Database Design for the Web Based University Project Management Information System

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Abstract: *Web applications and particularly Web based Information Systems are very popular due to several reasons. The main reason is the ability to update and maintain them without distributing and installing software on thousand of client computers. This paper describes the main stages of the development process and mainly requirement analysis and database design. Such kind of system will provide students with the opportunity to choose among more projects, to work with different specialists in other conditions, in international teams, in different environments and to have more opportunities for their future professional realization.*

Key words: *database design, web based information systems, design phases.*

INTRODUCTION

Nowadays a lot of information is collected and stored for different aspects of the everyday life and particularly in the education and in the universities. The database is the only professional structure for organizing, manipulating and retrieving deferent information structures and huge amount of data. [4, 7, 8]. Using database management systems (DBMS) brings several advantages, like quick access, high security, integrity, durability, automated reports and statistics, multiuser access etc. Some of these advantages are provided by the DBMS, but it is not easy for non-specialist users to work directly with DBMS interface and it is not safe to have data access in this level, and it is necessary to design and develop a specialized information system (IS). IS projects sometimes are initiated to improve the accuracy of the processing data or ensure that a procedure prescribing how to do specific task is always followed [4, 11, 12, 13]. The Web brings database information to the world and more and more IS, so-called Web-based Information Systems (WIS), are accessible on Internet. These WIS address various application domains such as e-business, education, geography, etc. As any other IS, WIS are designed to manage very large sets of data and to offer specialized services. Moreover, in the context of the Web, they are supposed to offer navigation facilities (through hyperlinks and/or dynamic web pages) generally embedded into a multimedia presentation of information [6, 10, 11, 13]. All these characteristics make these systems attractive and popular.

MOTIVATION

One of the aspects of the main goal of the project European Thematic Network for Teaching, Research and Innovations in Computing Education (ETN TRICE) is to integrate teams from universities, research institutes and companies so that this Network becomes teaching, research and innovations operator in Computing Education [14].

The main activities of ETN TRICE will be developed along three main lines:

- Teaching, leading to high quality education, utilising modern technologies such as e-Learning, m-Learning, development of new educational programs etc.
- Providing opportunities for active participation of students and staff in various research activities.
- Promoting innovations through close cooperation with companies and small and medium size enterprises.

For the purposes of the above tasks it is needed to be developed an application that provides storage, organization and access to the information for developing research projects for upcoming opportunities for collaboration between the participating partners of the project ETN TRICE.

Future young professionals have solved problems of different research areas by developing various types of projects during their education at university. These projects can be set both by professors at the universities and from real businesses or in combination - as a result of collaboration between business companies and universities. These projects can be classified in different types, depending on the degree of the students and also the period of the development – they can be teamwork or individual projects during the training and education, and graduation projects for bachelor and master degrees.

The presence of such an application would allow the ***opportunity*** for students to choose among more project topics not only from their own university or country, to work with different specialists in other conditions, in international teams, in different environments and to have more opportunities for their future professional realization.

Traditionally the students should use the following ***procedure in the process of project selection***:

- Professors individually or together with the companies with similar interests published their topics for students' projects on their web sites or on the Departments website, depends on the practice in the university.
- Students have to check for the new topics in their area of interest and to contact the publisher of the selected topics and to agree whether the topic is still free, what are the requirements and expectations, the deadlines, the expected, what is necessary to know and to develop. This may be realized in e-mail correspondence or they can discus about the project and at the end they agree for the future common work or not.
- They should then start the procedure of development and arrange the administrative formalities regarding their work together.

Usually this process requires a mandatory face to face contact and discussion between professors or project contractor and students. It is therefore difficult student from one university to work and develop a project from another university and more over from another country.

To facilitate and automate this process one of the tasks under the ETN TRICE is associated with the development of application that allows web based access to information about the project topics, partners and students who are interested in such collaborated work. This information is useful for students not only during their education but also for their realization. This tool will provide prospective students with a great source of knowledge about active research helping them to define their studies in a most efficient and up-to-date way. It is expected that students will be more motivated by being given access to this information.

THEORETICAL ASPECTS OF THE PROBLEM

During the past 30 years, software has conquered an essential and critical role in our society. We increasingly depend on the features and services offered through computerized systems. The development process for such type of information systems is very topical and widely discussed research problem. It can be represented with the diagram in figure 1 [2, 9].

What is needed is a methodology to discover the organization's requirements, define a specification, design a database, implement that database design, and finally maintain that database. Fortunately, there is a methodology; it is known as the System Development Life Cycle (SDLC). This methodology consists of the following main stages: Requirements, Design, Implementation, Verification, and Maintenance. Before designing and developing any information system it is necessary to clarify the objectives that this system should satisfy. The first step is to analyze the requirements to the information system and to propose the database model according them.

Database design is one of the main topics of any introductory database course. The creation of a database requires a design process to define types, structures and

constraints for the data to be stored in the computer [1, 3, 4, 5, 7]. This process can be summarized in four following main steps:

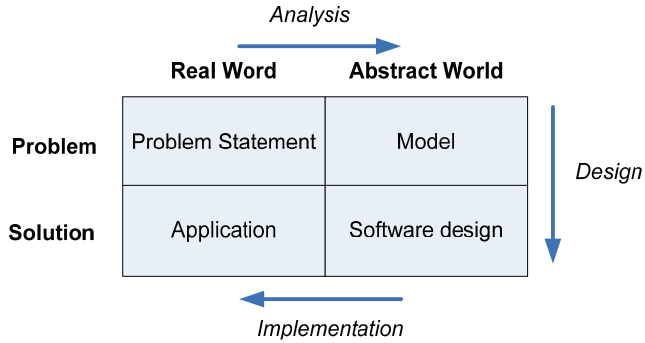

Fig. 1. The software process model

- First, the ***analysis of the requirements*** of the real world situation that has to be represented.
- Second, the ***definition of the conceptual schema*** that gives a high level description of the database and the requirements that data must satisfy. The most popular approach for conceptual schema designing is the Entity-Relationship (ER) model [1]. The ER- model considers the world as a set of entities and the relationships between them.
- Third, the ***definition of a logical design***, which gives a high level schema implementable on a database management system. The relational model [2, 3] is the most common data model used for database management. It represents the database as a collection of relations where each relation resembles a table of values. To create relations with no redundant data, with an efficient data organization and that can be modified in a consistent and correct manner, a normalization process is applied.
- Fourth, the ***definition of a physical design*** which represents the internal data storage details.

ANALYSIS OF THE REQUIREMENTS

According to the main goal of the application it will be implemented as a standard application with three-tire architecture (presentation, application or business logic and data tires) and will be integrated with the existing applications and the web site of the project and particularly with this part which concerns the user registration process. It will use the existing user registrations and the part of the database with partners and users information. In figure 2 is depicted a reduced use-case diagram of the system.

Four types of users will work with this information system:

- ***Administrator*** – in this application the main role of the administrator is to monitor the application process and if there are waiting applications for topics from the students without decision after the deadline he have to remind the partners to review their applicants and to make a decision about them. Administrator has full access to all different type of users and their information. He can see all reports and can manage them.
- ***Visitors / guests*** – they only could see the information about partners, topics, students – who is working on what project. The system will provide an appropriate user friendly interface to formulate various queries based on a set of criteria, whose values can be selected from predefined lists.

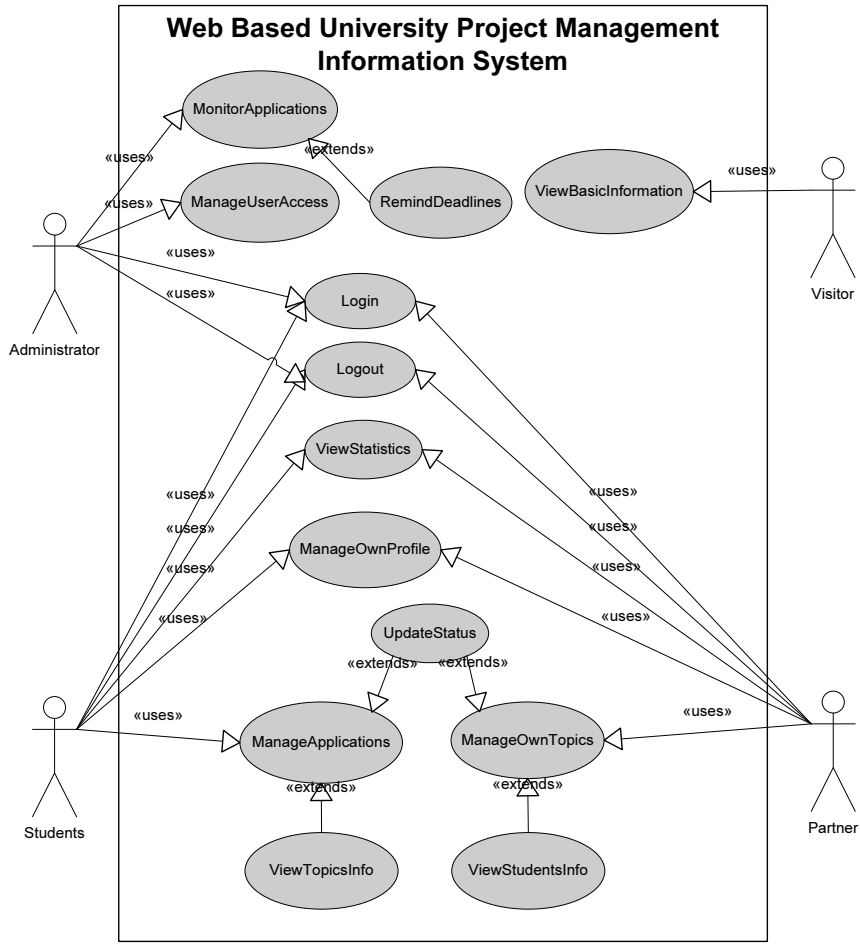

Fig. 2. Use-Case Diagram

- ***Partners*** – these could be organizations, universities, companies' representatives. They can be able to:
  - make a registration on the project's website and to use this registration to work with the application;
  - public new project details and topics;
  - edit their own data and data about their project's topics;
  - see the list of students (with options to see full details) who are applying for their project topics and to decide which application to reject or to approve;
  - see the students profiles with their details;
  - see the list of his own topics with statistical information about the students and details about their applications for the selected topic;
  - see the advisor of the most wanted topic and its details;
  - search and see all topics and projects with their details;

When the partner decided which student to select for the topic this will be registered in the system and all other applications (from other students) will be rejected and will be

registered as rejected in the system. This information about the rejected and accepted applications will be used in the future for statistical information about the most interesting topics, the most popular research areas and about the process of finding the most appropriate topic for the students and partners.

- ***Students*** – can be able to:
  - make a registration;
  - edit own registration information;
  - search for free topics matching the predefined criteria. The application will provide user interface for defining the various search criteria based on keywords, student's grade, project type;
  - see the list of all topics with their advisors and status (free or not);
  - apply for the free topics – one student can apply for more than one topic but not at once;
  - one student can work on more than one project during his study but it is not necessary to register more than once;

DEFINITION OF THE CONCEPTUAL SCHEMA

According to the described above functionalities the following entities and attributes will be needed in the designed database:

Users (Users are lecturers, professors or advisors of the students research projects and from every partner there is one or more registered ***Users***)

- **Email** – actual email of the user, which will be used from the administrator to contact him/her if it is necessary, there are not two persons with the same email addresses, this attribute identifies Users. This address will not be seen by another users except the administrator ;
- **User_Name** – Name and family ;
- **User_Pass** – this attribute will be used for the user authentication process and will not be seen, only the owner of the registration will be able to change it;
- **Org_Name** of the user - could be an organization, a university, a company, an institution which takes part in the project
- **Country** of the user;

Topics (Projects' descriptions and attributes)

- **Title** partly identifies Topics, because it is possible to appear two projects with the same titles, but with different advisors and because of this is added another attribute of the topics User_email;
- **User_email** partly identifies Topics, it identifies the advisors;
- **Abstract** – a few words or sentences about the project;
- **Advisor** - It is the same as User_email and it is not necessary to be here, but if the advisor is someone else from not registered organization or if the topic is common research work between more than one lecturers/professors;
- **Capabilities** – keywords which will be selected by the user/advisor from a predefined list, this is multi-valued attribute, because more than one keyword could be used for one project description and the same keywords could be used for different project descriptions;
- **Results** – what are the expected final results after the project;
- **Link** – this is a link to the partner's web site, where the same topic is specified too (it is optional);

- **Type** - final or during the year, Bachelor or Master – the number of different types is not very big and one project could be only one type, so it is not difficult to organize a short list with types to make it easier for users to specify and describe new projects;
- **Status –** Waiting – advisor have to decide which student from the waiting list to accept, Accepted – the application is accepted, Rejected – the student have to apply for another topic**.**

Students (only registered student could apply for a project and registered students will have a profile)

- **E-mail** – could be used as a user name, it identifies students;
- **Student_Name** – real names of the student;
- **Student_Pass** - Password;
- **University** – only students from the partners' universities will be registered ;
- **Country –** this attribute depends on the University not exactly on the student;
- **Degree -** Bachelor or Master;
- **Knowledge** – current level of the student's knowledge, areas of interest, whish will be described with list of keywords, selected from predefined list. This is multi-valued attribute;
- **Other** - information about the student, in a few sentences to present themselves and what they dealt, very short CV;

The last two attributes will be used during the decision process from the lecturers/professors to choose one from the applicants for their project. As it can be seen during the education one student can work on more than one project's topic, and there are group project's (teamwork projects) topics on which can work more than one student.

The UML-OO class diagram is shown in figure 3. There is additional class Students_Topics (association class) which is used to convert the M:N relationship to two 1:M relationships and to store the information about the selection process. This information will be very useful for future statistics and reports.

LOGICAL DESIGN

The process of converting the ERD into relational database model could be organized into following well-known steps [2, 8]:

1. Create relation schemas for all the entities/classes. The entity class will become the name of the relation schema. The primary key in the relation will became the key attribute from the ERD/CD.

2. Break down composite attributes into their components and add them individually to the relation schema.

3. Break out multi-valued attributes into a new relation schema (knowledge and capabilities which will be described with keywords in this model, figure 3). Because the degree of this relationship may be many to many, a weak entity between the two relation schemas might be required.

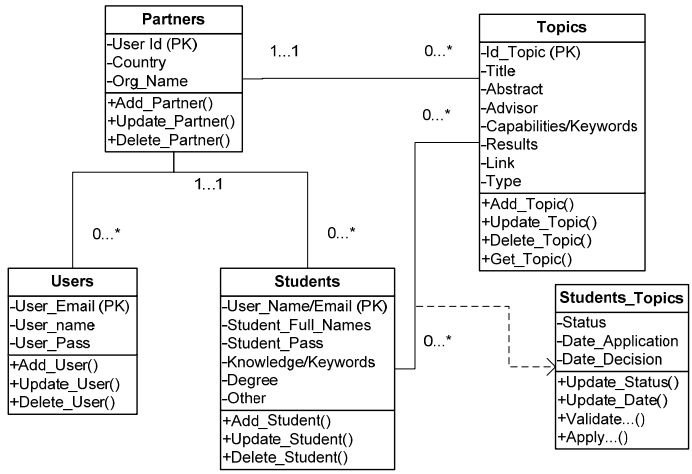

Fig. 3. UML-Class Diagram

4. Map the cardinality of the relationships 1:1 and 1:M by adding foreign keys to the appropriate relation schema.

- In a 1:1 relation, the foreign key can go in either schema. The designer must logically choose the appropriate relation. As an alternative, a 1:1 relation schema can be condensed into a single entity.
- In a M:M relation add a new table and two 1:M relationships.
- In a 1:M relation, the foreign key would go in the Many relation schema.

5. Map unary relationships. These are recursive relationships in a single entity class between instances or rows.

6. Finally, map the inherited attributes (superclass entities and subclass entities).

According to these steps the logical model will consist of the **following tables**:

- ***Partners*** – contains the information about project partners, the common part of the attributes for users and students;
- ***Users*** – contains the information about advisors of the students projects;
- ***Students*** – contains the information about the students and their knowledge;

Both Users and Students are from the organizations of the TRICE project partners and some of the information is better to be organized in the common entity Partners.

- ***Topics*** – contains information about projects and their attributes;
- ***KeyWords*** – contains the keywords which will be used for students' knowledge and topics capabilities description. More than one keyword can be used for this.
- ***KeyWords_Topics_Knowledge*** – this is an additional table to realize the M:M relation between ***Students***, ***Topics*** and ***Keywords***.
- ***Students_Topics*** – contains the information about the process of students' application for the selected topic and decision for the selected application and statistical information. This table is also needed for the realization the M:N relation between ***Students*** and ***Topics***.

PHYSICAL DESIGN

Physical model of the database is usually directly related to the choice of database management system. At this stage it can not be specified in details but the relational database management system will be used – Oracle or MySQL.

CONCLUSIONS AND FUTURE WORK

The need of managing the information electronically is growing rapidly in all areas in our life and work. One of these areas, considered to be crucial for the country and particularly for the university is education and realization of the young specialists in computer science. Therefore this WIS is very useful and will provide them with the necessary information about actual research and practical projects and opportunities to work with various teams and organizations. The next step is to choose the environment for the system development and to try to improve it with additional functionalities for example for automatic assignment between students and projects topics on the base of the keywords in topics description and students knowledge.

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The paper has been reviewed.