Towards a Decision Support System

An Ontology Validation

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***Abstract*— In certain complex situations Decision-making takes into account a large number of the so-called knowledge of decision-support. This knowledge is often represented as a set of database definitions, knowledge bases, general information, domain data, statistical data, etc. To make the right decisions and to make good use of this mass of knowledge, it is preferable to formalize, represent and model them. In the literature, several works suggest using the ontology as a adequate solution to represent the decision making and decision support knowledge. Inspired by this work and based on the main objective of our research work, decision ontology was proposed to represent and formalize our decision support system knowledge which is proposed for computer Project Manager. The problem here is that the good practice of a decision-making system or a decision support system is not limited to the structuring and representation of the knowledge used. This knowledge, and given the delicacy of the domain studied (computing) requires to be evaluated and to be validated by domain experts. Accordingly incremental and multi-intervention approaches for the validation of the proposed ontology were proposed. This validation also allowed us to confirm the set of concepts and relationships forming the given ontology. The result of this research is a validated ontology which will allow us to build the memory of our project and to feed a good consistent and rich decision knowledge base.**

Keywords- support decision; decision making; decision ontology; ontology validation; computer project.

I. INTRODUCTION

The main purpose the elaborated ontology [1] is to provide a basis for the proposal decision support system offered to the project managers in the computer field. This system consists essentially of two main modules: The decision-making module which functions as a support system to computer project leaders, to make a decision concerning the onset of their new projects and the decision support modules provides guidance and assistance inspired from historical projects which are already resolved or which have been already dealing with the problematic of their project in question. For the two modules, the need for knowledge, experience, historical information for resolved, unresolved, same context or same class projects, is too important in order to have a right course of the decision support system and especially the decision-making module. To have a broad knowledge of this domain,, we must model and represent it in a structured way. In addition, the newly created ontology must be validated and evaluated thanks to either experts or standard validation tools. Here, we can identify two scenarios [5] which justify the validation of the ontology: an adequate ontology will allow better reuse of the data and oncologists need methods to evaluate and validate their models in order to encourage them to share with confidence their results with the community. In this context, this paper will focus primarily on the problem of validating the content of domain ontology. Besides, an incremental approach for validation approaches was introduced for the proposed ontology which is composed of six steps. In this context, we have studied some ontology validation approaches: those which are questionnaire based, others based on question answering. The problem here that all approaches studied are single actor approaches where a single validation actor can validate the entire ontology and this by applying the semantic and the structural validation definitively with no return. The main novelty of our validation approach consists essentially of three criteria: the incremental validation, the multi-intervention, and the respecting of the −V cycle. In fact, the shift from one validation step to other results in an update of the initial ontology and this occurs-by the intervention of three experts (project management expert, a project computer expert and a specialist in ontology engineering). Our proposal approach requires a resort between all the validation phases and can return to any expert for revalidation if needed.

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The paper is organized as the following.. After the introduction, Section 2 describes the application of our ontology in the decision support system. Section 3 is made up of two sub-sections: The first sub-section illustrates some ontology validation approaches and their discussions. The second sub-section describes the proposed validation approach. Finally section 4 reveals the main conclusion and futures works.

II. RELATED WORKS

In the literature, several works have used ontology as a method of modeling and formalizing decision-making knowledge. In the following section, we will describe the most relevant ones.

A. Main Proposals

1) A Decision-Making Ontology for Information System Engineering[2]

The author proposed an ontology for the modeling of Decision-Making knowledge (DM). The proposed DM ontology is a representation of DM concepts and their relationships modeled using a Unified Modeling Language (UML) class diagram. Then an application in the field of Business Process Reengineering (BPR) has been proposed. This proposal is based mainly on the unification of the most important DM concepts within a single model. The suggested Decision-Making-Ontology (DMO) is of a dual use namely: to clarify the DM concepts to formalize the DM situations and to specify the DM requirements and to highlight the components of the DM method.

2) A Productive Credit Decision-Making System Based on the Ontology Model [3]

The author has constructed ontology for the development of Decision Support System (DSS) provoked by reviews of the effects of the pandemic on the global banking system. It emphasizes the relationship and support between companies and banks and the need for response from banks to ensure a reliable business customer experience. It is clear that the decision ontology in banking risk management is a component of the general “Banking” ontology.

3) A Decision Support Ontology for collaborative decision making in engineering design[4]

In this research, a Decision Support Ontology (DSO) is developed to facilitate decision making within the framework of collaborative design. The structure of the developed information model reflects a prior knowledge of decision making and supports the communication of information independent of any specific decision method. As a result, the DSO includes information related to the decision such as the design issue, alternatives, rating, criteria, and preferences. It also includes the rationale and assumptions for the decision, as well as any constraints created by the decision and the outcome of the decision. The DSO is based on the Ontology Web Language (OWL), which facilitates the sharing and integration of decision-making information between multiple collaborators via the Web and description logic.

B. Discusion and synthesis

The study of these different proposals has enabled us to observe that:

- The ontologies used for the proposal of a decision aid or a decision support are a generic ontology of large domain namely the domain of design techniques, the domain of knowledge engineering, the domain of insurance banking , etc.
- Most of these ontologies are not well validated and if this is the case the validation is not complete and suffers from being a support for the formalization and the modeling of knowledge.

It is in this context that we decided to propose decision ontology for the proposal of a decision support on three main levels. In addition and in order to remedy the problem of ontology validation, the following section of this paper is proposed as a validation approach. This approach is an attempt to guarantee an adequate formalization for the knowledge manipulated by the proposed aid system.

III. THE APPLICATION OF THE PROPOSED ONTOLOGY IN THE DECISION SUPPORT SYSTEM

In order to automate the knowledge capitalization approach [1] that we have suggested, we have proposed our decision support system offered mainly to computer project leaders. The main goal of this support system is to guide the manager of a computer project from the start of this new project until the resolution and the illustration of the final results. Our proposed ontology is described in three main concepts: project context, project features and project rational design. The proposed system offered three levels of assistance and for each level of help we will identify, the following: the main role for the proposed support decision ontology.

- The first level of help is "help oriented services". It allows the enrichment, consultation, statistics, framing and contextualization of new projects to be processed. At this stage the conceptualization and definition of concepts and terms describing computer projects are needed. The support decision knowledge recommended in this type of help is given by the instantiation of the concepts and relations defining these two classes "project features" and "project context" as well as their subclasses.
- The second level of help is "help oriented decision making": that presents the main goal of our decision support system. At this level, project leaders (chief or project manager) are into taking a decision of launching their new project. This decision is made by checking whether the problem of their new

project is already addressed or not. Here, the need to define a "problematic" concept for each project is very important. The instantiation of the project feature class that contains the concept "project problematic" forms the answer to the decision-making question.

- The third level of help is "help oriented decision support". For this type of help, the project leader will be inspired by the projects already resolved to complete their new projects. In this case, they will not only be inspired by the suggestions and solutions proposed for old projects, but also they will benefit from the problems and failures encountered during the resolution of these different projects. The instantiation of the project Rational Design (problem, suggestion and solution) forms a basis for decision support knowledge.

Even if the use of the proposed decision ontology plays a key role in determining the knowledge necessary for building a decision-making knowledge base, it is still insufficient. This insufficiency is explained by the fact that this knowledge is not always true and needs to be evaluated and to be validated by experts and specialists. It is in this context that we propose an ontology validation approach which aims to evaluate, to verify and to validate the content of this ontology, the choice of concepts and the relationships between them. The description of this approach is given in the following section.

IV. ONTOLOGY VALIDATION

The ontology validation is considered as a stakeholder of the life cycle of ontology that they can keep their interest related to the applications for which they were built. Then the validation of ontology knowledge has an influence on the evolution and the maintenance of systems using this ontology [6], [7]. In addition, the quality of the knowledge modeled by ontology directly affects the quality of these systems. It is in this context, and to guarantee a good quality of the proposed decision support system, we have decided to validate the content of our proposed ontology and we propose a validation approach for our proposed ontology which is built on a set of criteria.

A. Main Ontology Validation Approaches

Several works in the literature have been proposed approaches and validation methods. In what follows, we will present some proposals. To get the Integrity of the Specifications.

a) A validation approach proposed by Rim et al [8] : The authors proposed an ontology validation approach which minimizes the intervention of an expert in the validation of changes through an evolutionary process based on consistency check and quality assessment of the modified ontology. The verification of consistency is employed to ensure that all axioms remain valid after the occurance of the change. The proposed validation process consists in defining weights by the domain expert for each criterion by giving it a weight relative to its importance in relation to the domain and the use of the ontology. Thus, the process will minimize the intervention of an expert in the validation of changes.

2) An approach for validating the content of an ontology proposed by Ben Abacha et al [9]: Authors have proposed a semi-automatic approach called SAVANT based on the generation of questions to validate their ontologies. The first step is to automatically generate a list of Boolean questions from the ontology being validated. These questions are submitted to experts in the field who provide an agreement decision (Yes / No) and then an interpretation of these comments made to validate or modify the ontology. The originality of this approach rests on the fact that the interventions are manual and they are carried out only by health professionals.

3) An interactive method for the validation of ontology proposed by Richard [10]: An ontology validation method called OVIM "Ontology‘s Validation by Interactive Method" has been proposed. Authors proposed this method for the structural and semantic validation of ontology. This method is be based on five stages. They started with the structural validation that has four stages of validation namely; consistency, validation by OOps, validation by request and validation of the choice of the preferential label. In the fifth step, they realized the semantic validation by collaborating with actors of the modeled domain.

4) An ontology validation Approach by the experts via a questionnaire by Laila et al. [11]: An ontology evaluation and validation approach that has been proposed. This approach starts from an ontology to be evaluated and ends up with an updated ontology according to the evaluators' recommendations. The proposed approach consists essentially of five steps: In the first step, a questionnaire is produced from the components of the ontology. Secondly, results of the survey of the experts will be done. The third step is to analyze and synthesize the results obtained. The update of the questionnaire based on expert feedback as well as the update of the ontology according to the knowledge of the results is realized during the last two stages.

5) A validation approach based on evaluation by Tartir et all[12]: This approach essentially consists of verifying the consistency and measuring the impact of the change on the quality of the ontology. It also allows consistency checking and evaluation of the structure and content of the proposed ontology based on well-defined evaluation criteria and metrics.

B. Discussion

Although the validation approach proposed by [9] is a very important approach that allows the validation of concepts, relationships and axiom components of ontology. In fact, it has been evaluated experimentally on three ontologies of different methods of construction but this approach presents some lacuna:

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- A bad quality of validated ontology is related to two reasons: the absence of ontology-expert interaction and the absence of interface.
- Wrong time planning of the expert and the reduction of his level of concentration during the answers to the questions.
- The choice of questions is not generic. It also depends on the context of the problem.
- The validation method of [10] like any other method allows the structural and semantic validation.
- The problem here is that during the semantic validation domain actors verify only the existence of the general semantic domain.
- Another limit of this approach is the fact that the domain experts are not allowed to add, modify or update the used concepts.
- Expert, in this approach are simply domain actor and are not necessarily specialists in the field of ontology engineering.

The approach proposed in [11], is a very interesting approach but has some limitations:

- It is an approach not updated in the term of the novelties of the version of the OWL language.
- Uses only English for the generation of questionnaires in natural language.
- The questionnaires are generated using non-specialists in the construction of ontology study which reduces the quality of validated ontology.

The study of these different approaches allows us to notice that:

- A total absence of documentation.
- Absence of multi-expert validation [just one expert involved].

Generally, the major approaches make use simply of an evaluation of their ontology. Effectively, this evaluation could not be considered as a validation permitting to exploit their ontology. In this context, incremental validation approach is introduced which is mainly characterized by multi-intervention, documentation and incrementation. In the next section, we will describe both the process of building ontology and the proposed validation.

V. INCREMENTAL & MULTI-INTERVENTION VALIDATION APPROACH

Evaluating ontology means checking and validating two aspects: structural and semantic aspects. The validation of the structural aspect of ontology allows verifying the consistency and the coherence of a model to check. In this way, classes and sub-classes are verified according to the criteria of consistency and coherence between them and to avoid redundancy.

In this way, we proposed a validation approach based on three criteria:

- The first criterion: the Incremental validation of the ontology: the passage from one validation step to another results in an update [modification, deletion or addition] of the initial ontology.
- The second criterion: the Multi-intervention criteria: This approach is characterized by the intervention of several and different experts. Three experts are involved in the validation process:
  - ✓ The project management expert: He is an expert in the field of project management.
  - ✓ The project computer expert: He is an expert who masters all the concepts of computer projects.
  - ✓ The specialist in ontology engineering: This actor has a good command of all the tools and editors of the ontology.

These experts are the main players in the proposed approach; however they are not the only ones. They have the right to bring in other experts and specialists when necessary.

- The third criterion: Our validation approach is respecting the V cycle .We were inspired by the live cycle of software engineering. Effectively our approach like the V cycle requires a feedback between all the validation phases. Hence, in our validation phases, we can return to any expert for revalidation if needed. In contrary to a classic approach which applies semantics and structural validation definitively with no return, we can return at any phase of validation to enhance our ontology.

The proposed validation approach is based mainly on a two-level validation method:

- A technical validation level, which is carried out according to the tools and menus integrated into the "Protégé"(ontology construction environment). During this level, we checked at each phase the consistency and the coherence of the proposed ontology.
- A professional validation carried out by a specialist in the field of computer project and an expert in the field of engineering and ontological construction and a knowledge management expert.

The approach that we proposed is essentially composed of six steps (Fig.1):

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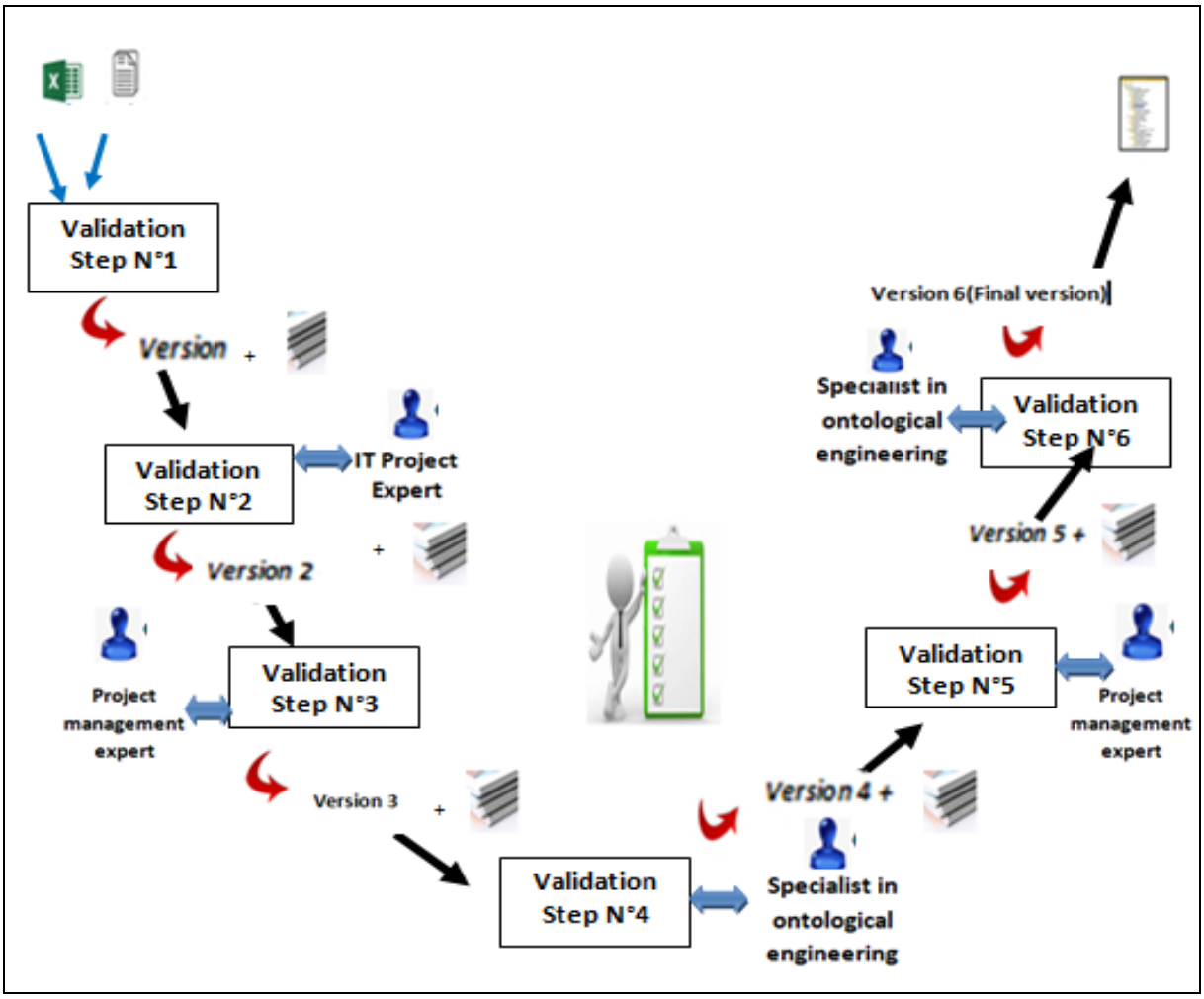

Figure 1. Incremental & Multi-intervention validation approach.

- Step 1: During the first validation step, a descriptive document is presented in a tabular form containing all the concepts and terms as well as their descriptions constituting the first version of the ontology prepared (Fig.2).
- Step 2: In the second step, it is up to us to update our proposal based on the remarks and the assertions given by the computer project expert. This step was considered as a meeting accompanied by discussions. The result of this phase is a second version of ontology that is ready for evaluation by "project computer expert". This version is an amelioration of the version 1 at the level of project features (Fig. 3).

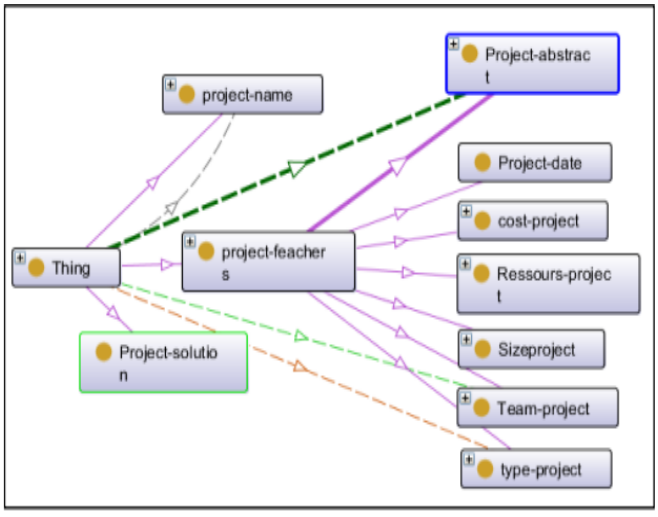

Figure 2. First ontology‘s version.

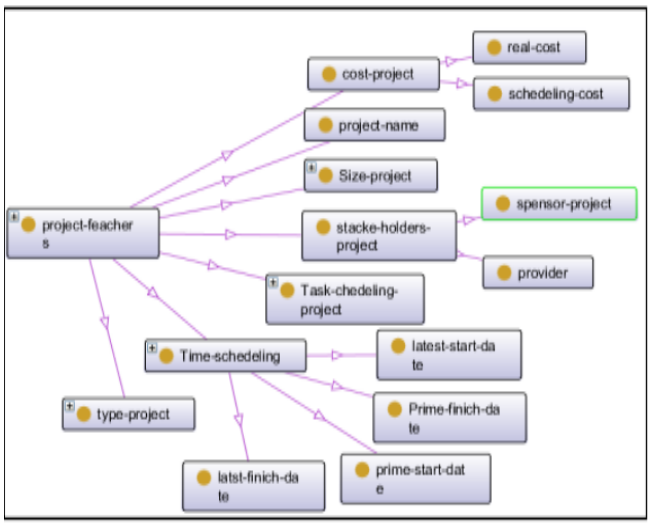

Figure 3. Second ontology‘s version.

- Step 3. During this step, we prepared a second report: a document describing our objectives and orientations. This report is then submitted to a project management expert for evaluation. This second expert could affirm or refute, add or modify the proposal by adding a textual justification. Effectively, in a version 3, this expert proposes to restrict the ontology by adding a new super class named "project context". This class gives a detailed idea about project deliverables, project abstract‖ and project keywords‖, etc (Fig.4).
- Step 4: After the evaluation done by the project management expert, technical check needs to be done .This check makes use of a software tool in the way to evaluate the consistency and the coherence of the latest version of our ontology. This mission is assured by a specialist in ontology engineering and results in a version 4.

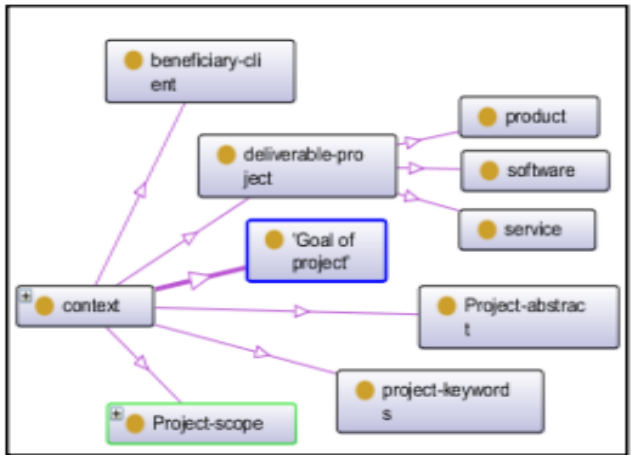

Figure 4. Third ontology‘s version.

- Step 5: At this step, the fourth version is sent to the project management expert according to our objective which is essentially to discuss projects problem solving. Our goal here is to enrich ontology in the way to facilitate problems solving in a new project by exploiting historical projects. This step leads to a new version of ontology labeled as version 5. At this stage the expert proposes to add a new sub-class baptized "Rational design" (Fig.5).

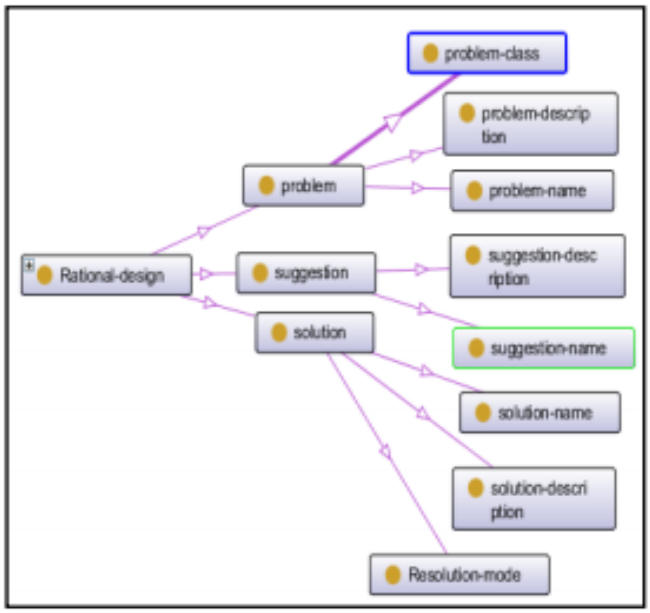

Figure 5. Fifth ontology‘s version.

- Step 6: For this validation phase the specialist of ontology engineering chooses to use HERMIT [tool integrated in protégé 4.2] to validate the consistency. This step results in a new version 6.

VI. Discussion and Result

The added value of our approach lies mainly in three points:

- The first point is presented by the multi-interventions of experts and specialists who cooperate for the validation of ontology. These will intervene not only when an error has occurred but in each phase where it is necessary to be present.
- The second point is the generic validation goal: a technical validation a semantic validation (contained in the meaning of the concept) and an ergonomic validation.
- The third point consists in favoring a documentation content of each validation step favoring an aspect of reuse and sharing of validation technique for future validation phases and even for future projects.

The validation methodology followed in our validation approach mainly consists in bringing in several experts with

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different skills and this improves the nature of the corrections and updates proposed each time.

However, this approach has some limitations:

- It is an approach that is limited to computer projects since our experts are restricted to those who are specialists in this field.
- The approach lacks a means of validating the logical aspect of ontology.

For all these reasons we want to improve our proposal with other decisions:

- ✓ We will try to add other experts to strengthen the intervention phase.
- ✓ Carry out the logical validation and this by adding a phase of logical validation ensured by the intervention of a specialist in the field.

For the validation of the proposed approach, the implementation of a prototype proved to be too essential. This prototype will always take as input the current version of the proposed ontology and based on recommendations and human interventions (expert interventions) validation is carried out step by step.

VII. CONCLUSION AND PERSPECTIVES

In this paper, we have presented how we have used our domain ontology for modelling knowledge decision. The proposed ontology decision is a representation of concepts and relationships of computer filed used to create a decision knowledge base. Then we have shown its application in our decision support system. In this context, we proposed a validation approach which is an incremental and a multi-intervention approach that allows a semantic and structural validation of the proposed ontology. After the validation phase, we will validate experimentally this ontology. In this context our future work must focus on the experimentation phase. This phase is carried out by building a knowledge base containing a real computer projects forming the basis of the facts and a set of rules forming the basis of the rules. These rules are of two types: classification rules which help to classify the projects and association rules which provide a help to describe in detail a new project. To do this, we will use the classification data mining techniques and we are going to propose classification and learning algorithms. Although the proposed validation approach seems too important to provide a fluid and reliable environment for the formalization of computer knowledge useful for decision support, it still remains incomplete and inconsistent. To do this an experimental study will prove too essential as a future contribution.

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