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TOWARDS A WEB BASED DECISION SUPPORT SYSTEM FOR CHOOSING HIGHER EDUCATION STUDIES

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Abstract: *The vocational orientation of youngsters that are about to enter, study at, or have recently graduated from higher education (HE) institutions, as well as linking between HE and labour market are two research areas that have not been investigated extensively in Balkan countries. Among the tools used in vocational orientation are the job (or occupational) profiles that provide standardized and digitized descriptions of different professions. This article focuses on the analysis and design of a web based decision support system (a digital guide) aiming to assist its users in getting thoroughly informed about and eventually in choosing HE studies in Greece, in relation to their vocational prospects. Apart from reviewing related previous research work and relevant web based systems, main elements of the system's analysis and design, extensions that could lead to even more powerful systems and conclusions about the advantages, limitations and practical application of the digital guide are presented.*

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

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 between higher education and labour market are two research areas that have not been investigated extensively, especially in Balkan countries. Nevertheless, these areas present exceptional scientific interest and practical implications because they are directly connected to the vocational orientation and socialization of the youngsters and the desired decrease of the unemployment rate, a very significant priority at personal, state and European level. Especially nowadays these are issues of top priority as they are directly related with 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 (Eurostat 2012).

Among the tools used in vocational orientation and in 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 and are in most cases recorded in digital data bases, accessed easily and freely though 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 (Field 1996).

This article focuses on the analysis and design of a digital guide; a web based Decision Support System (DSS) aiming to assist its users in getting thoroughly informed and eventually choosing the most appropriate for them higher education studies. The digital guide has a twofold goal: i) support youngsters in the decision making of their HE studies, and (ii) inform students or graduates about their department's vocational prospects. The digital guide will present the HE departments in Greece; these departments will be categorized according to their specialty, their vocational prospects and HE institutions. These categories will offer the opportunity to the users 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 will be designed and implemented. These will allow users to make their selection by mouse clicks and the least possible typing. Finally, the responsive web design approach will be utilized to provide an optimal viewing experience across a range of devices (desktop and laptop computer monitors, tablets and smartphones). This web design approach will assist users to easily read and navigate to the DSS with a minimum of resizing and scrolling.

The structure of this paper is as follows: Section 2 presents related previous research work and relevant web based systems. Section 3 deals with the main elements of system's analysis and design such as the relevant functionality, the data modeling, the architecture of the system and the human system interaction. Section 4 discusses extensions / additions that could create an even more powerful system. In article's last Section some conclusions are drawn about the advantages, the limitations and the 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 eventually their 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 (People Resolutions 2013).

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 (Communautés Européennes 1990). A relevant literature review revealed that despite the significant practical work carried out in some countries (the best examples being Australia, Canada, Finland, France, USA and UK) there is no adequate published work (Boreham *et al.* 2002, Mulder *et al.* 2005). 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) consider usually as job 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 can be found are in Austria (AMS-Qualifikationsbarometer), in Germany (Kompetenzenkatalog BerufeNet), in France (ROME), in United Kingdom (AGCAS), in Sweden (Taxonomy database), in Poland, in Belgium (VDAB), in Finland (Ministry of Employment and the Economy), in USA (O*NET), in Canada (National Occupational Classification), in Korea (KEIS) and a number of other countries (Tijdens et al. 2012a, Tijdens et al. 2012b).

Another common resource for the vocational orientation of youngsters is computer-assisted career guidance (CACG) systems (Chapman & Katz 1982). The first CAGS were introduced 40 years ago, with SIGI (Katz 1973) and DISCOVER (Rayman & Harris-Bowlsby 1977) being the first of them. The most recent and widely-used CACGS are CAPA and FOCUS. CAPA is based on the work of Betz and Hackett (1981) and Betz and Borgen (2000). CAPA is a web-based system that suggests college and career options to individuals using an integrated assessment of vocational interests and career confidence (Betz & Borgen 2009). FOCUS (Career Dimensions, Inc. 2007) 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 the 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 (Hellenic Statistical Authority 2013), 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 (Ganetsos *et al.* 2009, Karamesini 2008), 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 labour market; nevertheless very few of them correspond to HE graduates (National Organization for the Certification of Qualifications & Vocational Guidance 2013), 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 (Manpower Employment Organization 2013). 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 in a certain country or geographical area with common socio-economic characteristics, ii) be updated frequently in order to mirror the changes of HE, labour 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 for them 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) (Booch et al. 1999) has been adopted in the analysis and design of the proposed DSS. UML is the standard language for modeling large-scale software systems (Booch et al. 1999). 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. 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 were designed with Visual Paradigm (2013).

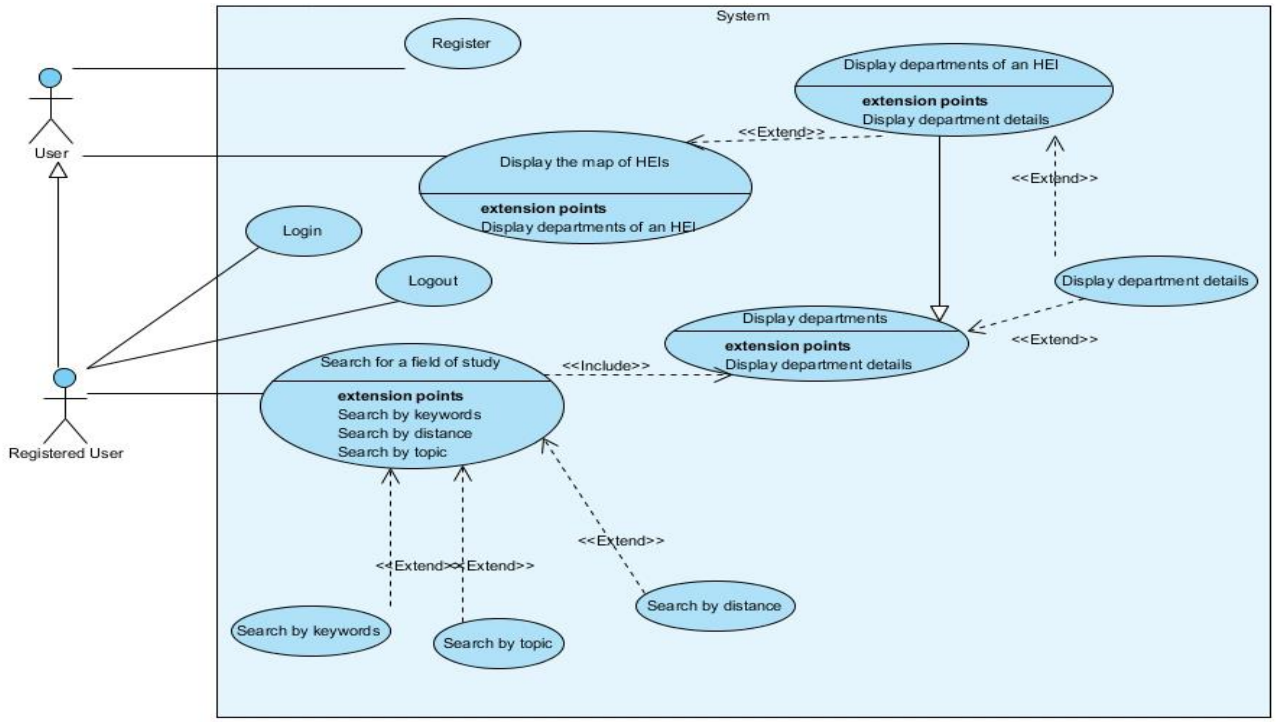

Figure 1: Use Case diagram

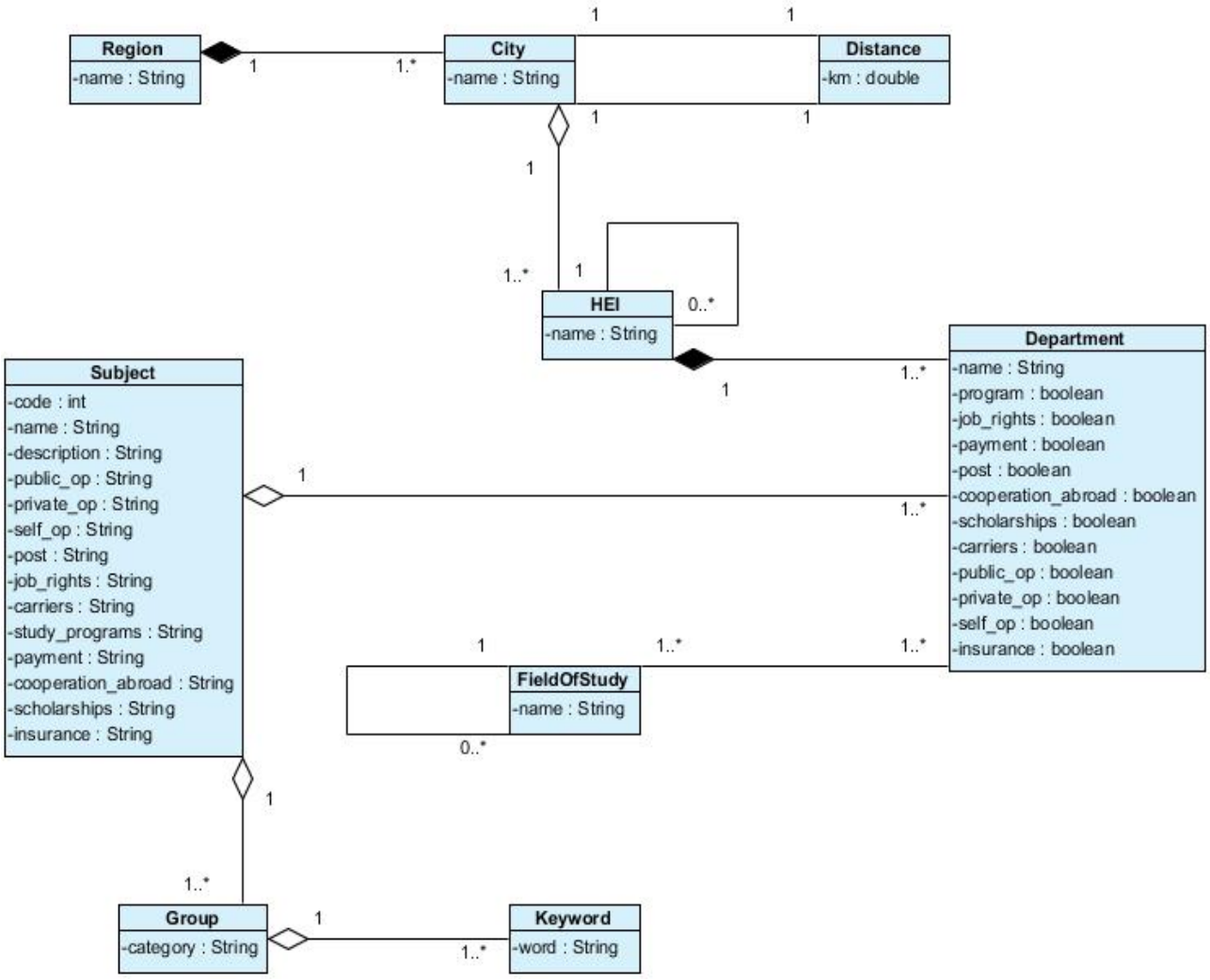

Figure 2: Class diagram

3.2. Data modeling

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 with MySQL Workbench (2013). 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

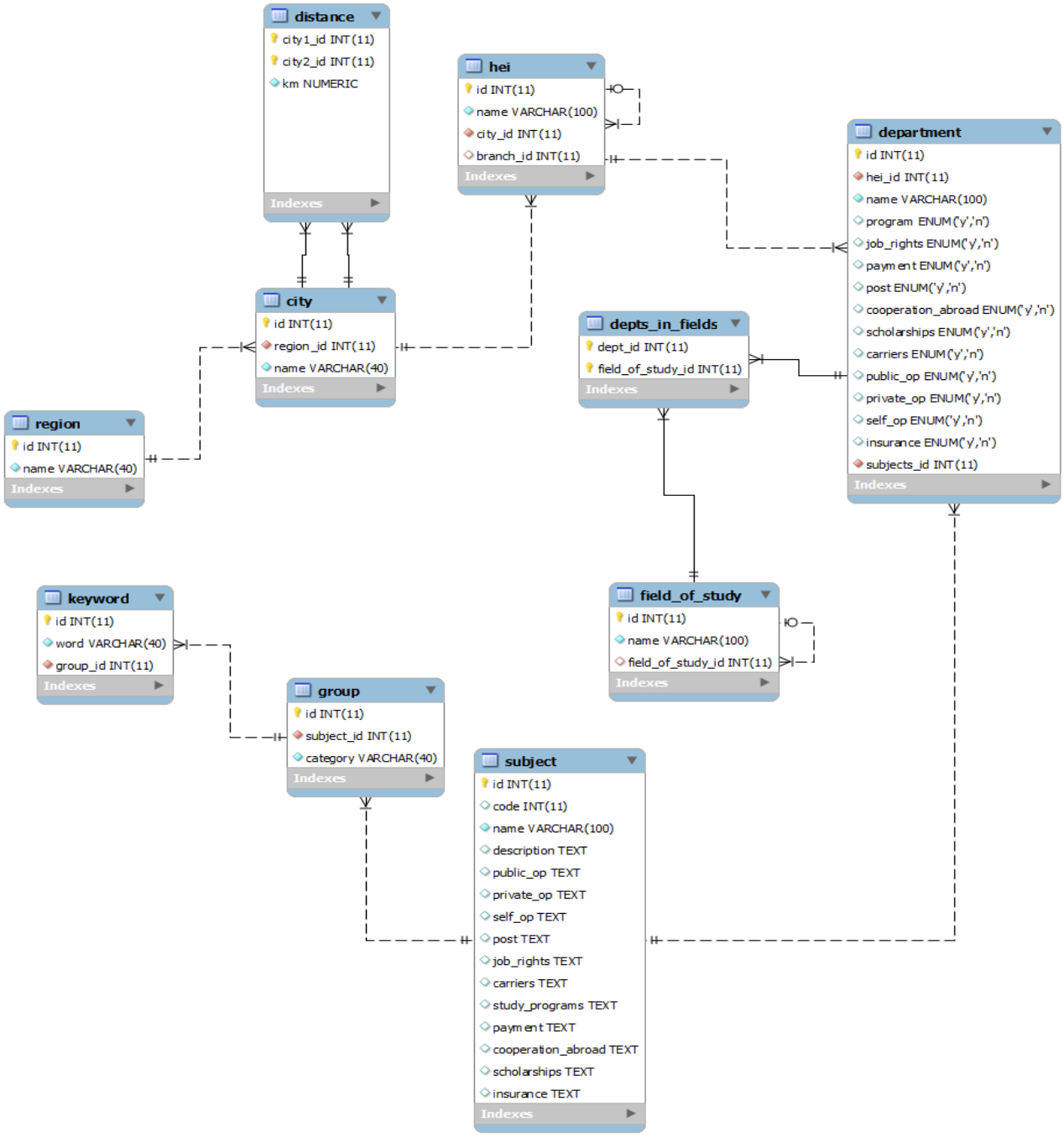

Figure 3: EER model

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 and lines designate physical communication channels of machines, purple arrows designate logical communication between components belonging to separate machines, while black colored arrows designate logical communication between components within the same machine. The main part of the system (excluding the System user PC) forms typical 3-tier architecture (Sommerville, 18th ch., 2010). The presentation tier consists of end-user machines (PCs / laptops / smart mobile devices) running web browsers that display web pages allowing access to the DSS (implementing the functionality illustrated in Figure 1). These web pages are based on Ajax techniques, 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, special versions of the web pages will be created, to deal with the limited screen size and the 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 by data that 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 ERR model of Figure 3. Moreover, the communication between the DBMS and its administrator, or the system users that update the DSS database follows a client-server architecture (Sommerville, 18th ch., 2010), for extra security (not exposing the data tier to the web). The Database Server, the Application Server and the System user PCs are interconnected through a high speed Local Area Network. The System user PCs run administrative utilities that communicate with the DBMS and enable performing administrative tasks and updates of the DSS database.

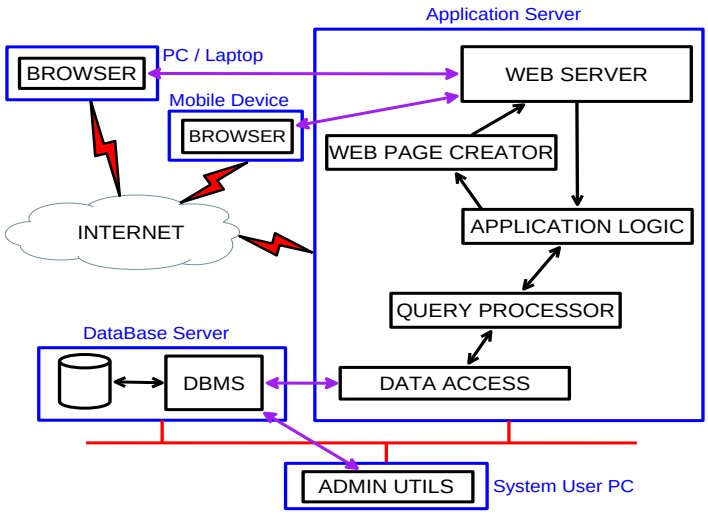

Figure 4: System architecture

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 should help the end user expressing powerful queries. The design of the UI should be based on forms providing the following capabilities (characteristics).

- Fields referring to limited numbers of items (like the Higher Institutions of Greece) should be 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) should 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 should be given.

- The selections made by the end user should be displayed along with the result (e.g. on a column on the left, or on a line on top), 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) should be able to be filled by mouse clicks and / or dragging on a map, or the search results should also be presented on a map, when possible. For example, in Figure 5, the position of departments related to "Tourism" is depicted.
- For text fields the ability to enter wild cards (or even regular expressions) should be provided (for example, in a field related to the subject of studies, "electr*" should return all departments that are related to "electrical", "electricity", "electronic). Moreover, the ability to search by lists of keywords should be provided.
- Search conditions and results should be saved for inspection, or reference at any future time point.
- The ability to enter conjunctions, or disjunctions of search conditions should be 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 should be provided. This could be 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 will probably be appropriate for non-mobile devices, having a wide enough screen).

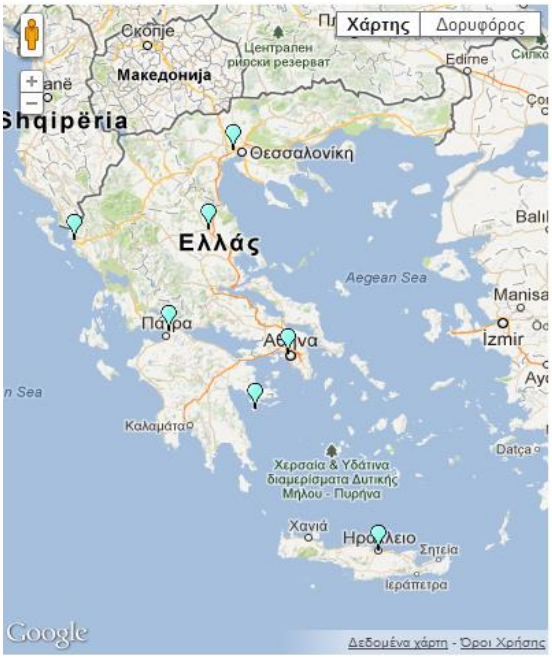

Figure 5: Departments related to "Tourism" on the map of Greece (Map of Greek Higher Education 2013).

4. DISCUSSION

The system presented in the previous sections 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 an advisor in the decision making of a youngster, who is confused about the studies provided and the vocational rehabilitation that these lead to. The functionality of the DSS and the information provided could be further enhanced:

- By embedding in the job profile database historical data that could help to answer aggregate queries (e.g. which is the average entry grade for a department, or for departments belonging to a specific school, or to a specific region). This would require dimensional modeling and creating a Data Warehouse (Golfarelli and Rizzi 2009).
- By embedding in the job profile database data related to the placement of graduates of each higher education specialty on the labor market.

- By extending the web based DSS to support personalized user information, provided by the user him/herself though wizards and questionnaires. The user profile information could be used as an additional filter for producing results, or for forming ranking criteria for the results.
- Apart from "pumping out" exact information existing in the job profile database based on the criteria entered by the user, the DSS could also use criteria and information provided by the user to form recommendations (Ricci et al. 2011) for his/her choice of job / study specialty.

5. CONCLUSIONS AND FUTURE WORK

A web based decision support system, which aims to support youngsters in Greece that are about to enter, study at, or have graduated from HE institutions, has been presented in this paper. The proposed DSS will inform its users about the available departments and their vocational prospects and finally assist them to choose HE studies in Greece.

Based on users' functional requirements, the 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. 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 presented in Section 4 can be summarized as follows: i) database historical data could be useful to answer aggregate questions, 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 their decision.

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