database according to their criteria.

Furthermore, a key aspect to enhance the usability of the proposed DSS is the design of user-friendly interfaces. Simple interfaces are designed and implemented. They allow users to make their selection by mouse clicks (or by tapping on smartphones and tablets), and the least possible by typing. Finally, the responsive web design approach is utilized to provide an optimal viewing experience across a range of devices (desktop and laptop computer monitors, tablets and smartphones). This web 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 web-based DSS with geographical data. Selected screenshots are presented in order to provide the key features of the system.

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The structure of this paper is as follows: Section 2 presents the related previous research work and relevant web-based systems. Section 3 deals with the main elements of system's analysis and its design, such as the relevant functionality, data modeling, architecture of the system, and the human/system interaction. Section 4 presents selected user interfaces of the web-based system. In the last Section, some conclusions are drawn about the advantages, limitations and practical application of the digital guide.

2. RELATED WORK

HE job profiles have been established in many developed countries and are used extensively by two main categories of users: i) lyceum graduates who are called to choose the field of their further studies and future profession, and ii) HE students or graduates wishing to know better the vocational and/or academic prospects of their specialization. The organization of the information (as well as the access to it) included in the job profiles is usually implemented through software linked to powerful desktop or sometimes web-based applications. These systems can be used for setting up multiple types of job profiles, e.g. job descriptions, performance agreements/contracts, competence profiles etc. [3].

The European Commission attempted the first major effort by setting up table NACE(Nomenclature Générale des Activités Economiques dans les Communautés Européennes) containing the nomenclature of all economic activities [4]. A relevant literature review revealed that despite the significant practical work carried out in some countries (the best examples being Australia, Canada, USA and among Europe, Finland, France and UK), there is no adequate published work [5], [6]. The majority of relevant work is mainly based on web-based actions (usually web pages) for the provision of information about certain fields of studies or employment.

In general terms, the examined relevant web sites present some general characteristics, the most important being: i) the inclusion of basic data with a certain, nearly common standardization without overload of information, ii) the ease of use, iii) they are addressed to certain target groups (e.g. secondary and HE graduates, students, practitioners, as well as persons looking for a career/job change), iv) considering job as the content of the work and not the specialization provided by the educational system, and v) they use an international codification or categorization system. National occupational web-based systems or databases are maintained in several countries. The best relevant examples that can be found are those in Austria (AMS-Qualifikations barometer), Germany (Kompetenzen katalog BerufeNet), France (ROME), United Kingdom (AGCAS) [7], Sweden (Taxonomy database), Poland, Belgium (VDAB), Finland (Ministry of Employment and the Economy), USA (O*NET) [8], Canada (National Occupational Classification), Korea (KEIS), and a number of other countries [9], [10].

Another common resource for the vocational orientation of youngsters is computer-assisted career guidance (CACG) systems [11]. The first CAGS were introduced 40 years ago, with SIGI [12] and DISCOVER [13] being the first. The most recent and widely-used CACGS are CAPA and FOCUS. CAPA is based on the work of Betz and Hackett [14], and Betz and Borgen [15], and is a web-based system that suggests college and career options to individuals using an integrated assessment of

vocational interests and career confidence [16]. FOCUS [17] is also a web-based system that provides suggestions for occupations based on five types of short assessments of interests, skills, work values, personality, and preferences.

In Greece, the administration and dissemination of HE job profiles, despite several relevant efforts, is until today occasional without long-term provision of the information and support to the users. Some relevant initiatives indicating the above are: i) The National Statistical Authority of Greece has codified all the professions, however without regular update [18], ii) The Career Services of HE establishments (all the Technological Educational Institutions (TEI) and some Universities) compiled 96 detailed job profiles of their departments without extensive dissemination to their interested categories of users [19], [20], iii) the Pedagogical Institute (named since 2012 Institute of Educational Policy) has produced through Nestor Network 250 summarized professional monographs and created a relevant database application, which has not been updated since 2006, iv) the National Organization for the Certification of Qualifications & Vocational Guidance has produced 202 detailed monographs of certified occupational profiles following the international practice, thus describing certain professions of the labor market; nevertheless very few of them correspond to HE graduates [21], and v) the Manpower Employment Organization carried out the probably best relevant work by the creation of 1450 professional monographs which are presented on a web application as well as in printed form [22]. However, only a small percentage of the above mentioned works and computer applications concern specializations directly related to HE studies.

The study of the related work as well as the examination of several websites revealed that there are significant differences in used professions' titles, as well as in the contents (analyzed fields) and the sizes of the job profiles. The main affecting factors are the place (country or geographical area), the time of publication or uploading on the WWW, and mainly the aim of each relevant study. These findings lead to some conclusions. The HE job profiles should: i) focus on a certain country or geographical area with common socio-economic characteristics, ii) be updated frequently in order to mirror the changes of HE, labor market and economy, and most importantly iii) be presented and disseminated to the stakeholders through a web-based system able to provide an in-depth search of the desired information, as well as to support their decisions for choosing the appropriate higher education studies. The present work attempts to fulfill this last significant need.

3. ELEMENTS OF ANALYSIS AND DESIGN

3.1. Object-Oriented Requirement Analysis

Object-oriented approach with Unified Modeling Language (UML) has been adopted in the analysis and the design of the proposed web-based DSS. UML is the standard language for modeling large-scale software systems [23]. UML includes several types of diagrams in order to model the static and dynamic behavior of a system. The Use Case diagram and the Class diagram of the proposed DSS are presented. Use Case diagrams consists of actors, use cases and their relationships. A use case refers to a specified functionality of the system under discussion. Class diagrams are fundamental

software elements of the DSS and consist of a set of classes, interfaces and associations that represent the object-oriented view of a system.

We have two types of actors in the proposed DSS: i) Users and ii) Registered Users. Users can register, 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. Registered users can search for one (or more) field(s) of study by keywords or/and topic or/and distance between different cities and display departments. This distinction is made, because registered users have filled out a registration form providing personal information. The proposed DSS builds a user profile in order to present suggestions depending on the information provided.

Referring to the static model of the system under discussion, a region includes a number of cities, a city has many HEIs and a HEI consists of multiple departments. A set of departments with related subjects form a school (faculty). A specific subject is related to several keywords. The Use Case and the Class diagram are illustrated in Figures 1 and 2, respectively. The diagrams have been designed with Visual Paradigm [24].

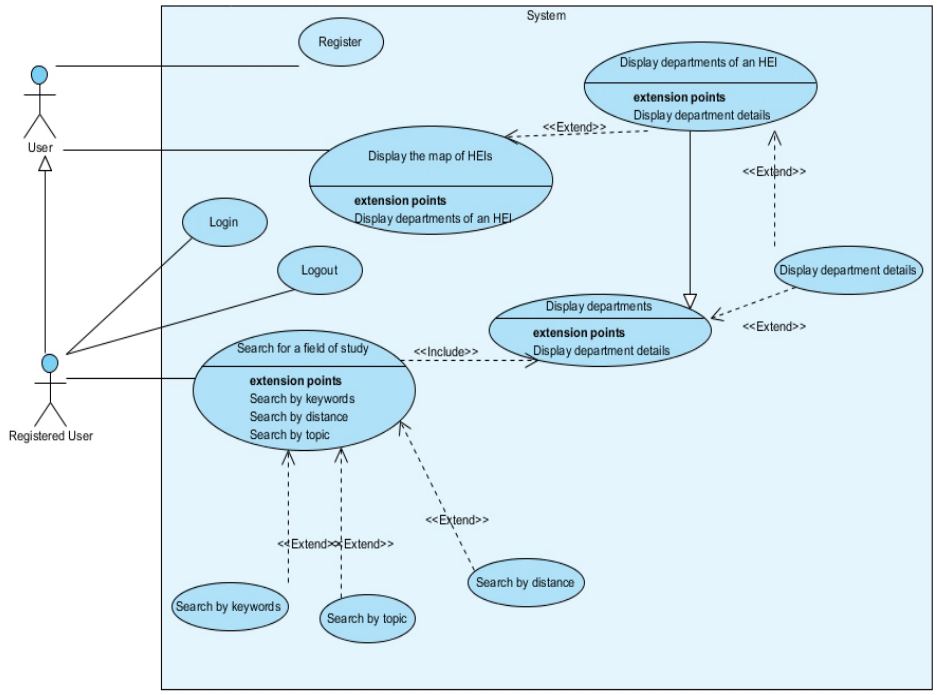

Figure 1: Use Case diagram

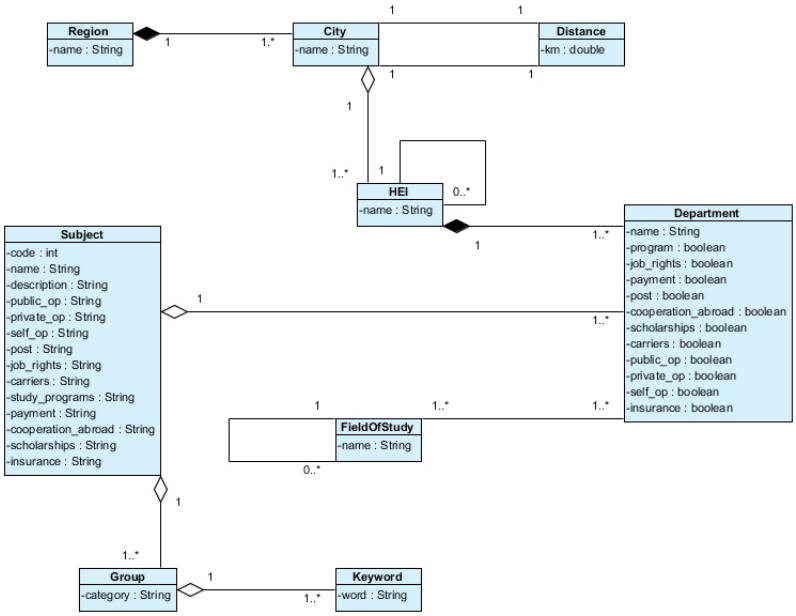

Figure 2: Class diagram

3.2. DataModeling

The database is used to store the adequate information for each entity and support the decision making process. The Extended Entity Relationship (EER) model is illustrated in Figure 3. The diagram was designed by MySQL Workbench [25]. The entities and relationships represent:

- regions of Greece
- cities in which HEIs are located
- distances between user's city and a HEI's city
- HEIs
- departments of HEIs
- schools that represent a set of departments
- subjects of related departments
- group of subjects
- keywords for each group of subjects

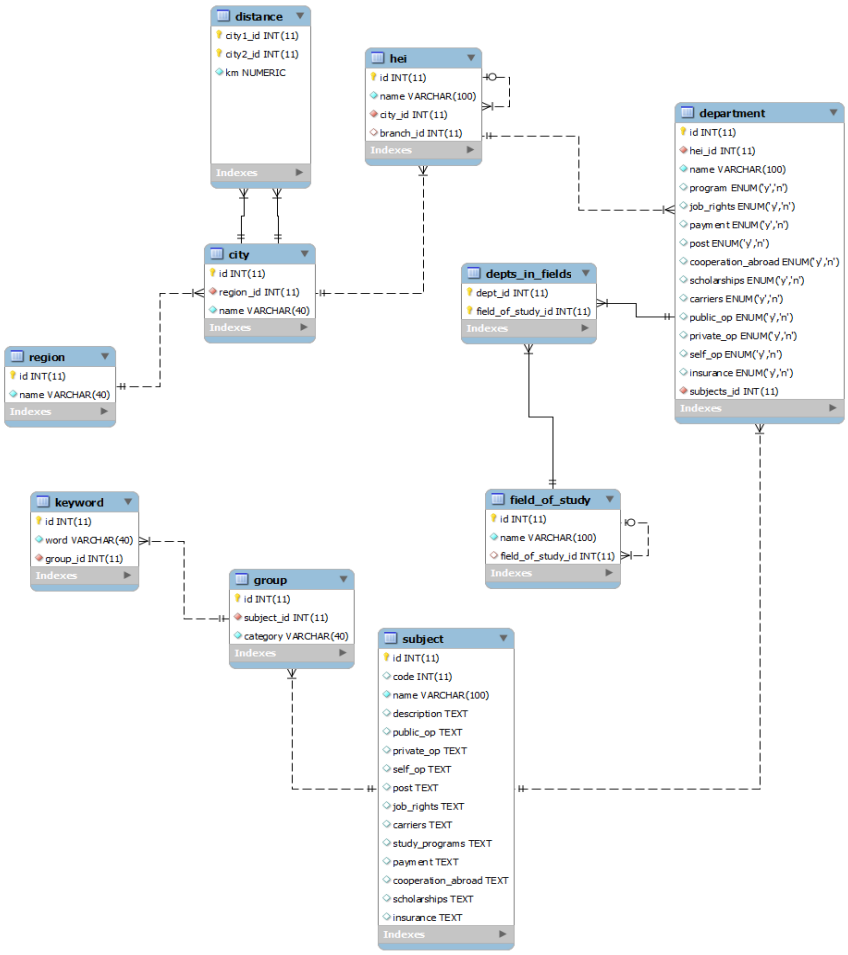

Figure 3: The Extended Entity Relationship (EER) model

3.3. System Architecture

The basic system architecture is illustrated in Figure 4. 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 main part of the system (excluding the Administrator's PC) formstypical 3-tier architecture [26]. The presentation tier consists of end-user machines (PCs / laptops / tablets / smart mobile devices) running web browsers that display web pages allowing access to the DSS (implementing the functionality illustrated in Figure 1). Theseweb pagesarebasedonAjaxtechniques to create

a synchronous web application. Thus, the browsers at end-user machines should support Ajax (like recent versions of most common browsers). For smart mobile devices and tablets, special versions of the web pages have been created to deal with limited screen size and touch-screen capabilities of these devices. The middle tier (application server machine) consists of a web server (e.g. Apache) that communicates with the web browsers at end user machines providing them with web pages (dynamic content). This content is created on the data which the application logic component (the actual DSS) produces by forwarding end user queries to the query processor component. The application logic component is based on the classes illustrated in Figure 2. 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 DBMS hosts the DSS database that is structured according to the EER model of Figure 3. Moreover, the communication between the DBMS and its administrator,which update the DSS database, follows client-server architecture [26] for extra security (not exposing the data tier to the web). 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.

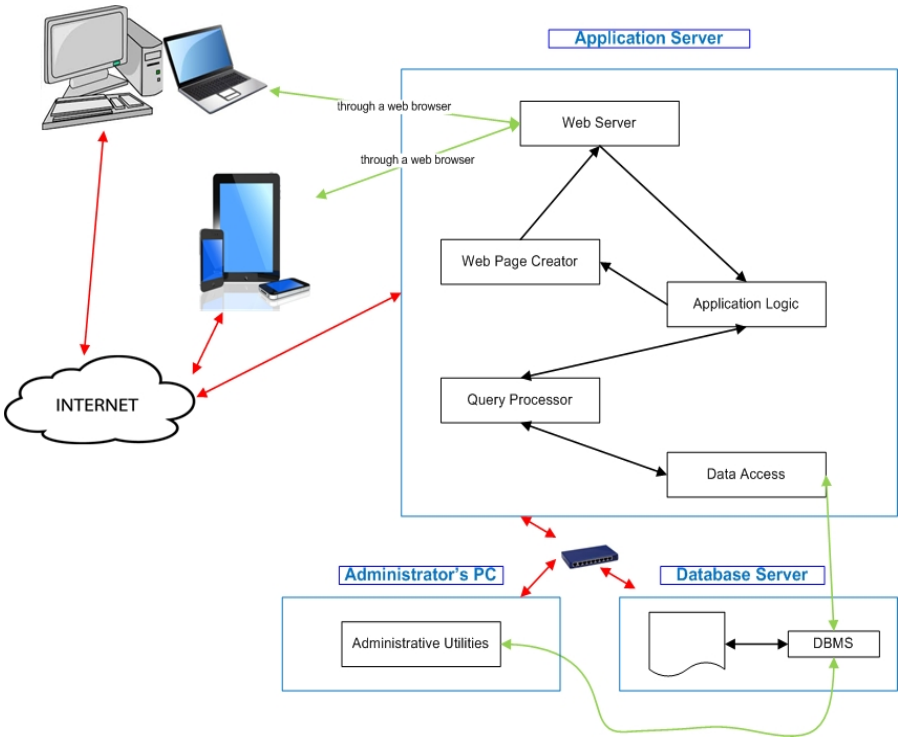

Figure 4: System Architecture

3.4. 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 powerful queries. The design of the UI is based on forms providing the following capabilities (characteristics):

- Fields referring to limited numbers of items (like the Higher Institutions of Greece) 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 (like titles of departments, which number several hundreds), typing part of the item (the first letters, or any subsequent letters of the item) narrow and display the list (by exchanging data with the database on-the-fly, through Ajax).
- For fields that are numerical of date / year type (like distances of departments from the residence of the end user, or the year of establishment of a department), the possibility to enter ranges of values are given.
- 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 (by exchanging data with the database on-the-fly, through Ajax).
- Since a key characteristic of HE departments and institutions is their position on the map of Greece, fields related to geography (like regions where the end user would prefer to study) are able to be filled by mouse clicks (or by tapping on smartphones and tablets) and / or dragging on a map, or the search results are also presented on a map, when possible.
- For text fields the ability to enter wild cards (or even regular expressions) is provided (for example, in a field related to the subject of studies, "electr*" returns all departments that are related to "electrical", "electricity", "electronic). Moreover, the ability to search by lists of 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 (this ability is appropriate for non-mobile devices, having a wide enough screen).

Selected screenshots are presented in Section 4 in order to present the key features of the system.

4. PRESENTATION OF THE WEB-BASED DSS

The web-based DSS has been implemented using PHP, MySQL and Javascript. Furthermore, Ajax has been used in order to exchange data with the database on-the-fly and Google Maps API has been utilized for the visualization of the geographical data of the HEI departments.

Figure 5 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.

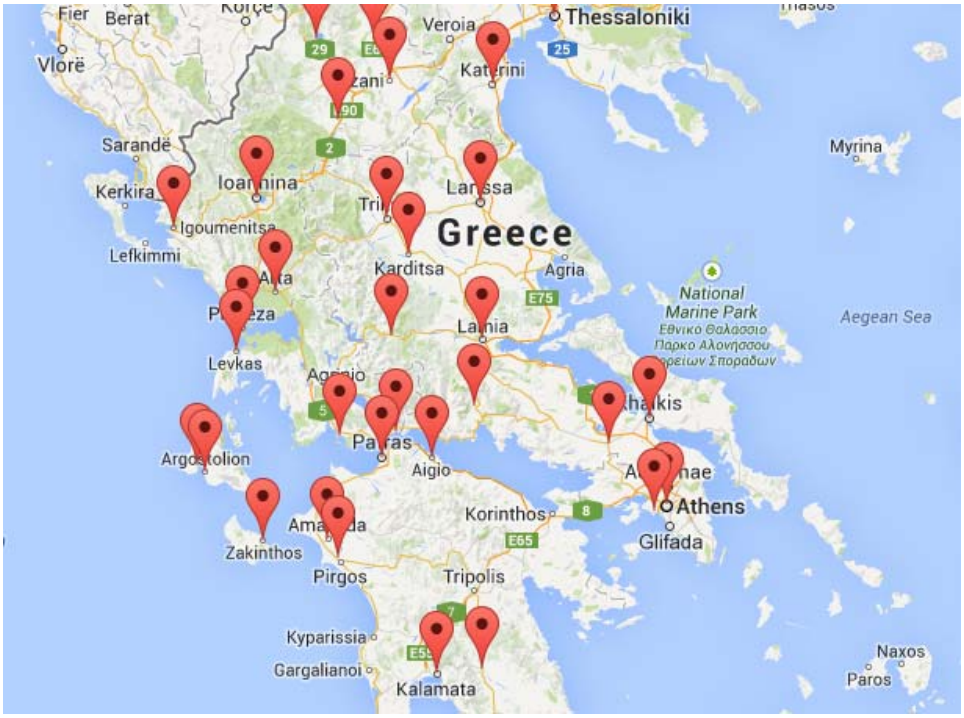

Figure 5: Interactive Map of Greek Technological Educational Institutions

Figure 6 shows the visualization that the DSS 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 (by exchanging data with the database on-the-fly, through Ajax). 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 specific criteria.

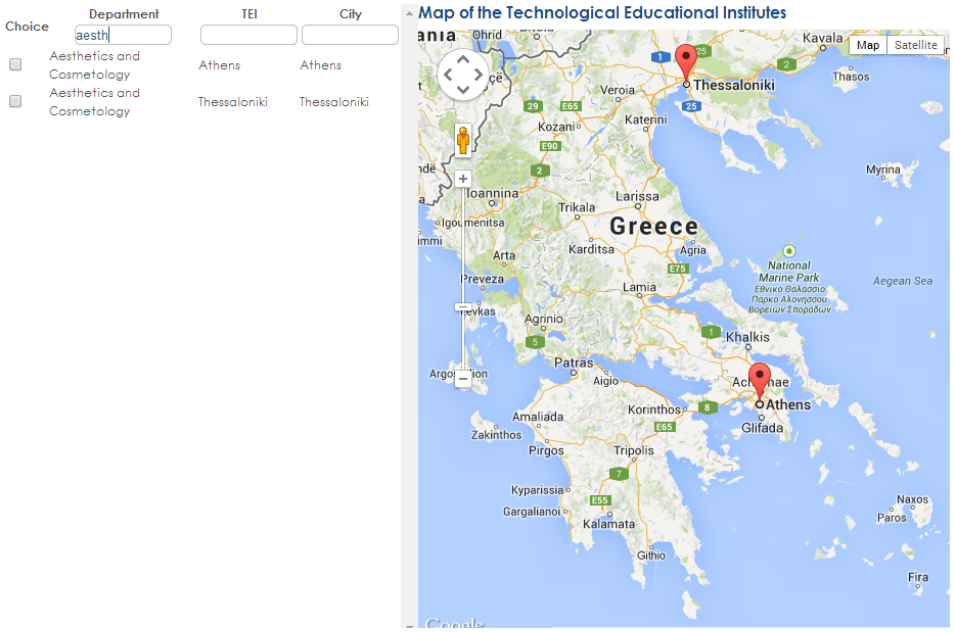

Figure 6: Geographical Visualization of Search Results

The web-based DSS utilized the responsive web design approach in order to provide an optimal viewing experience across a range of devices (desktop and laptop computer monitors, tablets and smartphones). This feature assists user to easily handle the DSS with a minimum of resizing and scrolling. Figure 7 presents the initial page of the DSS on smartphones and tablets. Furthermore, Figure 8 shows the interactive map of the Greek TEI on smartphones and tablets.

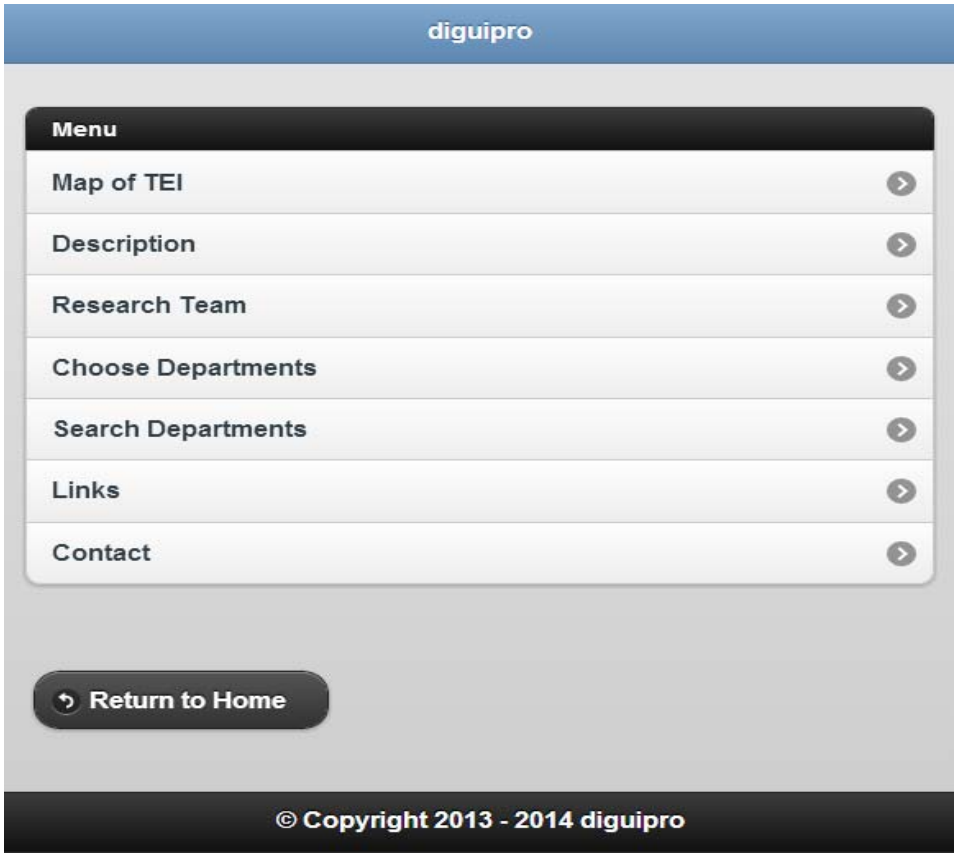

Figure 7: Initial Page of the DSS on Smartphones and Tablets

Figure 8: Interactive Map of Greek Technological Educational Institutions on Smartphone and Tablets

Finally, Figure 9 presents the advanced search screen that a user can utilize to find specific departments. The user can fill a keyword and / or select a department from the list and / or select the range of distance from a city that the departments are located.

Figure 9: Advanced Search of Departments

5. CONCLUSIONS AND FUTURE WORK

A web-based decision support system aiming to support youngsters in Greece who are about to enter, study, or have graduated at HE institutions has been presented in this paper. The proposed DSS informs its users about the available departments and their vocational prospects, and finally assist 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 in Greece 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 is confused about the provided studies and the vocational rehabilitation they lead to. The responsive web design approach was utilized to provide an optimal viewing experience across a range of devices. 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 Use Case diagram, Class diagram and EER model have been presented. Furthermore, the system architecture of this system was introduced, and selected screenshots were presented. 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 [27]), ii) data related to the placement of graduates of each higher education specialty in the labor market would give an overview of vocational prospects of each specialty, and iii) personalization and recommendation tools will further support youngsters to make their decisions.

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