Studies Orientation and Recommendation System (SORS): Use Case Model and Requirements

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Abstract — In this paper, a new perspective of the Studies Orientation and Recommendation System (SORS) is incorporate. This system is conceived to offer support to candidates that wish to enter into university education system in Venezuela. That perspective was related with the structural idea (logical), represented by some diagrams that describe, under UML, in theory and by design what the system will do. The different proposed ideas have contributed to the development of a good architecture of the system - unifying criteria of the different referring aspects from the design-, which aid to increase the productivity and offers a solid base to go deeper in the phases of analysis and design, and continue, subsequently, with the other stages of the project until the conformation of an initial prototype to be tested.

Keywords—Higher Education Institutions (HEIs), Recommender System, Object Oriented Paradigm (OOP), Rational Unified Process (RUP), Semantic Modeling, Professional Education Opportunities.

I. INTRODUCTION

THE question for a student who wants to continue university studies would be: Do you know what career you are going to study?, the answer means - for the candidate and some associate institutions - the departure point for the evaluation of important variables that implies uncertainty for a transcendental decision, from diverse perspective.

First, with the intention to respond to educational demands of the student population and to fulfill needs to development of the various regions of Venezuela, Higher Education Institutions (HEIs) offer courses in several areas of knowledge.

To make a selection, candidates must apply through the various mechanisms established by the University Sector Planning Office (OPSU - Oficina de Planificación del Sector Universitario) and/or comply with additional regulations and procedures established by every HEIs. The OPSU is the technical office of the Universities National Council (CNU - Consejo Nacional de Universidades), that has responsibility for implementing policies and strategies for counseling and support to HEIs in the performance of their functions, as well as rules and procedures for operation.

In this context, for any candidate that wishes to attend to the high education level, choose a career implies to take in consideration a large number of variables. If, moreover, there are inadequate resources and insufficient tools to drive the candidate through this process, that do not take care several

factors as the numerical possibilities, social, economic, financial, vocational, family, institutional, geographical and bio-psychological characteristics of applicant.

This is the situation in Venezuela, but may be present in greater or lesser extent in many other countries, especially in Latin America, where the dropout reaches alarming rates in some countries. For example, Guatemala reaches 82%, Bolivia 73.3%, Uruguay 72%, Brazil 59%, Costa Rica 54%, Chile 53.7%, Panama and Colombia 49% and Argentina 40%; Venezuela has a lower rate of 30%, as found in a study on retention and dropout [1], as in statistical studies related to this subject in individual countries [2] [3] [4].

The exposed problem is a motivation to promote the development of a innovative tool, based on Semantic Technology (Ontologies + Web Semantic), that helps both: the candidate as the institutions, in the decision making within an high uncertain atmosphere, avoiding blind decisions, with incomplete information that have an inescapable social impact, that will not contribute for the country development; economic impact, when constitute itself a high cost factor for the family, the state and the society; academic impact, increasing mobility, desertion and low achievement, and family impact, for being cause of contrarieties at familiar and personal levels.

Without doubt, a tool with these technological particularities and that in addition considers the multidimensional character of the candidate, to recommend the best options of study will allow him/her to choose a university career and it offers appreciable contributions, among which:

- The dominion ontology enriches the existing model "Study Opportunities Book" (LOE – Libro de Oportunidades de Estudios), which allows to reach a consensus on terms.

- The user profile ontology is useful to personalize the candidates' preferences.

- The axioms present in the ontologies help the software agents to infer knowledge.

- The semantic Web makes better use of marked Web documents with annotation, making their search more precise.

- The tool is aimed for the development of applications related to knowledge management and recovery.

- The application has a great potential to enrich itself and to auto-generate more knowledge.

In this paper, Section II presents the problem definition; Section III, refers to related works; Section IV, presents the

expected results of the research; Section V, exposes background and definitions used; Section VI, presents the bases that support the modeling, and finally, Section VII, the conclusions and future research, followed by references.

II. PROBLEM DEFINITION

It is noticeable how difficult it is for students in general and particularly for those who are about to begin high education level, the choice of a career, given the number and complexity of variables to be evaluated to get an answer that is adequate to their tastes or expectations, variables that act in heterogeneous scenes, each one with their characteristics and a very particular surroundings [5] [6].

It is necessary to add that the decision not only make for the candidate, other actors with different level of power influence it: parents and/or representatives, orienteer, school staff, teachers, friends and employers.

According to [5], the election of a career brings implicit conflicts for the candidate: because he/her does not have the capacity to make a reasoned and mature selection, on the basis of his/her preferences, attitudes, abilities, aptitudes, interest or previous knowledge.

Also difficulties in him/her interaction with the HEIs appear, by: lack of knowledge of the educative offer, to chose a saturated career, to be outside the geographic context, cost (public/private dependency), employment opportunities (knowledge area) and other socio-cultural reasons (tradition and familiar discrepancies, career image, academic records).

Also, in his/her socio-educative surroundings he/she finds inconsistencies, such as: lack of vocational advice, little or no support from the school staff, prejudices on some careers, and social, economic, familiar pressures and, in addition as previously it was stated, the existing information is out of date and is it no related to it environment, showing:

- Ambiguity, overloads and disorganization.
- Heterogeneity of sources.
- Interoperability problems.
- Searches on the basis of specific chains.
- Semantic aspects are not contemplated.

The consequence, logical and immediate, which generates this problem in the student is the resistance to use information available through various means, in the official reports of study and career opportunities offered (available in Venezuelan "Study Opportunities Book" (LOE - Libro de Oportunidades de Estudio)). This lead to make a choose with insufficient information, without assessing the various factors and variables related to offer and selection of a career. This situation could lead the student to select and initiate studies that subsequently do not meet his / her expectations, he / her could not estimate the cost / benefit study certain fields or opt for study at institutions where their academic profile is not suited to a career or institution of higher education, among other considerations that may be taken into account when choose in a conscious, free, informed and reasoned way.

With the intention of providing a tool to provide recommendations and guidance on study opportunities at university level is proposed Studies Orientation and Recommendation System (SORS), which aims to:

− Retrieving and integrate information from the Higher Education Institutions (HEIs) and the official reports on study and career opportunities offered.

− Collecting information on the user profile (applicant).

− Making recommendations of studies according to different variables considered for election.

− Retrieving recommendations made to other users.

− Promoting guidance from experts, strengthening the National Orientation Systems (NOS).

With this new system, which relies on the synergy of technologies, it is expected to meet formal requirements identified during the research, such as:

− Improving OPSU management information.

− Getting information needs (offers HEIs).

− Obtaining a candidate profile and use it to customize a recommendation.

− Assisting the applicant in the decision-making process.

− Generating statistics, which allow analysis and projections and recommendations for improving public policy.

− Generating new study recommendations not only for vocational aspects, but also for economic development issues, at country or regional level.

− Promoting the guidance that undoubtedly underpins the objectives of the NOS.

− Providing information that links study opportunities (educational opportunities) and occupational needs (labor demand), helping to balance the personal aspirations of the candidate with the real needs of the labor market.

III. RELATED WORK

Even though in the publishes papers that the research teams have access, a vast specialized Literature in Recommendations Systems was found, that could be related to Ontologies and others to Intelligent Agents, but no papers relates specifically to offer recommendations that help the user to choose a career within the academic offer was found.

However, a search was made with the purpose of explore techniques and tools that applications similar to the SORS use:

Lin [7] presents a system based on ontologies that uses tree decision algorithm to generate the inference rules. The author proposes to use ontologies to model the dominion knowledge integrating the inference mechanism to enrich the dynamic knowledge; with this model the roll of the Psychologist in the detection of psychiatric disorders could be replaced. This system based on ontologies for the detection of psychiatric disorders, is based on the implementation dominion ontology for the management of the static knowledge and ontology tasks to describe the dynamic knowledge.

A similar method can be used to improve the SORS proposal, since it agrees in the use of ontologies for the management of the existing knowledge and the necessity to generate dynamic knowledge from the intervention of human

actors (orientation, expert, and other candidates) and to update the information. The tree decision algorithm could be tested under an experimental atmosphere with Protégé [8] to analyze (generation and classification) the resulting values of the directions that the actors offer to the candidates to recommend the career that better agree with his/her.

There are proposals in which collaborative filtrate has been widely used to determine preferences and to combine them to formalize a prediction or a recommendation. The initial proposal of the SORS it has been thought to use both, the filtrate by content and the collaborative filtrate, this last one because the advantages that it would have to help to recommend difficult to analyze contents, to recommend items on the basis of the user preferences and to help to make valid recommendations, even when they are unexpected. [9].

But, as other recommendation systems, the SORS could be affected by problems of Cold-Start (new item or the new user) when using collaborative filtrate in their early stages, because there can be few or no information loaded, because of poor users interaction, affecting the quality of the initial recommendations.

This disadvantage is compensated in the proposal of [10] that suggests the operation of a module that could be used by the sites of electronic commerce like support, to decide on different market strategies, taking into consideration the benefits that it offers to users and to suppliers. For this purpose, it is very important the framework denominated Clique-Effects Collaborative Filtering (CECF) that helps to predict the behavior of the consumer.

IV. EXPECTED RESULTS

As currently designed, the product of this research aims to develop an application (Recommender System) for use in educational institutions Venezuela's second and third level, as a valid instrument to support decision-making related to career choices and Query results as valid for vocational orientation, thus, the SORS happens to have-well-entrenched legal basis in the State's current regulations. As part of the development of a prototype test SORS, it is essential to "... ensure the production of high quality software that meets the needs of your end users with a predictable cost and schedule." [11] Hence it will guide the system's progress under the Object Oriented Paradigm (OOP), following the methodological approach proposed by Rational Unified Process (RUP), through which it is possible to develop software iteratively and incrementally, focusing on system architecture and directed Use Case, giving preference to Business Modeling with the active participation of each of the stakeholders in the implementation.

V. BACKGROUND AND DEFINITIONS

There are some previous studies that support the conceptual modeling SROE. It begins with the simple representation of a system based on domain ontology (LOE), which could make content recommendations [12], [13] until to reach, gradually, a more complex representation. Thus, the system proposal is

modeled interacting with ontological structures combined - domain and user's profile-, supported by agent technology and methodological resources related to data mining and semantic Web [14], [15]. In particular, with the latter proposal improvements of SORS preliminary version that has been developed are implemented, encouraged by the synergy that provide semantic technology (ontologies + web) and intelligent agents.

A. Studies Orientation and Recommendation System (SORS)

SORS is a tool that helps users to get the information that they need according to their preferences, making their decisions based on available information, which must have some method of filtering [14]. Such applications are excellent tools for gaining knowledge without having to search and analyze information on all possible alternatives [16], and can even get personalized recommendations, according to their interests and preferences.

B. SORS: Guiding principles

The essence of the SORS is in the estimation of the multidimensional nature of the applicant [5] [6] to begin high education and mismanagement of information that may affect decision-making. This has given rise to a simple first approach to model the critical processes of the system, its actors and the interrelationships between them, effectively using Unified Modeling Language (UML) [17], [18] as the basic language to structure the most representative diagrams with the idea of modeling objects business and understand all the definitions of the ontological structures (knowledge bases) and database, and to understand the behavior of the system.

VI. CONCEPTUAL MODEL

As a first approach to solve the problem of providing stakeholders in making decisions about study opportunities, relevant, timely, more meaningful information and better articulate on their context, in changing scenarios where multiple variables act, it is proposed to implement the use of a tool to provide recommendations and guidance related, such as the Studies Orientation and Recommendation System (SORS), characterized by [19]:

− The use of domain ontologies and user profile, as well as intelligent agents, to provide recommendations to those applicants that wish to enter the higher education system.

− The semantics built into the application is an important foundation for software agents to infer knowledge from the axioms present in the ontology, which gives it the potential to enrich them and more self-generating knowledge by using a common language sufficient expressive power and reasoning to represent the semantics of ontologies.

− Using the knowledge base and user's profile, the SORS be empowered to recommend the best options inferred for choosing a study for a degree, adjusted to the multidimensionality of the applicant.

− The Semantic Web, as integrated interface, will ensure the use of Web documents marked ontology-based annotation or equivalent stored in a database or similar, which helps solve problems or limitations of a meaningless Web and substantially improve the search.

As a preview of the prototype, it is appropriate to model the application using a methodology for object-oriented design, such as RUP [11], [20], [21] for the purpose of describe, in the first instance, the reality of the business and domain application.

A. SORS Design: Information Management Logic

The design of the middle layer of SORS brings implicit appreciation of different points of view of those involved in the process of offer and demand study options and state intervention as information manager.

As can be seen in Fig.1, in Venezuela each of the actors in the system has a particular requirement: applicants need recommendations, the OPSU/CNU as information manager must manages the system, advisers and experts require an expeditious mean to give their guidance, the HEIs, as suppliers need to improve access to information.

Fig. 1 Business Model Design (SORS)

The applicant that has already surpassed the career selection process, wants to contribute with his / her experience.

B. Modeling Concepts

In the first phase of RUP it is estimated a business modeling, determining aspects of this process, such as: What is the business goal?; What are the objectives to achieve?; What information must it have?; What must it show?.

Depending on the analysis it was determined that the business goal is: to provide recommendations and guidance on study opportunities. The objectives to be achieved are:

− Retrieving and integrating information from the HEIs / OPSU / CNU.

− Collecting information on the user's profile and on the recommendations offered to other users.

− Making recommendations.

− Registering guidelines.

To meet these objectives it is required:

− Information bases (LOE / HEIs).

− Contact the agency that handles domestic supply (CNU / OPSU).

− Contacts with Higher Education Institutions (HEIs).

− Knowledge bases.

This could be useful in providing a portal to display:

− Career catalog.

− Assistance to applicants (formulation of questions and answers).

− Domain Management.

− User Profile Management.

− User Registration.

In this phase, obtain the requirements (lifting, treatment and refining) is also useful to clarify the functionality of the system and better define the use cases.

C. Context Process: Requirements in six stages

Within the scope of business processes pertaining to SORS six stages were identified:

− The business goal (GOAL): to formulate recommendations / management guidelines.

– Processes (PROCESS): hybrid filtering (collaborative recommendation + based on content + based on profile = hybrid filtering), use of agents, algorithms implementation.

– Events that hinder the process (EVENT): applicant's requirements and information integrity.

– Information processes inputs (INCOME): Ontologies (domain and profile information, expert's opinion).

– The resources to be "processed": profile data, careers list, expert referrals, and other recommendations.

The outputs of the process (OUTCOME): Hybrid Recommendation: personalized, content-and collaborative, expert guidance.

D. Vision System and Users Needs Assessment

In this part of modeling SORS also was reused some of the information provided by OPSU/ CNU in the official book LOE) [22], [23], which, coupled with the Requirements Model and Actors, allowed obtain a representative of the domain which shows a first approach of reality to represent the elements in the Model Business Use Cases.

In Figure 2 we can distinguish the actors who interact with the system and its key processes.
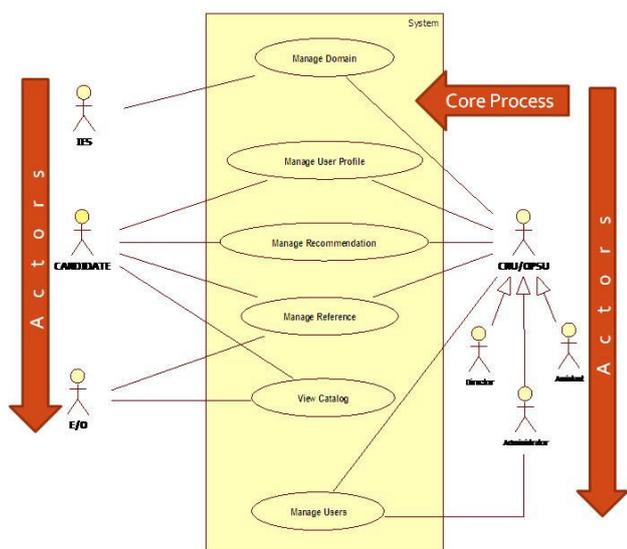

Fig. 2 Model Business Use Cases (SORS)

For this model it was raised the following statement in the document that shows SORS Vision (Tables 1 and 2):

Table 1   Problem Declaration

Problem Declaration	The Problem	The absence of a System for Studies Orientation and Recommendation prevents: – To satisfy the needs of information related to the selection of a university career, inside the abundant national offer that the HEIs make. – To support the applicants to make a better decision for, what career to choose? – To help OPSU to know the actual demand that exists in high education, by means of related information. – To help advisers, parents and careers to give the applicants suitable and opportune suggestions.
	Affects…	Directly it affects the applicants, the OPSU and the HEIs; indirectly the families and the Venezuelan State.

	Impacts …	At the applicant level, a poor decision (lack of information or disorientation), a career with which the applicant does not feel comfortable, do not has the resources to confront its requirements or, somehow, is not compatible with the applicant aspirations, potentials, motivations or interests, influencing a possible dropout, low performance or, a degree that never will be put into practice. For the official entity, the absence of a suitable mechanism to register and to manage the admission process to the high level education based on information linked directly with the applicant. For the HEIs case, it implies an ineffective relation between offer and demand. For the State and the family, it represents increases in the costs when the applicant does not continue the selected career.
	A successful solution would be …	A system that recommend the best options to the applicant using an important volume of information, on which good directionality can be archived for the career decision choose in high level education. This system must have friendly and simple interfaces to access the bases of knowledge and references.

Table 2   System Vision – Product Position

	In Order To	The OPSU´s, CNU dependant office, supply the applicant's software that orientates their decisions in relation to the career to be chosen at the high level education.
	Who	The OPSU´s, CNU dependant office, responsible for management of the policies and strategies for the high level education subsystem, as stated in the nation's plans.
	Denomination	Studies Orientation and Recommendation System - SORS.
Declaration of the Product Position	What	A system that guides the decisions of the users within complex and uncertain information environments.
	Differs From	The present tool does not give explicit response to any of the questions of an applicant, because it does not allow relate characteristics and personal preferences to make a choice and it generates doubts and uncertainty that impede the choice, since the information that shows appears isolated, without meaning and separated from the general context in which it is developed.
	The Product	It uses ontologies (domain and user profile) as a way of normalize the knowledge, to represent it as metadata and to use this structure to make knowledge accessible, shareable, reusable or modifiable by means of the semantic Web; all this, in order to achieve an approximation to the problem of orientate the applicants in the choice of a university career, that suit their needs and interests.

The statement of needs that gave rise to the Use Case Model initial (UCMi) or SORS basic features (Table 3 and Fig. 3):

Table 3   System Vision - Needs

Needs	Priority	Worries	Present Solution	Proposed Solution
Improve information management to obtain information from different HEI's offers related to the user needs	High	Information to the applicants is not opportune and isolated, meaningless and dissociated from the general applicant context	Each HEI has its Web page, and there is an option in the CNU's page that integrates this information through the LOE	Use information from the HEIs and the LOE to build a domain ontology that relates directly to the recommendation

To obtain an applicant profile that can be used to personalize a recommendation	High	The information on the diverse academic offers does not contemplate the personal data (does not know the applicant), as consequence there is no personalized handling in offer and demand	A vocational test is applied (National Vocational Exploration Test) and application in an admission registry is required (Unified Register of the National Higher Education Entrance), but the results are dissociated from contextual information	Create a user profile to conform a profile ontology directly related to the recommendation
To supply recommendations to the applicant that helps the decision-making process	High	The applicants can request and obtain valid recommendations that can be used in decision making	The recommendations are made orally and comes from advisers, parents, careers, friends, etc.	Use the Studies Orientation and Recommendation System (SORS)
To manage statistics and new recommendations	Medium	Use the recommendations from the system generates statistics and new recommendations	Statistics are extracted from mathematical references	Use information provided by SORS's filters for statistics and further recommendations
Compile references	Medium	Achieve the participation of experts, advisers and other applicants who have already gone through the process, as support to obtain references that contribute in the recommendations	The references are made orally and comes from, advisers, parents, careers, friends, etc.	Use the Studies Orientation and Recommendation System (SORS)

Fig. 3 Use Case Model initial of SORS (UCMi - SORS)

In this same order, each package of the UCMi is operated to let see the internal functionalities of the SORS. Of this form, in the fig. 4, the UCM of the functionality is denominated Catalogue, with which it is expected to offer to the user Consultations by Career, Dependency, Area of Knowledge and Region, aspects that conform the Dominion of the application.
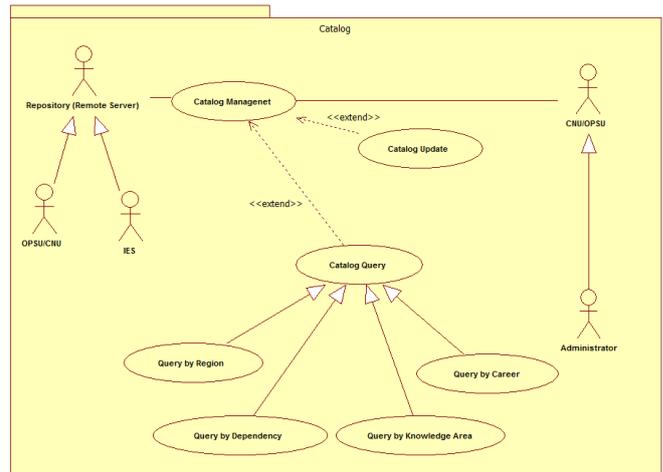

Fig. 4 Use Case Model of Catalog component

Another option of this component is to make possible the update of the content according to its modifications in the HEI´s.

This aspect imagines in the UCM of the functionality Dominion (fig. 5), which must locate, convert and update the information in the of Dominion ontology.
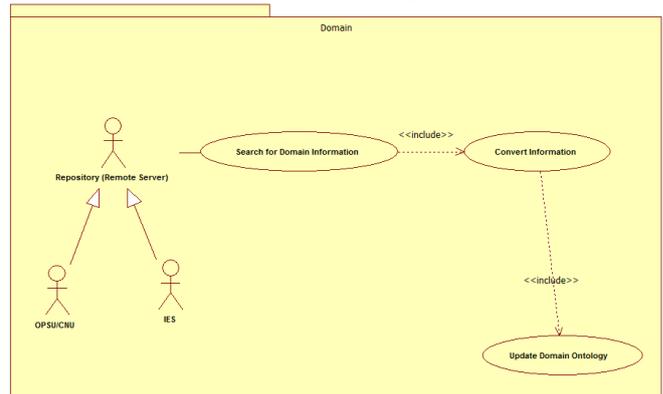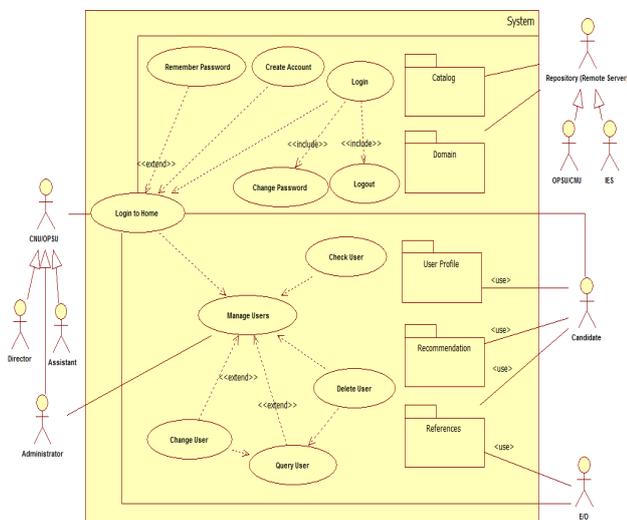

Fig. 5 Use Case Model of Domain component

Next, the functionality Recommendation (fig. 6) by means of which it is hoped to filter the information to offer personal recommendations (with the Profile of User), of Content (Dominion) and Collaborative (other users).
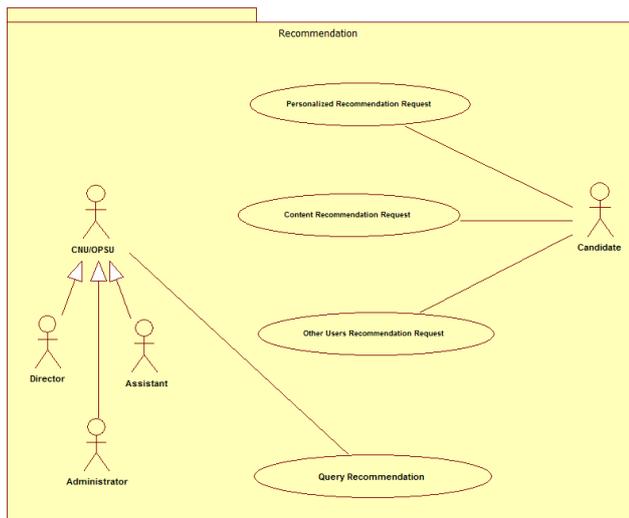
Fig. 6 Use Case Model of Recommendation component

This functionality, could offer to the official institution (OPSU/CNU) the possibility of making Consultations on the offered Recommendations.

The following functionality is the one that manages References (fig. 7). This term is referred to the important contributions that do particulars actors of the system, as counselors, the expert ones and others aspirants that already used the system and has an experience with which to participate.
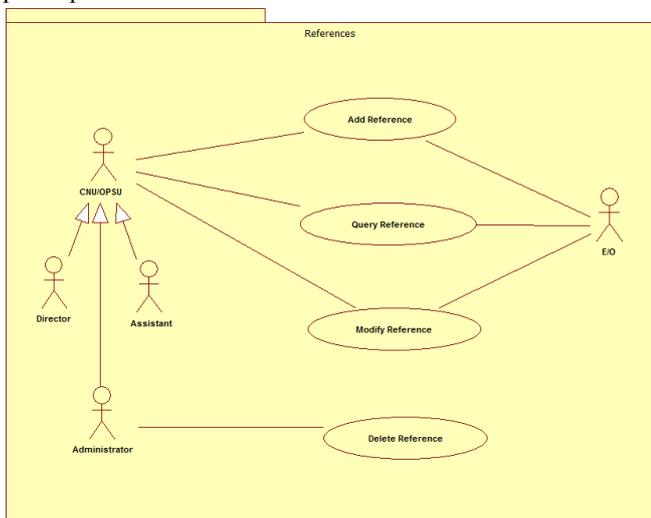

Fig. 7 Use Case Model of References component

The final component of the Model is the User Profile (fig. 8), where the maintenance will be managed and consults of the aspects macro of the Candidate, related to his/her personal data and the demographic profile, socioeconomic and academic.
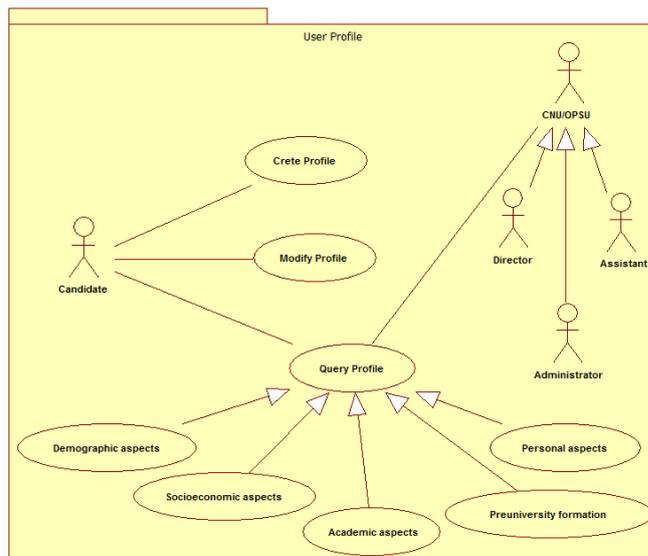

Fig. 8 Use Case Model of User Profile component

Finally, the Class Diagram was elaborated, which is fundamental for the analysis and design. In this diagram the classes of the system with their structural relations and of inheritance appear; in order to establish the classes, objects, attributes and operations between classes were taken as it bases the diagrams of cases of use.
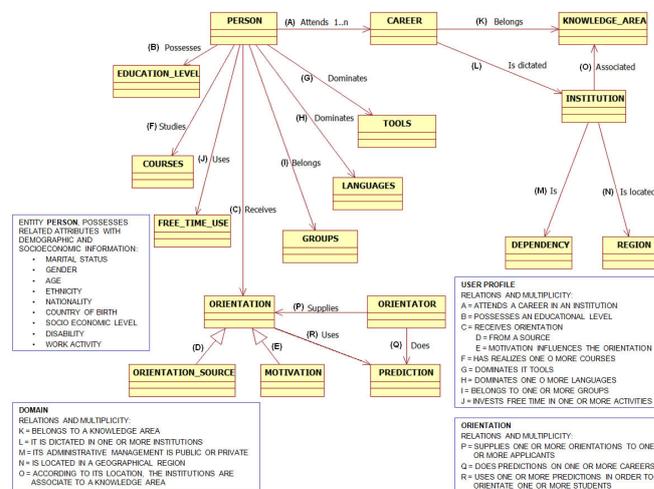

Fig. 9 Class Diagram with relations

VII. CONCLUSIONS AND FUTURE WORK

In order to make a robust conceptual model that represents the reality of the Studies Orientation and Recommendation System (SORS), and to further determine the requirements clearly and concisely, this research uses the RUP approach.

In this regard, business modeling has played a pivotal role in ensuring that the developed product will be useful, because it reaches the level of details required by the organization, while providing a common framework for communication among stakeholders.

Similarly, the lifting of requirements has allowed the establishment in a clear and precise way what SORS should do; in this research it was very helpful the implementation of the use cases to specify actors, functions and relationships.

On the other hand, the Vision document helped to collect, analyze and define needs and high level features of the system.

The incorporation of new models helps to the architectonic representation of the SORS, giving firm bases for the logical and physical structure of this system, which will be used as foundation for the construction of the prototype. The developed views are useful for the communication between the people working in the development and promote diverse analyses that orient the decision making process.

Regarding future work, it may be noted that there is still way ahead in terms of analysis and design to set the appropriate architectural basis for the SORS functional prototype, while advancing the documentation and evaluation as axes for development. Overall, this approach will develop high quality applications, more stable and easy to maintain.

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