ONTOLOGY SUPPORTING E-GOVERNMENT INITIATIVES FOR DEVELOPMENT PROJECTS MONITORING IN SUB SAHARAN AFRICA

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Abstract

In recent years, a number of developed countries have employed ontology in e-government projects (Ralf, 2002:4; Bettahar et al., 2005:100). On the other hand, Sub Saharan African (SSA) countries have followed the trends towards e-government and adoption of new technologies during the past seven years (Kaaya, 2004:39; Ngulube, 2007:4; Bwalya, 2009:1). Consequently, many applications have been and are currently being developed in various government departments (Kaaya, 2004:39; Kitaw, 2006:18; Bwalya, 2009:7; Shuppan, 2009:124), aimed at providing better delivery of services to citizens, businesses and organizations. However, little work has been done in building knowledge base ontologies that facilitate communication amongst stakeholders and that specify processes and data description of these applications; thereby, guaranteeing their maintainability, interoperability and sustainability.

In this paper, we present a case study of constructing ontology in support of e-government initiatives in the domain of development projects monitoring in a Sub Saharan African country. The ontology presented here is not intended to provide a definitive and comprehensive account of the many aspects of development projects implementation, but it aims at serving as a foundation for further specification efforts. Case studies of development projects conducted in different SSA countries as well as related published works in various fields including project management, project monitoring and evaluation, and capacity building are reviewed and the features of the ontology are extracted. The ontology and knowledge base editor Protégé is used to create and validate the ontology.

The main purposes of the ontology encompass:

- *Providing developers of potential e-government applications for development projects monitoring in Sub Saharan Africa and the developing world in large, with key concepts and activities of the domain,*

- *Facilitating communication amongst all the role players involve in development projects implementation by providing a common and shared representation of concepts and activities of the domain, and*

- *Serving as a knowledge base system to the monitoring and evaluation activities of development projects; thereby, strengthening efficiency, effective and sustainable implementation of development projects in Sub Saharan Africa.*

Further, our work aims at sensitizing and serving as a practical case study of building ontology in support of e-government adoption processes in Sub Saharan Africa.

Key Words: *E-government, Ontology, Knowledge Base System, Development Project, Protégé*

JEL Classification: O32

1. INTRODUCTION

The continuous improvement of Information and Communication Technologies (ICT) has drastically changed the way governments the world over, deliver services to citizens, businesses and organizations. The use of ICT for public services delivery is called electronic government (e-government). The ICT facilities and the Internet technologies are used to deploy web-based applications that support government processes. This support consists of:

- Providing a large range of government information and services (health care, education, social services, community development, taxes return, etc.) online,

- Facilitating online citizens' participation to government processes and decision making, and

- Streamlining and reorganizing government processes.

A number of developed countries employ ontology in e-government projects (Ralf, 2002:4; Bettahar et al., 2005:100). The OntoGov project which aims at developing an ontology platform that facilitates the consistent configuration and re-configuration of e-government services is presented by Apostolou et al. (2005). Bettahar et al. (2005) describe a methodology of building ontology in the social care domain within the context of e-government. Gomez-Perez et al. (2006a) present an ontology-based model for efficient and fast retrieval of government documentation; they further introduce a set of legal ontologies for transaction domain in e-government (Gomez-Perez et al., 2006b). Ortiz-Rodriguez (2006) uses a set of government ontologies to represent Mexican local government processes. An ontology-based fraud detection system for e-government is presented by Alexopoulos et al. (2008). Herborn and Wimmer (2004) present an ontology driven semantics for business registers; which aims at facilitating business transactions amongst companies across European Union countries. In light of the above works, there are advantages in building ontologies for web-based applications as e-government applications. Bettahar et al., (2005) argued that any implementation of a web service should start with the building of ontology to describe its capability. In fact,

- Ontology represents the concepts of a domain of knowledge and the relationships between them; which provide a shared and common understanding of the structure of information among people and software agents (Ceccaroni and Kendall, 2003:1; Usero and Orenes, 2005:2); thereby, facilitating software development and improving processes in the corresponding domain,

- Aside the semantic representation of concepts of a domain of knowledge, ontology also provides data type description which specifies the data component of web-based applications, and

- Ontologies are application independent; which allow domain knowledge reuse and easy software maintenance, and contributes to the semantic interoperability of applications (Gruber, 1993:907).

The complexity of government processes (Estevez et al., 2007) along with the increasing number of applications that are implemented in various government departments, need ontologies to streamline and re-organize government services and facilitate their integration, maintenance and interoperability (Bettahar et al., 2005; Mondorf and Herborn, 2008:342).

On the other hand, Sub Saharan African (SSA) countries have followed the trends towards e-government and adoption of new technologies during the past seven years (Bwalya, 2009:1; Kaaya, 2004:39; Ngulube, 2007:4). Consequently, many applications have been and are currently being developed in various government's departments (Bwalya, 2009:7; Kaaya, 2004:39; Kitaw, 2006:18; Shuppan, 2009:124), aimed at providing better delivery of services to citizens, businesses and organizations. However, little work has been done in building knowledge base ontologies that facilitate communication amongst stakeholders and that specify processes and data description of these applications.

Jakachira et al. (2008:1) present a web-based e-government application that allows citizens from the Dwesa rural area in South Africa to access government services online; through the application, citizens from the Dwesa rural area can download, fill and send forms and reports electronically to the department of Home Affairs and the municipality respectively. The Zambia Health Management Information System (ZHMIS) and Immigration Management System (ZIMS) are presented by Bwalya (2009:7); both systems are e-government applications that provide online services delivery in the health and immigration sectors. Shuppan (2009:124) presents three case studies of e-government applications implemented in Ghana, Tanzania and Kenya. In Ghana, the e-government application called GCNet allows all customs transactions related to the import and export of goods to be done electronically. The Tanzanian e-government application is an integrated tax management system (ITAX). Implemented with the support of the German Agency for Technical Cooperation (GTZ), the ITAX allows electronic collection of tax revenues all over Tanzania. In Kenya, the Business Keeper Monitoring System (BKMS) is an e-government application that allows anonymous online reporting of incidents of corruption. To facilitate anonymous reporting, the BKMS uses a secure website; this makes it possible for a whistleblower to communicate with the corruption investigators of private businesses or with the police without revealing his or her identity (Shuppan, 2009:125). Kaaya (2004:39) presents an analysis of the status of e-government services in three East Africa countries including Kenya, Tanzania and Uganda. The study has conducted the visibility and usability tests of government websites in the three countries and has concluded that all of the East Africa websites are at the first and second stages of e-government development. Three case studies of e-government initiatives carried out in Rwanda, Ethiopia and Mauritius are presented by Kitaw (2006:18); the case studies were selected to illustrate the three e-government delivery models (government to citizens (G2C), government to government (G2G) and government to business (G2B)) in Sub Saharan Africa. The Rwanda case study illustrates the G2C model; it focuses on e-government applications which deliver secure web-based email service, online electronic forms for national identity document or passport and

visa, as well as Public Internet Access Centers (Kitaw, 2006:25). The Ethiopian WeredaNET project have been selected to illustrate the G2G model; its aim was to build terrestrial and satellite-based network connecting lowest levels of government (federal, regional and local) and deliver the following services: video conferencing, Web services, Voice over IP, and electronic messaging (Kitaw:36). In Mauritius, the Contributions Network Project (CNP) illustrates a G2B e-government model; the CNP has developed an e-government application that allows electronic submission of returns, payment of taxes and contributions (Kitaw, 2006: 45).

Most of the above e-government applications currently run in SSA countries provide only one way interaction with citizens. They present government information in form of simple web pages and offer few online services to citizens and stakeholders. Government services delivered online mainly consist of downloading, filling and submitting forms to government departments; in many cases, the online submission is still unavailable and citizens have to visit government offices in order to submit their forms (Kaaya, 2004:49; Ngulube, 2007:4). Largely, there is no structured databases of government valuable information accessible interactively through these applications nor evidence of proper knowledge base systems that specify processes and data description of these applications; thereby, guaranteeing their maintainability, interoperability and sustainability.

In this paper, we present a case study of constructing ontology in support of e-government initiatives in the domain of development projects monitoring in a Sub Saharan African country. The ontology presented here is not intended to provide a definitive and comprehensive account of the many aspects of development projects implementation, but it aims at serving as a foundation for further specification efforts. Case studies of development projects conducted in different SSA countries as well as related published works in various fields including project management, project monitoring and evaluation, and capacity building are reviewed and the features of the ontology are extracted. The ontology and knowledge base editor Protégé is used to create and validate the ontology. The main purposes of the ontology encompass;

- Providing developers of potential e-government applications for development projects monitoring in Sub Saharan Africa and the developing world in large, with key concepts and activities of the domain,

- Facilitating communication amongst all the role players involved in development projects implementation by providing a common and shared representation of concepts and activities of the domain, and

- Serving as a knowledge base system to the monitoring and evaluation activities of development projects; thereby, strengthening efficiency, effective and sustainable implementation of development projects in Sub Saharan Africa.

Further, our work aims at sensitizing and serving as a practical case study of building ontology in support of e-government adoption processes in Sub Saharan Africa.

The rest of the paper is organized as follows. Section 2 presents the methodology we followed to gather information and to build the ontology. The results are presented in section 3. A conclusion is drawn and future works are presented in the last section.

2. METHODOLOGY

2.1. Data collection

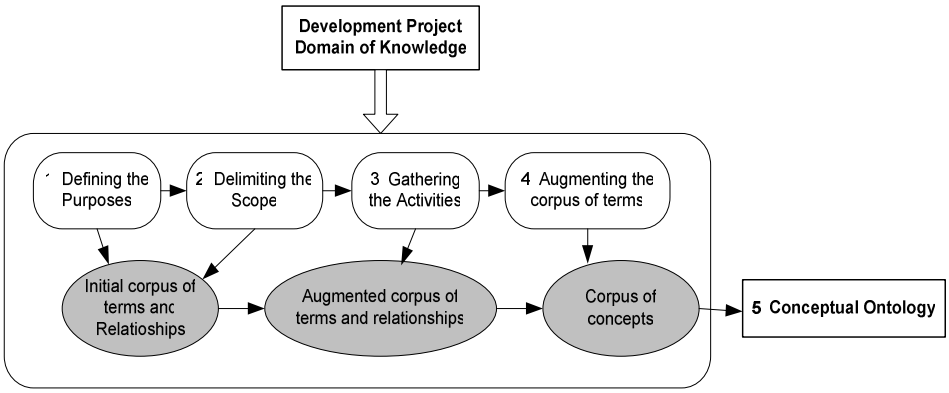
We gathered concepts and activities of the domain by:

- Reviewing case studies of development projects implemented in Sub Saharan Africa,
- Interviewing municipalities' and non-governmental organizations' employees, and academic members, and
- Reviewing related published and working papers in various fields including project management, project monitoring and evaluation, and capacity building.

2.2. Framework for building the ontology

We followed five steps in building the ontology. Figure 1 shows the framework of the ontology building process.

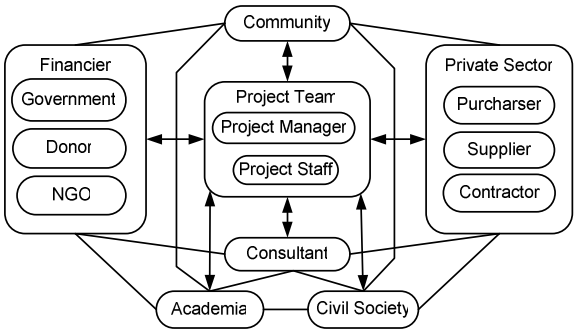
Figure-1: Framework of the Ontology Building Process



2.2. 1. Purposes of the ontology

The purposes of the ontology were deduced from the analysis of the role and the current state of impact of development projects in Sub Saharan Africa. Clearly speaking, Sub Saharan African governments use development projects as tools for providing solutions to problems facing their people. However, the number of actors involved (See Figure 2) makes development projects implementation a complex task; furthermore, other human factors such as corruption, incompetence, weak monitoring and evaluation have led to poor performance of development projects in Sub Saharan Africa since many decades of multiple aids from national and international aids agencies, government and non-governmental organizations (NGOs) (Copson, 2006; Okereke, 2007). Then, in this era of e-government adoption in Sub Saharan Africa (Kaaya, 2004:49; Ngulube, 2007:4), we believe that it is important to look at building consistent knowledge base systems as ontologies to support potential e-government initiatives towards effective monitoring and evaluation mechanisms of projects, for efficient, effective, transparent and sustainable implementation of development projects in Sub Saharan Africa.

Figure-2: Potential Role Players involved in Development Projects Implementation



2.2. 2. Scope of the ontology

The scope of the ontology was delimited by analyzing the life cycle of a development project and the activities that are carried out during various phases. According to the works in (Quartey, 1996:49; Ahsan and Gunawan, 2009:4) the life cycle of a development project can be broadly broken into three main phases including planning, implementation and evaluation. In our research, we assume that development projects have been designed and planned conveniently and that all the role players are known. Our work focuses on the implementation phase of projects i.e. the phase of the real delivery to people. The resulting ontology will then serve as a knowledge base system to the monitoring and evaluation activities of projects; thereby strengthening efficiency and effective delivery to communities.

2.2. 3. Activities of the domain

The two previous steps of the framework provided the first corpus of terms of the domain including potential role players involved in the implementation phase of development projects as shown in Figure 2. Further, we gathered the activities of the domain by reviewing case studies of development projects implemented in Sub Saharan Africa and interviewing some municipalities' and NGO's employees and academic members. Table 1 presents selected development projects that we have reviewed.

The case studies and project reports we reviewed (See examples in Table 1) do not provide information on activities related to the finance and the monitoring aspects of development projects implementation; then, we conducted interviews and investigated related published and working papers in various fields including project management, project monitoring and evaluation, and capacity building (Ahsan and Gunawan, 2009:4; Bergeron, et al., 2006:2; Crawford and Bryce, 2003:3; Goldman, et al., 2006; Mosse and Sontheimer, 1996; Quartey, 1996:49; World Bank, 1996). This step produced an augmented corpus of terms and the relationships between them.

Table 1: Selected Case Studies of Development Projects in Sub Saharan Africa

Project	Country of Implementation	Financier	Development Sectors
Participatory Design of a Community-Based Child Health Information System in South Africa (http://www.egov4dev.org/health/case/childhealthis.shtml)	South Africa	- South Africa Government - UK Department for International Development	Heath Care
Ghana Agricultural Information Network System (GAINS) (http://www.ciard.net/index.php?id=580)	Ghana	- Government - World Bank - International Institute of communication and Development (IICD)	Agriculture and Rural development
Integrated Urban Housing Project (IUHP) (http://practicalaction.org/?id=iuhd_working_papers)	Kenya	- United Kingdom Department for International Development (DFID)	Housing
The Women's Information Resource Electronic Service (WIRES) (http://www.bridges.org/case_studies/135)	Uganda	- International Development Research Centre (IRDC) (http://www.idrc.ca/) - World Bank - Hivos	Information and Communication Technology (ICT)
Integrated Development project with the "Wa Nyè U Saalu Zie" Union (http://www.fao.org/sd/erp/Celim.pdf)	Burkina Faso	-Celim Bergamo (Non-Governmental Organization)	Socia Health and Agriculture

2.2. 3. Improving the corpus of terms of the ontology

The corpus of terms obtained from the previous steps may not be complete enough to satisfy the purposes of the ontology. Then, the actual corpus has to be improved (Bettahar et al., 2005:101). Our approach consisted of building a set of questions which needed to be answered by the ontology in order to fulfil its purposes; this process has added a set of new terms in the corpus.

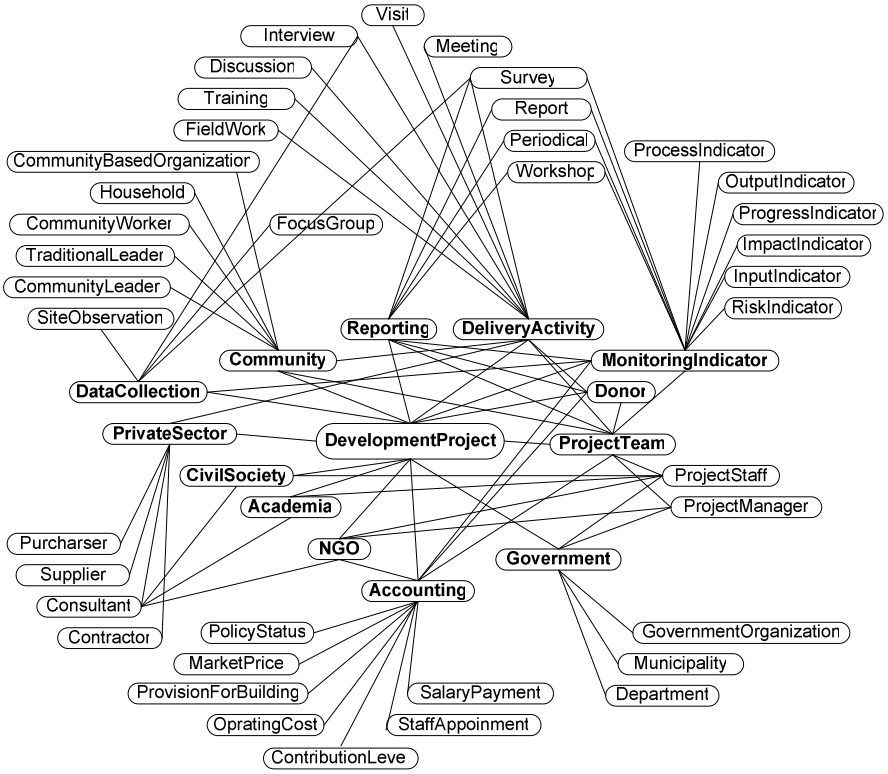
The concepts of the ontology are terms that define the domain or activities carried out in the domain (Bettahar et al., 2005:101). Finally, we represented the conceptual version of the ontology as in Figure 3.

3. RESULT

We have represented in Figure 3 the conceptual ontology of concepts and activities of development projects monitoring in a SSA country. Further, we used the ontology knowledge base editor Protégé to create the ontology in Figure 3. Figure 4 and Figure 5 present the class diagram of the ontology and some screenshots of the Protégé version of the ontology respectively.

The conceptual ontology in Figure 3 informs that a number of key role players are involved in development projects implementation in Sub Saharan Africa, including government, NGOs, civil society, private sector, academia, donors and communities. The development project's activities are managed, monitored and coordinated by the project manager and the project staff. They are responsible for the accounting and management of project records. The project management team takes care of operating costs, provision for buildings, staff appointment, salaries, level of contribution from government or donors, status of policies and market prices (Bergeron, et al., 2006:2; World Bank, 1996:2). Further, the project management team must define specific indicators to monitor development projects implementation. The types of indicators dictate the nature of the data to be collected and the processes that must be used in collecting these data during the day-to-day implementation of projects. Possible indicators encompass: input indicators, output indicators, process indicators, progress indicators, impact indicators and risk indicators (Bergeron, et al., 2006:2; Crawford & Bryce, 2003:3; World Bank, 1996).

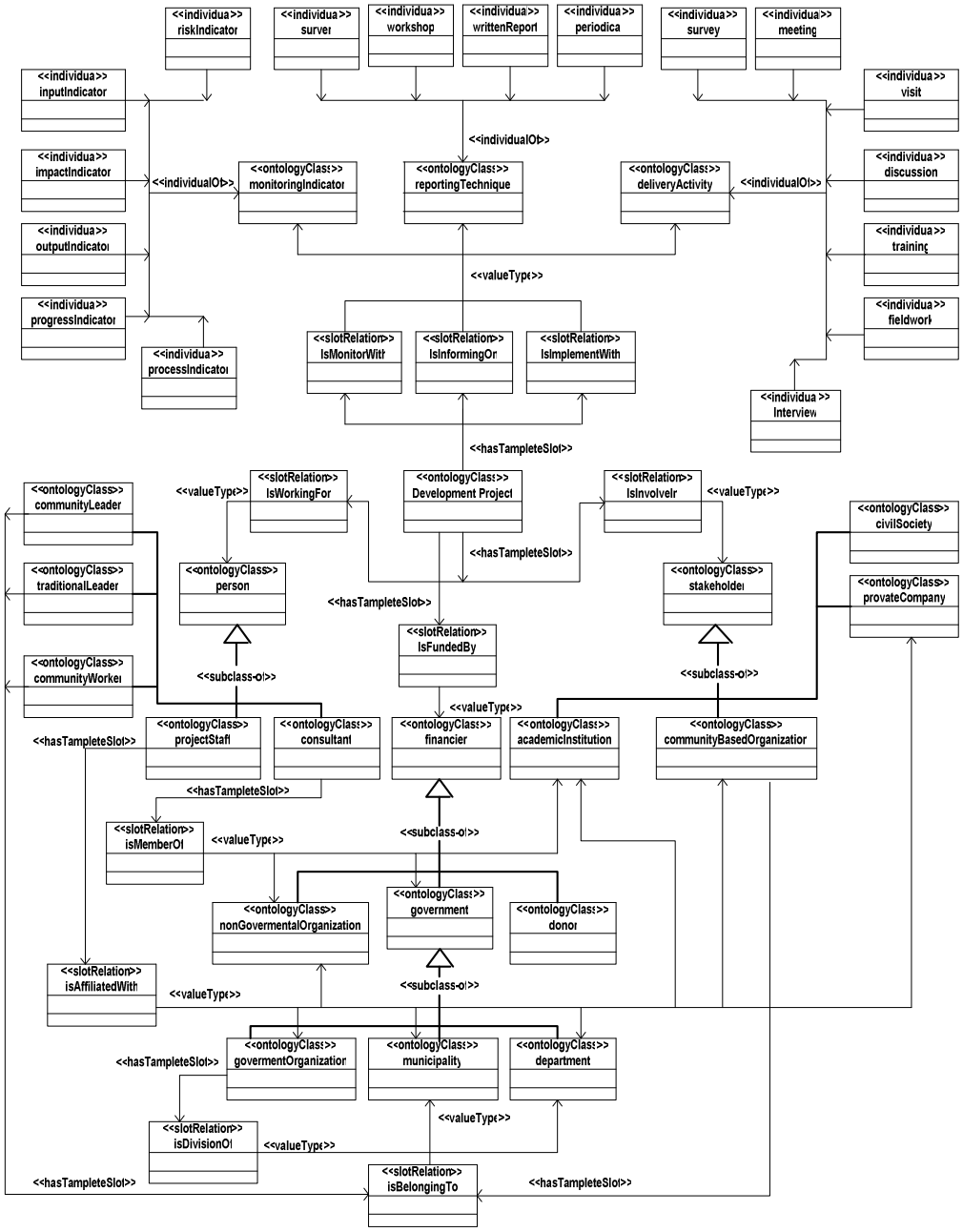
Figure-3: Conceptual Representation of the Ontology



The project teams of development projects deliver services to communities through community workers, community-based organizations, community leaders, traditional leaders, providers, suppliers, and households.

The activities carried out during the delivery depend on the type of project (infrastructure development, water supply and sanitation, education, healthcare, etc.) and include: fieldworks, trainings, group reflections, discussions, interviews, surveys, meetings, and field visits. The data collection is done by means of site observation, focus group, interview and survey. Finally, feedback is given to donors and stakeholders through regular reports or periodicals, and workshops.

Figure-4: Class Diagram of the Ontology



In light of the above comments, one can see that the ontology provides sufficient information about development projects implementation, to be able to facilitate communication between actors

involved and to provide answers to stakeholder's queries. For instance, the ontology shows that the level of impact of a project on a given community could be obtained by conducting a survey to get output indicators that provide the needed information.

4. CONCLUSION

In this paper, we demonstrate that ontology is useful in the e-government development processes as it provides a common and shared representation of concepts and activities of a domain of knowledge; thereby, allowing easy communication between stakeholders and facilitating integration, maintenance and interoperability of applications. We highlighted the fact that current e-government applications being run in SSA countries lack knowledge base components as ontologies that support their sustainability. Our claim was illustrated with a case study of building ontology supporting development projects monitoring in a SSA country. We described the framework we followed in building the ontology. Finally, the conceptual representation of the ontology was presented as well as samples screenshots of the Protégé version of the ontology. The future direction of our research will be to construct process ontologies to provide detailed description of how activities of development projects implementation are carried out in the field.

Figure-5: Screenshots of the Protégé Version of the Ontology

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