Researches in Progress

Web ontology and semantics for governance of scientific research and technological development in inputs for public health

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Abstract

The increasing adoption of information and communication technology (ICT) in public administration has changed the way governments make the purchases of products and service procurement, activities that are essential for the rendering of services in quantities and quality appropriate to meet the needs of the population. The present project suggests the use of a type of ICT aiming at good governance of scientific research and technological development in inputs for health at the Fundação Oswaldo Cruz: Web semantics and ontologies. From a theoretical point of view, this project is in tune with one of the emerging approaches for the understanding and outlining of current policies for research and technological development in health - an innovation systems approach. Despite the economic advantages of the adoption of electronic methods in governmental purchasing policy, it is necessary to keep in mind that it is a long term change process, since many administrative stages are being transferred to the electronic environment, requiring a new work flow design, as well as integration of electronic purchasing and management and administration systems such as, for instance, orders, purchase orders, logistics, finance and accounting. We propose the sharing of ontologies so as to allow interoperability between systems used in the purchasing process as well as in other key institutional management and administration systems.

Keywords

The increasing adoption of information and communications technology (ICT) in public administration has changed the way governments do purchasing and service procurement s, activities that are essential for the rendering of services in quantities and quality appropriate to meet the needs of the population. The present project suggests the use of a type of ICT aiming at good governance of scientific research and technological development in inputs for health in Brazil: web semantics and ontologies. The term ontology, originally from philosophy, was incorporated by computer science in the early 1980's, when John McCarthy used it for the first time (WELTY, 2003). Since then, many definitions for ontology have appeared; however, to the present there has been no consensus about the term in computer science. According to WELTY (2003), ontology in computer science refers to the meaning and existence of objects and concepts; for the author, ontology defines the objects and concepts existing within the sphere of a system, how those relate to each other, and what the clearest possible meaning of those objects and concepts is. For GRUBER (1983), what matters is the purpose of the ontology and, in the context of sharing and recycling knowledge, it can be defined as an explicit specification of a conceptualization - that is – ontology is a description of the concepts and relationships that may exist among them. In this context, the specification of ontology generates ontological commitments, which mean an agreement on the use of a reliable vocabulary, yet incomplete, with the theory specified by an ontology. According to GRUBER (1983), conceptualization is the foundation of a formally represented body of knowledge. For STUDER et al., (1998), conceptualization refers to an abstract model of a phenomenon that identifies important concepts regarding such phenomenon; the explicit specification indicates that the types of concepts used and the restrictions regarding the use of the respective concepts are explicitly defined.

The Internet offers easy and immediate access to information on governmental purchases, potentializing the reduction of costs both for suppliers and governments. The web also makes it easier for small- and mid-sized companies to participate, increasing the competition for government contracts. Electronic purchasing via Internet, including electronic procurement, is used in countries with different levels of development, such as the United Kingdom and Brazil. But, Brazil, still needs analyses that present a real picture of the impact of electronic purchases, mainly for public research institutions, and that must take into consideration the quality of equipment, materials, and technical guarantees for set- up and training present in purchase contracts.

Notwithstanding the advantages, in economic terms, of the adoption of electronic methods in government purchases, it is necessary to bear in mind that it is a long-term change process, since many administrative stages are transferred to the electronic environment, which requires a new work flow design, such as the integration of the electronic purchases and management and administration systems such as, orders, purchase orders, logistics, finance and accounting (TALERO, 2001). In this sense, the first stage of the project, which began in March of the current year, consisted of a debate on the purchase process adopted by public research organizations , since one of the goals is the analysis and the development of tools that enable interoperability between systems used in several organizational processes. In order to reach this objective, it was decided to use, for the of investigation and development of locally situated ontologies, the Oswaldo Cruz Foundation (*Fundação Oswaldo Cruz*), one of the largest public health research institutions in Brazil, operating in the scientific research and the technological development areas as well as in the area of health sciences (clinical research and public health), biological sciences (biosciences research), in addition

to social sciences and humanities in health. In terms of budget, FIOCRUZ's expenditures, between January and June of 2007, amounted to R$ 572 million, a little more than 8% of the total expenditures accrued by the Ministry of Health in the same period (BRAZIL). The expenditures on services from third parties (companies), supplies, equipment and permanent material amounted to R$ 87 million in the same period. Purchasing activity at FIOCRUZ is, therefore, a key element in reaching its institutional goals, not only due to the expense (for a country like Brazil), but, mainly, for determining the availability of medicines, vaccines, and diagnostic tests for the population, as well as inputs for the production of scientific knowledge and technologies.

The present project, coordinated by Laura Viana, is a consequence of the results reached throughout the last 12 months with projects financed by CNPq (National Council of Scientific and Technological Development)(2006-2008) called: " Ciência, tecnologia e inovação em saúde: uma análise socioantropológica da política de C&T&I da Fiocruz" (Science, Technology and Innovation in Health: a Socio-anthropological Analysis of Fiocruz's Science, Technology and Innovation Policy), coordinated by Carlos Saldanha, and "Redes Cooperativas e Inovação em Saúde Pública – estudo de caso do processo de construção social, coletivo e local da Rede Vacinas Recombinantes e DNA da Fundação Oswaldo Cruz" (Cooperative Networks and Innovation in Public Health – Case Study of the Process of Collective and Local Social Construction of the *Network of Recombinant Vaccines and DNA* of the Oswaldo Cruz Foundation), coordinated by Márcia de Oliveira Teixeira. Both projects analyze the process of construction and implementation of public policies for research and technological development in health in Brazil. Concerning the Oswaldo Cruz Foundation, both projects favor the analysis of following objects: a) the process of construction and implementation of an institutional policy for research and technological development in health at the Oswaldo Cruz Foundation; b) the forms of organization of the technical-scientific research for the production of knowledge and for the development of health technologies, focused on networks, technological platforms, and flexible laboratories. The projects have been developed by a multidisciplinary team formed by a sociologist, an anthropologist, two engineers, a philosopher, a specialist in public administration, a lawyer, and a physicist, all part of the "Science, Technology and Innovation in Health" Research Group, of the Directory of the Research Groups in Brazil of the National Council of Scientific and Technological Development (CNPq).

At Fiocruz, as in many other Brazilian public research organizations, researchers are required to know and daily deal with the legal provisions that regulate the process of public purchasing, in order to seek solutions in view of the specificities of their purchase orders. Researchers get involved with an activity that is foreign to their professional qualifications and to their functional role in the organization. The law that regulates the purchasing process, the Bid Law No. 8,666, from June 21, 1993, in its turn, requires carrying out progressively more rigorous bidding processes, by means of slow and bureaucratic procedural rites, if compared to other public and private international research organizations. It is a paradoxical institutional reality, because, in the last five years, the National Policy on Science, Technology and Innovation in Health (PNCTIS) has been encouraging the translation of scientific knowledge into innovative products and services, aimed at the improvement of the quality of life and the welfare of the population, so that it can contribute to the technological and economic development of the country (BRAZIL, 2007). But, such translation is jeopardized. The slowness of the purchasing process for basic inputs for R&D activities leads to delays in the schedules, in the bilateral cooperation agreements, and in contracts. On the other hand, the current process does not always guarantee the selection of the bid that is the most advantageous for the administration. The project considers that the success of the PNCTIS and of public research organizations dedicated to the generation of knowledge and innovative products necessarily involves the improvement of institutional governance, as well as critical analyses of factors ignored by the policy makers and by economic thought, yet essential for the construction of a local capacity suitable to R&D and innovation. An example of a little analyzed factor is the purchase process.

From a theoretical point of view, this project is in tune with one of the emerging approaches to the understanding and design of the current policies of research and technological development in health - innovation systems (LASTRES et al., 2007). This approach is used in the study to understand the underlying conditions of the programs and projects of research, development, and technological innovation capable of favoring successful national, regional, or sector experiences.

Even though the literature includes variations in approaches to innovative systems, a generic definition includes all the economic, social, political, organizational and institutional factors that influence the development, diffusion, and use of innovation (EDQUIST, 2007). By sheltering a wide group of innovation determining factors, notwithstanding its favoring the organizations, the institutions and the multiple possibilities of relations among organizations and institutions, the interdisciplinary approach of the innovation systems canalizes a diversity of perspectives in the social sciences, such as economy, sociology, and economic history (EDQUIST, 2007).

According to PAVITT (2007), the innovation process involves adjustments between technical offer and market demand, presents uncertainties and varies according to the economic sector, the area of knowledge, the type of innovation, the historical period, the country of occurrence, the size of the company, the corporative strategy(ies) and prior experience with innovation. PAVITT identifies three partially superimposed innovation subprocesses from which are pointed out the subprocess of production of scientific and technological knowledge that, over time, has been specialized by discipline, function, and organiza-

tion. According to PAVITT, this developing expertise has increased the levels of complexity – in the very devices, in the knowledge which serves as the foundation for those devices and in the organizational means and practices for the development and commercial exploitation of those devices and knowledge. As a result, only the processes of coordination and integration of specialized knowledge and learning in conditions of uncertainty remain generic.

In their turn, MAZZOLENI et al. (2006) state that, in the contemporary world, it may be easier to acquire and learn device-integrated technologies - "physical" technologies, than organizationally incorporated technologies, in legislation and regulation, in public policies, in codes of administrative and business good practices, in habits and rules - "social" technologies. For the authors, the assimilation of the "physical" technologies needs the implementation of several "social" technologies, such as the effective installation of the organization carrying out the researches, linked to a management structure that efficiently operates the "physical" technologies, or the implementation of efficient procedures for the procurement of goods and services.

An effective system of public research capable of providing qualification and advanced training is, according to MAZZOLENI et al. (2006), basic for the national, regional, or technological and economic sector development, especially for situations that require the appropriate technologies for a specific place, as in the example of prevalent diseases that are not uniformly distributed.

Although research in Brazil has offered little contribution for the technological innovation in health inputs (MOREL, 2007) - necessary to fight international diseases such as the neglected and most neglected diseases , it is understood that the Brazilian reality may be even worse than that of other countries with lower relative development, because it interposes neglected diseases, such as dengue fever, Chagas disease, and leishmaniasis, widespread in those countries, with diseases prevalent in the developed nations, such as diabetes, hypertension, and obesity (MOREL, 2007). However, if it is believed that there are improvements to be made, they will be in "social" technologies, (as defined by MAZZOLENI et al. 2006).

Therefore, with the development of this project, the aim is to contribute to the improvement of governance through the use of advanced tools of information technology and communication in Fiocruz's internal processes, especially in the programs and projects of research and technological development of the Research and Technological Development Vice-presidency (VPPDT). In the public sector, governance refers to the rules, processes, and behaviors through which interests are articulated, resources are managed, and power is exercised in society, that is, it means the capacity of the state to assist the citizens (FARAZMAND et al., 2006). Among other products, we are analyzing and organizing a flowchart for Fiocruz's future purchase process of programs and projects of research and technological development. The working theory consists of the understanding that this process, like Fiocruz's other organizational processes, will soon be entirely available in a Web environment,

keeping the decentralization of the research units and their internal processes, which will have support from different interoperable systems. Therefore, we propose the sharing of ontologies so as to allow the interoperability between the systems used in the purchasing processes and in the other institutional management and administration systems.

However, before developing such ontologies, it is necessary to understand the regulatory framework of the public administration purchasing process, in general, and, specifically, Fiocruz's purchasing process. At Fiocruz, we focus our analysis on the purchasing process carried out within the sphere of the programs of promotion of research and technological development (R&D), coordinated by the Research and Technological Development Vice-presidency (VPPDT) In brief, the legal framework determines that public bidding is the rule to be applied in governmental purchasing. There are exceptions; some of purchasing and procurement may be exempted or may not be required, in situations that are clearly defined in the legislation, and provided that they are justified. But, if on one the hand, the law is the basis for the formation of purchasing processes; on the other hand, the strategic role that many of the materials and services play in research projects should also be recognized. For instance, if the purchasing process is not capable of making supplies available in the amounts and qualities required by projects as per the schedules of the projects, laboratory experiments either cease being carried out or are carried out unsatisfactorily, thus jeopardizing the quality of results and the institutional goals to be reached.

At the same time, the study has have started carrying out interviews with representatives of the users (researchers) and managers/administrators of the purchasing process for Fiocruz's program of promotion of R&D, aiming at a better understanding of the purchasing practices of the institution (HANSEN, 2006). In general, this process comprises two stages: one that is characterized by definition and preparation, and a second one characterized by execution of the purchasing/procurement.

The first stage is internal to each of Fiocruz's Units while the other can be carried out by the decentralized units of the Foundation or by their Administrative Board, in the case of the centralized units, such as the Presidency and its Vice-presidencies, for example.

The interviews that have been carried out to the present, confirm, once again, all the difficulties that have already been previously pointed out, and the following has to be added: *i)* the precariousness of the planning of necessary purchasing and its control; *ii)* the non-availability of tools for the consultation of information required for the definition of purchasing (such as consultations with warehouses and verification of regulatory requirements for certain products); *iii)* the precariousness of logistics, especially for products requiring special handling, and *iv)* the multiplicity of specifications and synonymies of consumption materials.

Right at the beginning of research into understanding the purchasing processes at Fiocruz, it was noticed that there is considerable room for improvement in the

purchasing activities of R&D promotion programs. For example, at the VPPDT, a large portion of activities are still manual, such as, for example, activities related to the purchasing process. The few computerized stages (request of promotion and scholarships for research and research support) have become so without taking into account the flow of information, in addition to not being integrated with other management and administration systems of the institution that, in their turn, are not interoperable.

Regardless of the internal difficulties endemic in Brazilian public research organizations the management and use of information in current organizations is a complex task. The tools that are currently available do not overcome the barrier of heterogeneity observed, both in the database systems, and in the web environment (CARDOSO et al., 2006). Also according to CARDOSO et al. (2006),

heterogeneity happens when there is no agreement on the meaning, interpretation, or intended use of the same piece of data or related data. Figure 1 below shows two possible solutions for the problem of the semantic heterogeneity that occurs when the meaning of one single piece of data is expressed in different ways (CARDOSO et al., 2006). The first consists of the use of "from-to" tables (or translators), a solution known and used in many systems, but which does not solve the problem of the semantic heterogeneity, and the second one, which consists of the use of ontologies to achieve integration and interoperability between systems (sharing of ontologies).

In view of the objective and the project's theory, the most appropriate solution consists, therefore, in the sharing of ontologies in order to achieve the interoperability between the systems used in the purchasing

Figure 1 - Possible solutions for the semantic heterogeneity

Translators

Shared Ontology
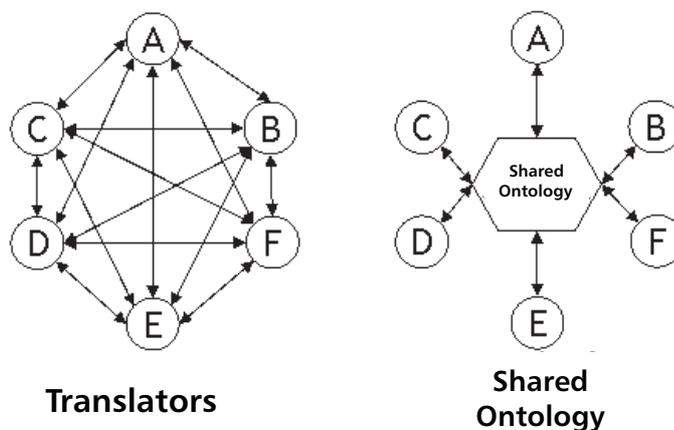
processes and the other institutional management and administration systems.

A necessity for developing the current project is to increase the sample (or the field of analysis) by means of the incorporation of other governmental institutions. The Intention is to identify bottlenecks, possible simplifications, and the best coordination possible for modeling a purchasing process that meets the needs of research projects. In order to increase the variability, we are considering the possibility of analyzing a public, complex research organization similar to Fiocruz, but one outside the health sector, such as the Brazilian Agricultural Research Corporation (Embrapa) of the Ministry of Agriculture, and Supply. The internal survey and the external comparison should allow identifying the route of information, activities that can be automated, and systems that will suffer impacts. Another group of activities of the project will be in charge of deepening analyses of the technological possibilities of web semantics, emphasizing the construction and reuse of ontologies.

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