Semantic portals from sociothecnical perspective of the actor-network theory

Josefina Aparecida Soares Guedes [I]
https://orcid.org/0000-0002-0806-4450

Rita de Cássia Fonseca [II]
https://orcid.org/0000-0001-9727-104X

Faimara do Rocio Strauhs [III]
https://orcid.org/0000-0002-4013-2724

[I] *Universidade Federal do Paraná, PR, Brasil.*
Doutoranda do Programa de Tecnologia e Sociedade da Universidade Tecnológica Federal do Paraná.

[II] *Universidade Federal do Paraná, PR, Brasil.*
Doutoranda do Programa de Tecnologia e Sociedade da Universidade Tecnológica Federal do Paraná.

[III] *Universidade Tecnológica Federal do Paraná, PR, Brasil.*
Professora no Programa de Pós-graduação em Tecnologia e Sociedade.

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Semantic portals, such as socio-technical artifacts, involve different actors that are aligned to offer communication and information search services more quickly and accurately. The objective of this study is to describe the network of actors involved in the construction of semantic portals and their interrelationships. The precepts of the Actor-Network Theory were used as a methodology to design a network of semantic portals from selected studies in the literature. The results indicated that the design of the network of semantic portals points to actions of human actors: portal administrators, portal

developers and end users, but also of non-human actors, which are made up mainly of technologies. Each actor has his or her interest contemplated as the other actors fulfill their roles towards a common goal - information of high added value. It can be concluded that the study of the features of the portal actors' network can guide changes in current standards, focusing on the quality of research results and the informational needs of the user community.

Keywords: *Portals. Semantic Web. Semantic Networks. Ontology. Information retrieval.*

Portais semânticos na perspectiva sociotécnica da teoria ator-rede

Os portais semânticos, como artefatos sociotécnicos, envolvem diferentes atores que são alinhados para ofertar serviços de comunicação e de busca de informação de forma mais rápida e precisa. O objetivo desse estudo é descrever a rede de atores envolvidos na construção de portais semânticos e suas interrelações. Os preceitos da Teoria Ator-Rede foram utilizados como metodologia para desenhar uma rede de portais semânticos a partir de estudos selecionados na literatura. Os resultados indicaram que o desenho da rede de portais semânticos aponta ações de atores humanos: administradores do portal, desenvolvedores do portal e os usuários finais, mas também dos atores não humanos, que são constituídos, sobretudo, pelas tecnologias. Cada ator tem seu interesse contemplado à medida que os demais atores cumprem seus papéis em prol de um objetivo comum – informação de alto valor agregado. Conclui-se que o estudo dos traços da rede de atores dos portais pode nortear mudanças das normas vigentes, com foco na qualidade dos resultados das pesquisas e nas necessidades informacionais da comunidade de usuários.

Palavras-chave*: Portais. Web Semântica. Redes semânticas. Ontologia. Recuperação da informação.*

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1 Introduction

The portals consist of a single point of access to the information resources of organizations on the Web (TERRA; BAX, 2003). The increasing growth in available data makes it difficult to select and retrieve information, however, which drives the use of new technologies for structuring the portals (BAJENARU, 2018). The semantic portals are an evolution of the conventional portals and use the Semantic Web technologies that make it possible to add meaning to the information content (BERNES-LEE; HANDLE; LASSILA, 2001; LAUSEN *et al*., 2005).

The data retrieval system used in conventional portals is based on keyword research or hierarchical vocabulary subject to linguistic phenomena of synonymy and polysemy, which strongly alter the accuracy of the query (MARTINS; SOARES; FRANCELIN, 2012). In these portals, the searches are imprecise and generally recover many pages of results and the user needs to spend a lot of time in the task of reading the recovered documents in order to extract the desired information (LEE *et al*., 2018; FERNÁNDEZ *et al*., 2011).

Semantic portals use the formal domain ontology as a retrieval system, which makes the search results more accurate, and it is possible to build a more elaborate response from various relationships between search terms and available documents (GIRASE; PATNAI; PATIL, 2016).

The content of the semantic portals is structured and represented from specific data modeling for representation and description of Web resources (FERREIRA; SANTOS, 2013). This modeling, together with semantic inference mechanisms and ontology, allows the addition of semantic value not only for the treatment and retrieval of information, but also to access new knowledge from it. In this way, semantic portals deliver value and quality to both organizations and end users, with dynamic and automatic feeding and efficient retrieval (GAVRILOVA *et al*., 2011; CLUNIS, 2018; TAHMASEBI *et al*., 2019).

Considering the semantic portal, a socio-technical artifact, the description of the human and non-human actors that compose it can offer subsidies for the construction or updating of these portals focusing on offering more efficient mechanisms of information retrieval. The objective of this study is, in this scope, to describe the network of actors involved in the construction of semantic portals listing interests and interrelations.

Following the logic of social theory, technology is seen as a socio-technical system marked by the interconnection between its components, enabling a deeper understanding of the impact of the deployment, use and management of technologies (IYAMU; MGUDLWA, 2018).

The structure of the article includes the presentation of the theories that underpin the semantic portals and the socio-technical systems that subsidize the construction of the network of semantic portals. These theories describe the network and the actors that compose it.

2 Theoretical Background

In the light of the literature, we present the foundations for the structuring of semantic portals and the precepts of Actor-Network Theory (ANT) and socio-technical networks.

2.1 Semantic Portals

Semantic portals are derived from conventional portals, distinguished from them by the use of Semantic Web technologies in their structuring (LAUSEN *et al*., 2005). They are characterized by storing and structuring contents according to domain ontologies that provide a robust semantic base to describe the metadata of documents, improving the efficiency of searches in the interface of the portals (CVERDELJ-FOGARASI *et al*., 2017).

The Semantic Web proposal was presented by Tim Berners-Lee in 2001 in order to promote data sharing and reuse on the Web. The main goal was to insert meaning in the documents so that the machines (computers and their support devices) could also understand them (BERNERS-LEE; HENDLER; LASSILA, 2001). In this way, besides humans, computers can "understand" the meaning of information and thus recover, manipulate information and increase the efficiency of searches, facilitating the recovery of relevant information for the Web user (BELLANDI *et al*., 2012; WIMMER, YOON; RADA, 2013).

Semantic technologies enable more exhaustive and accurate searches compared to traditional portals characterized by high revocation and low accuracy (LACHTIM; MOURA; CAVALCANTI, 2009; WINNER; YOONE; RADA, 2013). Therefore, it is possible to overcome the limitations of traditional portals and have more quality in the recovery of the information contained in the portals.

Reynolds, Shabajee and Cayzer (2004), highlighted that to considered semantic, the portal must present some requirements that involve: a) search interface - multidimensional search by meaning of a rich domain ontology; b) navigation - multidimensional with facets, semi-structured and extensible information and decentralized changes; c) updating - addition of new classifications with expansion of the

information structure; d) content management - decentralized management with the possibility of multiple aggregations and views of the same data; e) processing - automated processing for access by intelligent agents and for facilitating integration between portals; f) publication - automatic integration of ontologies, providers publish data in forms reused by the organization in multiple portals. Such requirements are possible with the addition of technologies and semantic modeling.

According to Guedes and Strauhs (2016), the structure of the semantic portals is composed of technologies aimed at: a) data storage: traditional open standard technologies such as operating system, database; network security (ELMASRI; NAVATHE, 2011; MASNER *et al*., 2019) and Web server, network security (NIELSEN, 2000; ROSENFELD; MORVILLE; ARANGO, 2015) and inference mechanisms (BERNERS-LEE; HENDLER; LASSILA, 2001; AZANI, 2009; STALLINGS, 2015); b) information management: tools and information retrieval system, content management; (MANIEGA-LEGARDA; PÉREZ-SALMERÓN, GUERRERO-TORRES, 2008), information processing and publishing (BELLANDI, *et a.l*, 2012; LACHTIM; MOURA; CAVALCANTI, 2009; MARUTHA; NGULUBE, 2018); and c) ontology management: tools that support ontology engineering tasks.

The Resource Description Framework (RDF) data model, Ontology Language (OWL), and SPARQL query language are the main technologies essential to characterize portals as semantic (EL HAJI; AZMANI; EL HARZLI, 2014).

The RDF data model allows the description of metadata related to the resources available on the Web, such as data about author, title, year, among others, whose meanings are coded in triples, each one containing subject, predicate and object. Subject and object are identified by Uniform Resource Locators (URIs) that identify resources on the Web. The predicate indicates the type of relationship present between subject and object (BIZER; HEATH; BERNERS-LEE, 2009). The RDF Schema, the semantic extension of the RDF, allows the creation of vocabularies to define the specific nomenclature for a data set of as given domain (BIZER; HEATH; BERNERS-LEE, 2009). XML is the representation language commonly used for the conceptual RDF data model to be processed by computers, so that, from a specific domain vocabulary, it is possible to make inferences and semantic relations between contents (BIZER; HEATH; BERNERS-LEE, 2009).

The foundation of ontology comes from the field of philosophy, but when applied to computer science it provides a formal specification to a term and its relationships, associated with other terms in a given field of knowledge (GRUBER; 1993; MALHOTRA; NAIR, 2015). The use of ontologies allows the definition of a common vocabulary to describe basic

concepts and relationships in a specific domain. The main components of ontologies are classes, concepts, instances, properties, relationships and axioms, among other elements (BLANDÓN ANDRADE; ZAPATA JARAMILLO, 2018).

The ontology provides the representation of knowledge that can be shared and reused and includes descriptions of concepts and properties of a domain of knowledge, the relationships between concepts, constraints and how relationships can be used (TELNOV, 2015). In this way, the ontology becomes an essential tool in the design of semantic portals, since it serves as a communication vocabulary among intelligent agents, which enables the organization, reuse and dissemination of knowledge (GUARINO, 1997; GRUBER, 1993).

The domain ontology has been applied in the semantic structuring of web portals for information retrieval in different fields of action such as, for example, electronic commerce (BAHAFID *et al*., 2015); medicine (CLUNIS, 2018; TAHMASEBI *et al*., 2019), image and object research (MK; NOAH, 2017); nanotechnology (SHARMA, 2016); database-based organizational decision making (GIRASE; PATANAIK; PATIL, 2016).

In a semantic annotation context, the trend is to move from a simple "keyword" approach to a "metadata" approach. Metadata can be defined in general as machine-readable structured collections of lexical items to be used to express statements about the organization and content of some sets of digital or non-digital documents (ZARRI, 2014). Thus, to perform the semantic analysis of the keyword in an ambiguous search, from a word that has more than one meaning, inserted by users, an ontological knowledge base built on refined metadata is required to provide accurate search results (LEE *et al*., 2018).

OWL is the standard recommended by the World Wide Web Consortium (W3C) and characterizes a metaontology (MARTINEZ-CRUZ; BLANCO; VILA, 2012), that is, a language for ontology definition and instantiation (explanation), formalizing a domain, defining classes and properties of these classes: identity, equivalence, opposition, cardinality, symmetry, transitivity, disjunction, among others. This structuring makes it possible to represent rich and complex knowledge about things, groups of things and relationships among them (W3C, 2019). OWL is constructed from the XML and RDF standards and makes it possible to expand the RDF vocabulary used to enrich the RDF data model, defining a vast vocabulary to describe complex ontologies that improve the search in the semantic portal interface (BAJENARU, 2018; EL HAJI; AZMANI; EL HARZLI, 2014).

The recovery of information in portals, from the use of semantic networks, aims to equalize the interest of users and Web content (LI *et al*., 2017; MALGAONKA; DEVALE, 2016). For this task the inference mechanisms are fundamental, since they use logical rules to deduce

information from a knowledge base. Traditional portals are marked by the use of simple textual search engines, while in semantic portals inference engines are used from SPARQL query language, based on RDF and OWL, and which allows inferences based on the axioms of the ontologies used, optimizing responses in semantic searches (DUARTE; HARA, 2018; W3C, 2019).

The process of building semantic portals then involves different activities such as structural design, selection, organization and presentation of information, use of ontology, choice of technologies, functionality and user support (FERNÁNDEZ *et al*., 2011).

The elements involved in creating a semantic portal are interconnected and cannot be viewed in isolation. This assumption is contained in the ANT, proposed by Michel Callon (1986), John Law (1992) and Bruno Latour (2012) and which guides a new methodology for understanding science and technology, from the analysis of social relations that permeate the environments of creation and scientific innovation. In this perspective, the technical and technological designs of the artifacts should emphasize the interrelationships between human and non-human actors, both having the same importance in a system, due to their agency capacity (CALLON; LATOUR 1981; LAW, 1992).

The following section presents the theoretical assumptions of the ANT that underpin the view of portals as socially constructed artifacts and so that the interests of all network actors are taken into account.

2.2 Socio-technical Network and ANT

According to Burns (2006), technology is understood as a particular type of human construction and conceptualized, in terms of a dynamic system of actors, as a complex of physical artifacts, coupled with systems of rules employed by social actors to use and manage these artifacts.

The various technical and physical structures that are part of the socio-technical systems are managed and organized by different actors with different professionals, composing a variety of groups of social networks and entities involved in the construction, operation and maintenance of socio-technical systems. Human actors, including individuals, groups, organizations, communities and other collectivities are the producers, transporters and reformers of social rule systems (BURNS; DIETZ, 2001).

The role of social actors is to understand and predict what happens in a given social context in order to justify, explain and criticize an action and/or its consequences. To this end, these actors establish and use norms and rule systems appropriate for each situation and, over time, acquire experiences and skills to adapt or reform rules in interaction environments, from situational policies to manage processes. This defines

the scenario for the social struggle, the exercise of the power to impose or resist rules, and the negotiation of changes to them (BURNS; DIETZ, 2001).

A socio-technical network can then be understood as a set of heterogeneous actors, composed of human and non-human elements that interact in the process of conception, production and dissemination of knowledge, giving rise to technological definitions obtained in the process of problem solving (LATOUR, 2000). Thus, the analysis of the network of actors that compose a technical artifact can contribute to the description of their problems and the identification of gaps or controversies, in addition to highlighting the strong and weak links that subsidize decision making and the integration of social systems, favoring the rapid dissemination of new ideas (GRANOVETTER, 1983).

The concept of networking refers to the idea of alliances, flows and mediations resulting from the connection between heterogeneous elements that can be material - non-human - and human. This concept was presented by French and English anthropologists, sociologists and engineers associated, among them Bruno Latour, Michel Callon and John Law who established and disseminated the Actor-Net Theory (ANT) (MAIA; SERAFIM, 2011; CALLON, 1986; LATOUR, 2000; LAW, 1992).

The ANT assumes that human and non-human actors have the same importance in a system, due to their agency capacity. From this perspective, human beings are not victims of the process or autonomous protagonists in action, as well as objects have agency, that is, they are associated in such a way that they make other actors do things (Latour, 2012). Thus, the actors construct the social based on controversies that, through agreements, dilute divergences, enabling the construction of collaborative networks to satisfy the interests of all actors (CALLON; LATOUR, 1981; LAW, 1992).

Assim, os atores controem o social a partir de controvérsias que, mediante acordos, diluem as divergências, possibilitando a construção de redes de colaboração para satisfazer os interesses de todos os atores

From ANT it is possible to map socio-technical networks that give rise to technological definitions obtained in the process of solving controversies or divergences. Thus, such contexts of conflicts and agreements are gateways for investigations in different contexts (CALLON, 1986; CALLON; LATOUR, 1981; CALLON; LAW; RIP, 1986; LATOUR, 2000; HUGHES, 1989).

ANT makes it possible to describe technological artifacts in the social and natural contexts in which they operate, unlike traditional scientific methods that are not sufficient to explain the relationship between science, technology and society (CALLON, 1986).

In this conception, technological artifacts such as portals, especially semantic ones, are socially constructed and, therefore, are inserted in a socio-technical network. The conception of technology from a socio-technical point of view is associated with technological constructivism, a trend followed by several authors such as Callon (1986), Hughes (1989) and Latour (2000), who preach methodological changes that bring the humanistic culture closer to the scientific-technological.

According to Law (1992), ANT seeks to explore and describe the social dynamics of science in opposition to the perspective of neutrality proclaimed by the privileged scientific methodology that reinforces the split between technology and society. In ANT, social relations are considered in a context where societies, power, organizations, agents and machines are entities formed by the network. The analysis of the network consists in exploring and describing the social orchestration of the actors, in order to know how they mobilize, juxtapose and remain united (CALLON, 1986; CALLON; LATOUR, 1981; LATOUR, 2000).

According to Iyamu and Mgudlwa (2018), ANT is considered a highly influential theory within the sociology of science that seeks to explain and interpret development and socio-technical change. In ANT, actors are human and non-human entities that have the capacity to change the state of affairs, and these actors are viewed equally, with no priority given to technology or the social issues surrounding it. People, technology and processes are considered of equal importance and value, and regardless of whether the actor is human or non-human, both are equally weighted, offering the same contribution to a network.

The network will be strong as long as all the constituent elements are united in the same purpose. However, the ordinances or arrangements of a network are always precarious and incomplete, and at any given moment, one or more actors may leave the network and follow their own inclinations, just as new actors may enter and share the ordered arrangement. In both situations, this causes a reordering of the network of relationships (LAW, 1992).

This reordering of the network demystifies the concept of the black box that denotes the idea of something finished, stabilized, consecrated and unquestionable, as Latour (2000) reported. The solidity of a fact depends on the movement of all those who keep it moving, the allies (PEDRO, 2010) and, in this way, the successive black boxes form a structure with macro and micro actors. Thus, every actor is a black box, through a continuous negotiation process in which reinterpretation, representation or appropriation of an actor's interests takes place, so that these can be followed by the other actors in the network (CALLON; LATOUR, 1981).

According to Callon and Latour (1981), ANT is based on concepts of translation and displacement that reflect the interests of the actors. In translation, interests, responsibilities, needs, mechanisms of action and regulation are defined. Displacement consists in convincing the actors to displace themselves according to a common objective.

In translation, processes of identifying, mobilizing, assigning roles and influencing actors take place, forming an alliance among them so that they all support the construction of the network (LATOUR, 1992).

According to Prado and Baranauskas (2012), the translation process consists of building associations between actors in which there is a desire to change a certain state of affairs, stimulate the interests of the actors to unite and define roles to ensure the fulfillment of responsibilities. In translation an activity is transformed or given a new meaning. Elbanna (2012) emphasized that translation is the mechanism by which the network builder recruits actors and ensures their faithful associations. However, translation is not deterministic, because what actors do when they come together in a network is unpredictable. Cordella (2010) clarified that actors are influenced by the network and, in turn, influence the network by negotiating their forces through translation.

Non-human elements influence human behavior and can alter expected relationships and actions, modifying the design of technical objects (CALLON, 1986; LATOUR, 2000). Latour (2000) emphasizes that it is necessary to follow the actors, registering and describing, in order to point out the opposites and the resolution given by the actors who will configure in the social and technological field the grey box processes of the artifacts that have not yet been stabilized as black boxes and that maintain a collective of mediations and negotiations involving human and non-human interests. In this way, ANT can be used as a methodology to identify the main actors, spokespersons, connections and the dynamics of a specific situation at a specific moment.

In this scope, this study aims to describe the network of actors involved in the construction of semantic portals, the controversies surrounding conventional and semantic technologies and mechanisms of action and regulation of the network in the interests of all actors.

3 Methodology

This study was configured as bibliographic research, with the use of Content Analysis as a technique for analysis of the collected data. Initially, a bibliographic survey was carried out in Capes Portal databases to identify the seminal authors related to the themes and sub-themes under study, by means of a bibliometric survey.

The search in the databases was done through search strategies combining terms for content recovery involving: Semantic Web, Semantic Portals, Socio-technical Systems and Actor-Network Theory.

Next, content analysis was performed, according to the precepts of Bardin (2010), to identify the categories of context and analysis and the registration units that composed the literature review. Table 1 presents the research corpus of this study.

Table 1 - Research corpus according to the main theme.

MAIN TOPIC	AUTHORS	STUDIES
Information retrieval	Bellandi et al. (2012); Fernández et al. (2011); Wimmer; Yoon; Rada (2013); Gavrilova et al. (2011); Stallings (2015); Nielsen; Loranger (2007); Bajenaru (2018); Martins, Soares; Francel 2012).	8
Domain onthology	Guarino (1997); Gruber (1993); Girase; Patanaik; Patil (2016); Bahafid *et al*. (2015); Clunis (2018); Tahmasebi *et al*., (2019); MK; Noah (2017); Lachtim; Moura; Cavalcanti (2009)	8
Semantic portals	Azani (2009); Guedes; Strauhs (2016); Lausen et al. (2005); Ferreira; Santos (2013); Blandón Andrade; Zapata Jaramillo (2018); Lee et al. (2018) ; Li et al. (2017; Malgaonka; Devale (2016); Malhotra; Nair (2015); Marutha; Ngulube (2018); Sharma (2016); Telnov (2015); Zarri (2014); Maniega-Legarda; Pérez-Salmerón; Guerrero-Torres (2008); Duarte; Hara (2018); Elmasri; Navathe (2011); Börner et al (2012); Bizer; Heath; Berners-lee (2009); Nielsen, 2000; Rosenfeld, Morville; Arango, 2015; Cverdelj-Fogarasi et al (2017); Terra; Bax (2003); Guedes; Strauhs (2016)	23
Semantic Web	Berners-Lee; Hendler; Lassila (2001); Masner *et al*., 2019; Nguyen et al., 2020; Spyns *et al*., 2002; Open Knowledge International (2019); W3C (2019); Lawan; Rakib, (2019). El Haji, Azmani; El Harzli, 2014); Koivunen; Miller (2001); Martinez-cruz; Blanco; Vila, 2012	10
Socio-technical systems	Burns; Dietz (2001); Hughes (1989); Burns (2006); Granovetter (1983); Pedro (2010)	5
Actor-Network Theory	Callon (1986); Law (1992); Callon; Latour (1981); Latour (2012); Latour (2000); Lemos (2013); Callon; Rip; Law (1986); Maia; Serafim (2011); Iyamu; Mgudlwa, 2018); Prado; Baranauskas (2012); Cordella (2010); Elbanna (2012)	12
Total		66

Source: Authors.

The unfolding of the context categories, highlighted the systems of information retrieval by keywords and the formal ontology used in semantic portals, according to the precepts of the Semantic Web, totaling 49 studies. The approach of sociotechnical systematics eve identified the portals as socio-technical artifacts, socially constructed forming networks of human actors and technologies for semantic annotation, listing 17 studies.

The ANT was used as the underlying methodology to design the network of portals, from the analysis of literature. The Pajek tool was used to build the network, detailing the actors and their connections.

The construction of the portal network was based on the components of the portal structure, according to the precepts of the semantic Web and the ANT that highlight the non-human elements and

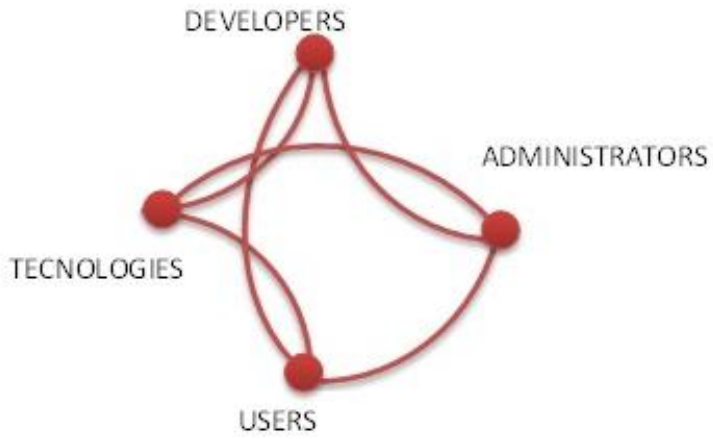
the human actors that articulate themselves to design the portals in order to meet the interests of all network users (CALLON; LAW; RIP, 1986).

The following section presents the analysis and discussion of the results, based on the theories used in the study. The network of actors of the semantic portal and the connections between macro and micro actors are presented.

4 Discussion of Results

The mapping of the network of actors involved in the construction of a semantic portal makes it possible to understand the procedures necessary to provide a research interface that aims to promote access to information quickly and accurately. In the socio-technical approach, the translation process of the portal network basically involves the interests of administrators, developers, users and the technologies used in the construction of the portal. Figure 1 presents the simple semantic portal network.

Figure 1. Simple translation network of the semantic portal.



Source: Authors.

According to Callon and Latour (1981), actors (i.e., individuals) form alliances and lure other actors to strengthen these alliances, creating heterogeneous networks made up of humans and non-human artifacts, which act autonomously. Thus, in the network of semantic portals, developers, administrators, technologies and users are obligatory waypoints. In these points, the actors change their preferences in order to overcome barriers to achieve the initial goal that is semantic structuring of the portals (CALLON, 1986). At each crossing point, human and non-human actors connect to strengthen and characterize the network, providing them with heterogeneous elements.

The portal administrators are responsible for defining the objectives and target audience, as well as establishing the portal's governance guidelines. This team includes as actors: a) content manager; b) content manager; c) database manager; d) local security and cloud manager (NIELSEN, 2000; ROSENFELD; MORVILLE; ARANGO, 2015).

The contentists are responsible for the indication of content for insertion in portals. The content manager is responsible for receiving publisher's demands, approving and updating content, as well as excluding obsolete content (LEGARDA; PÉREZ-SALMERÓN; GUERRERO-TORRES, 2008). In order to facilitate tasks, the manager needs open-standard content management software (SPYNS *et al*., 2002), such as Wordpress, Joomla, Drupal, Textpatern, Radiant, among others (W3C, 2019).

In the network of semantic portals, open-source technologies cause the opening of black boxes, with the reordering of actors that reveal new possibilities of technical arrangements (LAW, 1992; LEMOS, 2013, PEDRO, 2010; IYAMU; MGUDLWA, 2018). These technologies translate the interests of collaboration, exchange and reuse of data, communicability, publication, self-regulation, self-organization and democratization of access to information, meeting the precepts of the semantic Web (BERNERS-LEE; HENDLER; LASSILA, 2001; AZANI, 2009, NGUYEN *et al*., 2020).

The use of open-source technologies characterizes a strong point (GRANOVETTER, 1983) in the structuring of semantic portals, since their use has been increasingly recommended (AZANI, 2009). In addition, the strong worldwide movement for the use of this type of technologies can be interpreted as a major milestone in the opening of the large black box technology, since it mobilizes micro and macro actors, revealing new network connections (LATOUR, 2012; LEMOS, 2013)

In the semantic portal network, the content manager translates the interests of the portal's contentists. Although in conventional portals, this actor also translates the interests of those, in the semantic perspective of portals in the light of ANT, he/she convinces the related actors about the need to use technologies to execute the automatic content management, aiming at a better process of information availability (CALLON, 1986, LATOUR, 1992; LI *et al*., 2017; MALGAONKA; DEVALE, 2016; MARUTHA;NGULUBE, 2018).

The database manager is responsible for definitions about the organization of data distributed in informational repositories, schemes, tables, reports and other objects that are organized to model aspects of reality in a way that supports the processes of information requests (ELMASRI AND NAVATHE, 2011). The conventional portals, as well as the semantic ones, need a data management system for actions of creation,

consultation, updating and administration of the used database. However, considering the precepts of the Semantic Web and ANT, in the semantic portals again occurs a reordering of actors with interests in the use of free and open-source databases, such as: Oracle, MySQL, PostgreSQL having as manager the Linux operating system (OPEN KNOWLEDGE INTERNATIONAL, 2019; NGUYEN *et al*., 2020). In the semantic portal this actor connects with the native databases RDF (triple stores) and OWL.

The network and cloud security manager are responsible for defining rules of use and controlling database access credentials, ensuring confidentiality of information (STALLINGS, 2015; MASNER et al., 2019). These actors translate the security of the local database and cloud services. Convincing other actors permeates the use of open-source tools such as: Nagios Core, Snort, OpenStack, KeePassXC.

Considering the objective of building a semantic portal, it is in the interests of administrators that the technological structuring of the portal enables the delivery of quality services to their community. These interests should be aligned in the portal's network, through negotiation processes involving the agency of developers, technologies and users of the semantic portal (LAW, 1992; CALLON; LATOUR, 1981).

The developers are composed by professionals in the technology area who work in different tasks such as: programming, software engineering, knowledge engineering, ontology engineering, portal design and usability. These actors are mobilized by the interests of the administrators, assuming roles and mobilizing themselves in the network to support the construction, maintenance and updating of the portal, also negotiating the choice of technologies that express semantics.

The semantic technologies translate the interests of developers, administrators and users, following the methodology indicated in the semantic portal design. RDF and OWL are essential tools that provide support for the exchange of the various rules-based technologies for the semantic structuring of the portal (W3C, 2019). These technologies have unveiled the black box of conventional portal suturing, modifying the technical suturing of these artifacts (LATOUR, 2000, LAW, 1992).

The Resource Description Framework (RDF) data model enables the descriptive representation of Web resources that express meanings, encoded in a set of triples, each containing subject, predicate and object of an elementary sentence and that native RDF database (triple stores) (BIZER; HEATH; BERNERS-LEE, 2009). These triples can be expressed in XML tags, which recover the content of documents, from the XML language (FERREIRA; SANTOS, 2013). The RDF Schema allows the definition of vocabulary for representation of simple ontologies and description of classes and properties (KOIVUNEN; MILLER 2001).

OWL is also an important technology for implementing the semantic portal. It is characterized as a metaontology that allows the creation of ontologies, enabling the processing of information content and not only its presentation to human actors (LAUSEN *et al*., 2005; BERNERS-LEE; HENDLER; LASSILA, 2001). SWRL, RIF and RuleML configure semantic rule languages that provide expressiveness for efficient inclusion in OWL metaontologies (LAWAN; RAKIB, 2019).

The SPARQL query language is a fundamental standard of semantic portals as it provides fast and accurate retrieval of information (DUARTE; HARA, 2018). This technology is based on the RDF structure and the axioms of the ontologies used to make the searches, configuring an inference mechanism that combines automated reasoning, increasing the efficiency of the search compared to the search engines used in conventional portals (Bellandi *et al*., 2012; Börner *et al*., 2012). Thus, the use of these logical reasoning mechanisms, associated with other technologies favor semantic research.

The domain ontology mobilizes non-human actors represented by semantic technologies to characterize the semantic portal, connecting with the basic technologies (database, operating system, Web server) data modeling and inference mechanisms, aligning with the interests of human actors represented by managers, developers and users (CALLON, 1986).

The domain specialists and the knowledge engineer are involved in the management of ontologies and connect to the shared semantic vocabulary and the mechanisms of editing and capturing ontology that enable the automatic and integrated sharing of information. These mechanisms allow the extraction, interpretation and processing of information, so that publication in a semantic portal can be done by modifying or extending the concepts of the semantic vocabulary used (LACHTIM; MOURA; CAVALCANTI, 2009).

The ontology is also connected to plug-ins that allow the use of collaboration, communication, sharing, personalization and personal topics map resources that consist of additional functionalities of the portal such as: discussion list, chats, forums, among others (LAUSEN *et al*., 2005; LACHTIM; MOURA; CAVALCANTI, 2009).

The ontology connects strongly with the direct and indirect users of the semantic portal, who may have different profiles. Indirect users may include associated institutions, sponsors and other stakeholders/actors whose interests are focused on fast and accurate retrieval of information. The formal and controlled vocabulary provided by the ontology is an essential point in the alliance of actors in the heterogeneous network composed of humans and non-human artifacts (CALLON; LATOUR, 1981).

Considering the complexity of implementing semantic portals in practice, ontology can be considered a weak link in the network

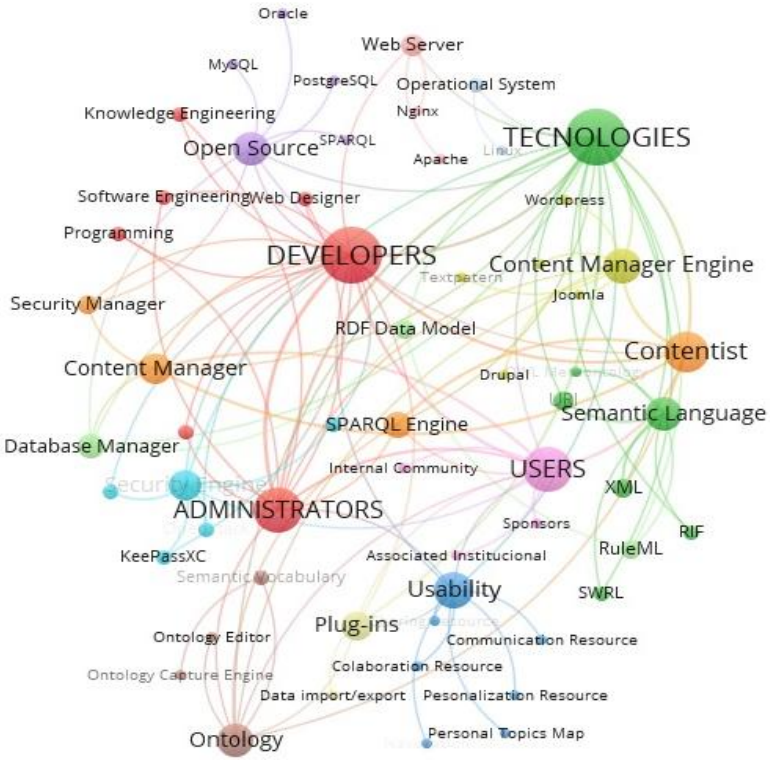
(GRANOVETTER, 1983) that needs to be strengthened and articulated by the other actors of the portal so that the network is not broken (CALLON; LATOUR, 1981; LAW, 1992).

The use of ontology and semantic technologies alter relationships and expected actions, modifying the technical design of traditional portals, marking the evolution of scientific and technological knowledge, structural components of society.

In translation, processes of identifying, mobilizing, assigning roles take place, as well as influencing actors by forming an alliance among them so that they all support the construction of a network (LATOUR, 1992; CALLON; LATOUR, 1981). The alignment of the actors' interests is done through a continuous negotiation process in which reinterpretation, representation or appropriation of an actor's interests occurs, so that they can be followed by the other actors in the network (CALLON; LATOUR, 1981). Thus, actors influence the network and are also influenced by it (PRADO; BARANAUSKAS, 2012; ELBANNA, 2012; CORDELLA, 2010).

Based on Berners-Lee, Hendler & Lassila's (2001) semantic web studies, the semantic structuring for portals described by Lausen et al. (2005) and the reference framework of minimum conditions for establishing semantic potential proposed by Guedes and Strauhs (2016), it was possible to unfold the network of a portal, in order to further specify the complex traits of the network of a semantic portal according to Figure 2, outlined with the Vosviewer tool and composed by the various actors treated.

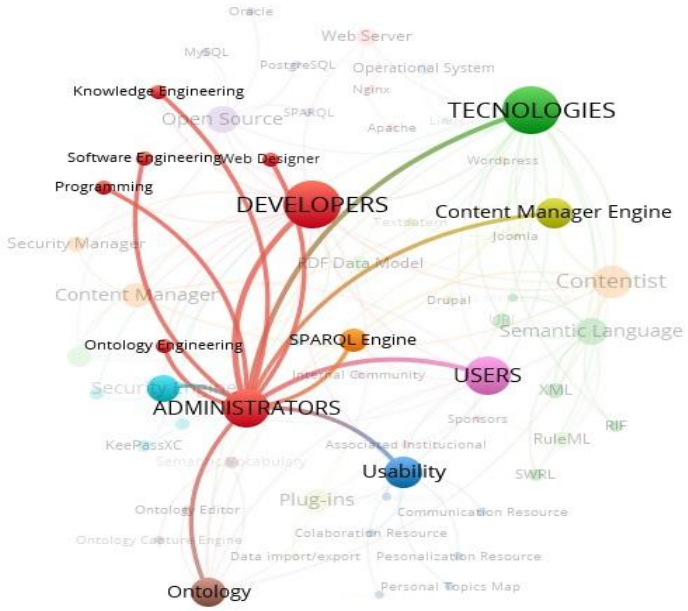
Figure 2 - Network of actors of the semantic portal.



Source: Authors.

Considering that the construction of portals arises as an internal demand of the institutions, coordinated by their managers, the translation of the portal administrators includes the following interests and actions: propose the construction or improvement of the portal in order to make content related to the area of operation available to its users. Thus, in the semantic portal, the administrators unfold into micro actors (publishers or proponents of content for the portal, content manager, database manager, security manager) mobilizing them in the network with the purpose of managing the portal. Administrators connect with developers, technologies and users (Figure 3)

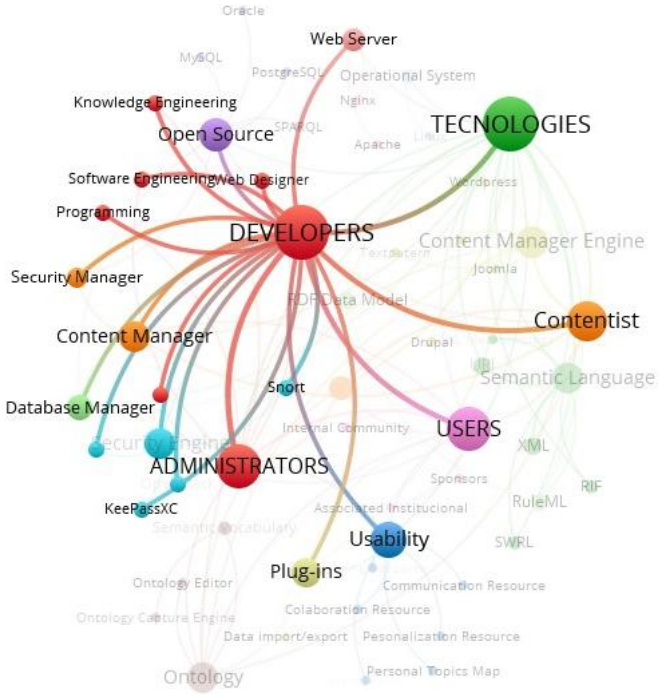
Figure 3 – Administrators in the semantic portal network.



Source: Authors.

The developers, also represented by micro actors of the technology area (programmers, software engineers, knowledge engineers, ontology engineers, web designers) translate the interests of administrators and users, and through negotiations defend technologies that can characterize the portal as semantic, to the detriment of conventional technologies, solving possible controversies (Figure 4).

Figure 4 **-** Developers in the semantic portal network

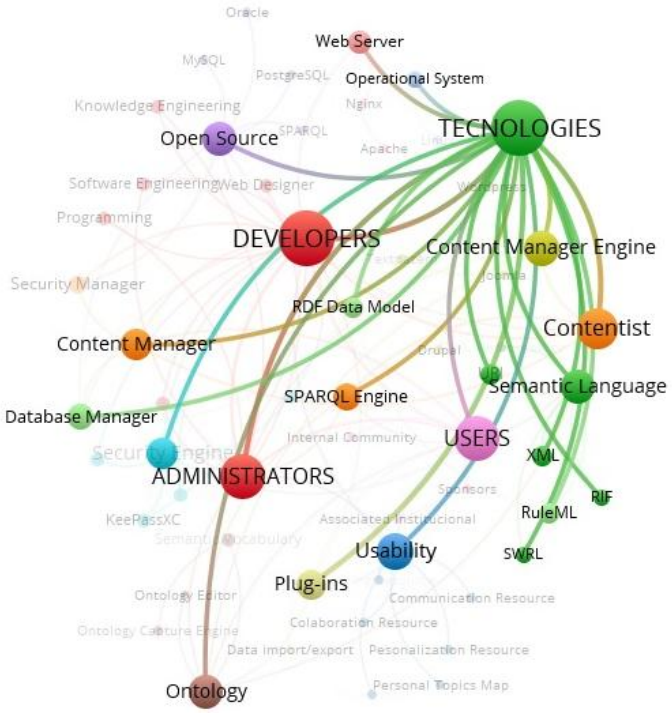


Source: Authors.

RDF data modeling has connection with native RDF database, RDF Schema, OWL, SWRL, RIF, RuleML, ontology and SPARQL inference mechanism, to increase the search efficiency in portals by combining automated reasoning (BELLANDI *et al*, 2012; BÖRNER *et al*., 2012; FERREIRA; SANTOS, 2013; BERNERS-LEE; HENDLER; LASSILA, 2001; KOIVUNEN; MILLER, 2001; LAWAN; RAKIB, 2019). These actors maintain connections that translate the interests of the portal users by the quality in the recovery of the information.

Figure 5 illustrates the actors that represent the technologies of a semantic portal.

Figure 5 **-** Technologies in the semantic portal network.



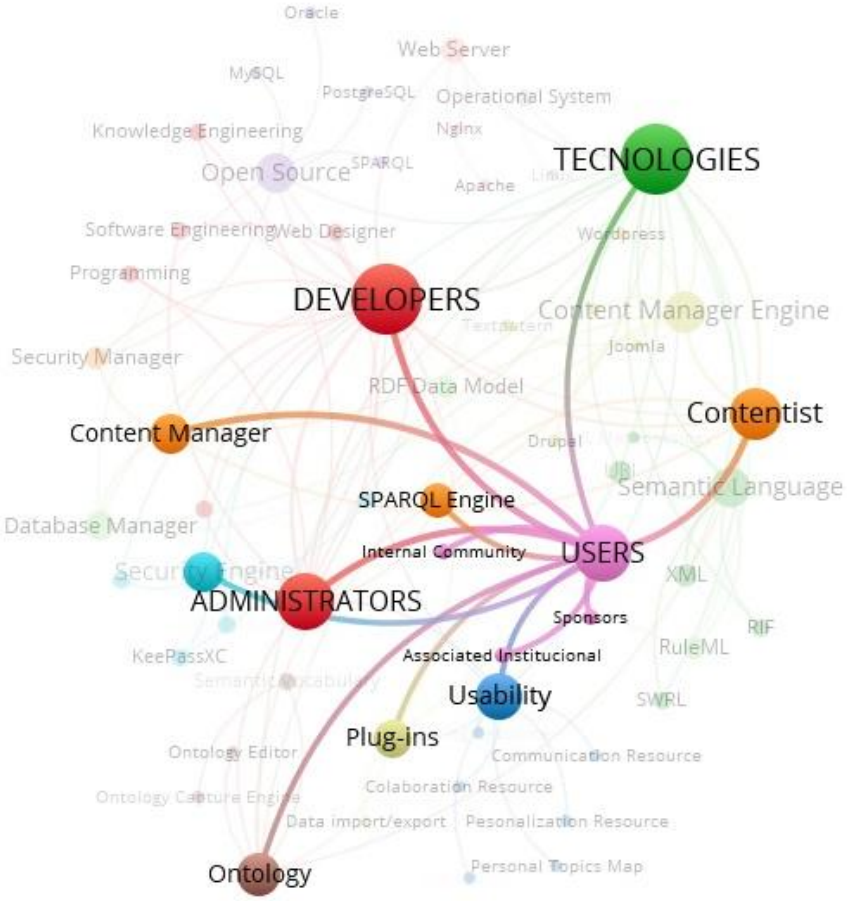
Source: Authors.

The ontology is connected to the shared semantic vocabulary, the editing and ontology capture engines, the SPARQL search engine, the native RDF database, OWL languages, the content manager and the plugins. The mechanisms for editing and capturing ontologies enable the automatic and integrated sharing of information that allows the extraction, interpretation and processing of information, so that the publication in a semantic portal can be done by modifying or expanding the concepts of the semantic vocabulary used (LACHTIM; MOURA; CAVALCANTI, 2009).

The interests of users of different profiles of the semantic portal are translated by the semantic structuring of technologies, search engines, content management and, above all, by the use of ontology as a model of information retrieval (Figure 6). These interests are translated into

relevant results and in a quick manner from the content made available on the portal.

Figure 6 - Users in the semantic portal network.



Source: Authors.

Users are connected to all the actors of the semantic portal network, because the translation of interests is directly related to the acceptance and use of these portals. Thus, the structure formed by human and non-human elements, symmetrically and focusing on semantics, can correspond more effectively to the need for quick and accurate retrieval of information available in the portals.

5 Conclusions

Semantic portals, in order to be effective, need to have a structure that favors access to information quickly and accurately. By providing semantics, there are changes in the policies and rules established in the structuring of the portals, with reordering of human actors - professional - and non-human - technologies. Thus, the semantic portal can be seen as a socio-technical artifact, built by a set of actors who interact to fulfill common goals in the portal network.

The conventional portal can be considered a black box of technology, since its basic structure is stabilized. However, considering the portals socio-technical and socially constructed artifacts, the stabilization is temporary until a new fact or new actors are incorporated into the portal network. In this context, semantics was introduced in the portals structuring, through different technologies, to solve the problems of lack of precision and speed in searches.

Some basic technologies are common to portals, but the use of open standard technologies is a very striking feature in applications for semantic portals. In the same way, semantic inference mechanisms replace conventional search engines with gains in quality and speed of results. Additionally, RDF modeling, OWL metaontology and the formal ontology incorporated into the portals make it possible to open the "black boxes", with new arrangements, joints and connections to the portal network.

The design of the semantic portals network points out the actions of human actors, administrators, IT developers and users, and also of non-human actors, which are largely constituted by technologies. In the translation of the portal network, each actor's interest is contemplated as the other actors play their roles, so that everyone agrees on a single objective which, in the case of the semantic portals, is to communicate and offer information quickly recoverable, with delivery of value to users.

The semantic portal constitutes, then, a technological advance marked by the action of different actors who, through mechanisms of action and regulation, highlight the role of the social scientist in opening the black boxes, tracing associations and regrouping the social, from the perspective of Callon and Latour, (1981) and Law (1992).

References

AZANI, Cyrus. An open systems approach to system of systems engineering. *System of systems engineering: Innovations for the 21st century*, p. 21-43, 2008.

BAHAFID, Abdelhadi *et al*. Toward a new information retrieval system based on an e-commerce ontology. *International Journal of Advanced Studies in Computers, Science and Engineering*, v. 4, n. 10, p. 26, 2015.

BAJENARU, Lidia *et al*. An ontology-based e-learning approach for the healthcare management system. *In*: CONFERENCE OF Elearning AND SOFTWARE FOR EDUCATION «(eLSE).” *Proceedings […]* Carol I” National Defence University Publishing House, 2018. p. 356-362.

BARDIN, Laurence. *Análise de conteúdo*. São Paulo: Edições 70, 2010.

BELLANDI, Andrea *et al*. Geração assistida de base de conhecimento, gestão e recuperação de competências. *Jornal Internacional de Engenharia de Software e Engenharia do Conhecimento* , v. 22, n. 08, p. 1007-1037, 2012.

BERNERS-LEE, Tim; HENDLER, James; LASSILA, Ora. A web semântica. *Scientific American*, v. 284, n.5, p. 34-43, 2001.

BIZER, C.; HEATH, T.; BERNERS-LEE, T. *Linked data-the story so far*. 2009. Disponível em: http://tomheath.com/papers/bizer-heath-berners-lee-ijswis-linked-data.pdf. Acesso em: 14 ago. 2020.

BLANDÓN ANDRADE, Juan Carlos; ZAPATA JARAMILLO, Carlos Mario. Uma revisão da literatura sobre população de ontologias. *Engenharia e Desenvolvimento*, v. 36, n. 1, p. 259-284, 2018.

BÖRNER, Katy *et al*. VIVO: A semantic approach to scholarly networking and discovery. *Synthesis lectures on the Semantic Web*: theory and technology, v. 7, n. 1, p. 1-178, 2012.

BURNS, Tom R. The sociology of complex systems: An overview of actor-system-dynamics theory. *World Futures*, v. 62, n. 6, p. 411-440, 2006.

BURNS, Tom R.; DIETZ, Thomas. Revolution: An evolutionary perspective. *International Sociology*, v. 16, n. 4, p. 531-555, 2001.

CALLON, Michel. The sociology of an actor-network: The case of the electric vehicle. *In*: CALLON, Michel, RIP, Arie, LAW, John (eds.)*Mapping the dynamics of science and technology.* London: Palgrave Macmillan, 1986. p. 19-34.

CALLON, Michel; LATOUR, Bruno. Unscrewing the big Leviathan: how actors macro-structure reality and how sociologists help them to do so. *Advances in social theory and methodology:* Toward an integration of micro-and macro-sociologies, v. 1, 1981.

CALLON, Michel; LAW, John; RIP, Arie. Qualitative scientometrics. *In*: _____. *Mapping the dynamics of science and technology*. London: Palgrave Macmillan, 1986. p. 103-123.

CLUNIS, Julaine. Designing an ontology for managing the diets of hypertensive individuals. *International Journal on Digital Libraries*, v. 20, n. 3, p. 269-284, 2019.

CORDELLA, Antonio. Information infrastructure: an actor-network perspective. *In:* TATNALL, Arthur. *Social Influences on Information and*

Communication Technology Innovations. Hershey: IGI Global, 2012. p. 20-39.

CVERDELJ-FOGARAŠI, Igor et al. Semantic integration of enterprise information systems using meta-metadata ontology. *Information Systems and e-Business Management*, v. 15, n. 2, p. 257-304, 2017.

DUARTE, Mariana Machado Garcez; HARA, Carmem S. Otimização do Mapeamento de Consultas SPARQL para SQL. *In*: ESCOLA REGIONAL DE BANCO DE DADOS, 14. *Anais [...]* SBC, 2018.

EL HAJI, Essaid; AZMANI, Abdellah; EL HARZLI, Mohamed. Multi-expert system design for educational and career guidance: an approach based on a multi-agent system and ontology. *International Journal of Computer Science Issues (IJCSI)*, v. 11, n. 5, p. 46, 2014.

ELBANNA, Amany. Applying actor network theory and managing controversy. *In*: DWIVEDI, Y., WADE, M.R. SCHNEBERGER, Scott L. (eds.). New York: Springer, 2012. p. 117-129.

ELMASRI, R.; NAVATHE, Shamkant B. *Sistemas de banco de dados*. 6. ed. São Paulo: Person. 2011.

FERNÁNDEZ, Miriam *et al*. Semantically enhanced information retrieval: An ontology-based approach. *Journal of Web Semantics*, v. 9, n. 4, p. 434-452, 2011.

FERREIRA, Jaider Andrade; SANTOS, Plácida Leopoldina Ventura Amorim da Costa. O modelo de dados resource description framework (rdf) e o seu papel na descrição de recursos*. Informação & Sociedade*: Estudos, p. 13-23, 2013.

GAVRILOVA, E. A. Implementation features a university data portal using the Semantic Web technology. *Programming and Computer Software*, v. 37, n. 1, p. 48-55, 2011.

GIRASE, Ashutosh V.; PATNAIK, Girish Kumar; PATIL, Sandip S. ontology driven approach for effective decision making. *International Journal of Computer Applications*, v. 148, n. 7, 2016.

GRANOVETTER, Mark. The strength of weak ties: A network theory revisited. *Sociological theory*, p. 201-233, 1983.

GRUBER, Tom. *What is an ontology?* 1993. Diponivel em: http://www-ksl.stanford.edu/kst/what-is-an-ontology.html. Acesso em: 01 maio. 2019.

GUARINO, Nicola. Understanding, building and using ontologies. *International Journal of Human-Computer Studies*, v. 46, n. 2-3, p. 293-310, 1997.

GUEDES, Josefina Aparecida Soares; STRAUHS, Faimara do Rocio . Portais do conhecimento de universidades: um quadro referencial para avaliação de potencial semântico. *Liinc em Revista,* v. 12, n. 1, 2016.

HUGHES, T. The Evolution of large technological systems. *In*: BIJKER, W., HUGHES, T., PINCH, T. *The social construction of technological systems.* Cambridge: The MIT Press, 1989, p. 51-82.

IYAMU, Tiko; MGUDLWA, Sibulela. Transformation of healthcare big data through the lens of actor network theory. *International Journal of Healthcare Management*, v. 11, n. 3, p. 182-192, 2018.

LACHTIM, Fernanda Aparecida; MOURA, Ana Maria C; CAVALCANTI, Maria Cláudia. Ontology matching for dynamic publication in semantic portals. *Journal of the Brazilian Computer Society*, v. 15, n. 1, p. 27-43, 2009.

LATOUR, Bruno. *Ciência em ação*: como seguir cientistas e engenheiros sociedade afora. São Paulo: Unesp, 2000.

LATOUR, Bruno. *Reagregando o social*: uma introdução à teoria do ator-rede. Salvador: Edufba, 2012.

DAVIES, John *et al*. Semantic web portals: state-of-the-art survey. *Journal of knowledge Management*, 2005.

LAW, John. Notes on the theory of the actor-network: Ordering, strategy, and heterogeneity. *Systems practice*, v. 5, n. 4, p. 379-393, 1992.

LAWAN, Abba; RAKIB, Abdur. The semantic web rule language expressiveness extensions-a survey. *arXiv preprint arXiv*: 1903.11723, 2019.

LEE, Jinhyuk et al. Ranking paragraphs for improving answer recall in open-domain question answering. *arXiv preprint arXiv:1810.00494*, 2018.

LEMOS, André. *A comunicação das coisas*: Teoria Ator-rede e cibercultura. São Paulo: Annablume, v. 310, 2013.

LI, Huakang *et al*. An optimized approach for massive web page classification using entity similarity based on semantic network. *Future Generation Computer Systems*, v. 76, p. 510-518, 2017.

KOIVUNEN, Marja-Riitta; MILLER, Eric. W3c semantic web activity. *Semantic Web Kick-Off in Finland,* v. 2, p. 27-44, 2001.

MAIA, Alessandra; SERAFIM, Sabrina. Análise da Teoria Ator-Rede (TAR) e sua relação com os paradigmas de relações públicas. *Contemporânea (Título não-corrente),* v. 9, n. 1, 2011.

MALGAONKAR, R.; DEVALE, P. Optimizing web image search with alternative optimization technique. *International Journal of Application or Innovation in Engineering & Management*, v. 5, n. 6, p. 1-10, June 2016.

MANIEGA-LEGARDA, David; PÉREZ-SALMERÓN, Glòria; GUERRERO-TORRES, Yolanda. O Portal de Biblioteques de la Generalitat de Catalunya: um projeto para cidadãos e profissionais da biblioteca pública. *O profissional da informação* , v. 17, n. 2 P. 183-187, 2008.

MK, Yanti Idaya Aspura; NOAH, Shahrul Azman Mohd. Semantic text-based image retrieval with multi-modality ontology and DBpedia. *The Electronic Library*, v. 35, n.6, p.1191-1214, 2017.

MARTINEZ-CRUZ, Carmen; BLANCO, Ignacio J.; VILA, M. Amparo. Ontologies versus relational databases: are they so different? A comparison. *Artificial Intelligence Review*, v. 38, n. 4, p. 271-290, 2012.

MARTINS, Mariana Thamires; SOARES, Maria Sueny Barbosa; FRANCELIN, Marivalde Moacir. Questões preliminares sobre os espaços de significação e a organização do conhecimento: conceitos, linguagens e conhecimentos marginais. *Informe*: Estudos em Biblioteconomia e Gestão da Informação, v. 1, n. 1, p. 78-86, 2012.

MARUTHA, Ngoako Solomon; NGULUBE, Patrick. Enterprise content management system implementation readiness to improve medical records management in Limpopo Province, South Africa*. Library Philosophy & Practice*, v. 1, p.1-23, 2018.

MASNER, Jan *et al*. Creation, Storage and Presentation of Information Content–Semantics, Sharing, Presentation, and Archiving. *AGRIS on-line Papers in Economics and Informatics*, v. 11, n. 665-2019-3997, p. 75-82, 2019.

NGUYEN, Phuong T. *et al*. An automated approach to assess the similarity of GitHub repositories. *Software Quality Journal*, p. 1-37, 2020.

NIELSEN, Jakob. Loranger, Hoa. *Usabilidade na web*: projetando websites com qualidade. Rio de Janeiro: Elsevier, 2007.

NIELSEN, J. *Projetando Web sites*. Rio de Janeiro, Editora Campus. 2000.

OPEN KNOWLEDGE INTERNACIONAL. Disponivel em: https://okfn.org/opendata/how-to-opendata/. 23 dez. 2019.

PRADO, Alysson Bolognesi; BARANAUSKAS, Maria Cecilia Calani. Representing scientific associations through the lens of Actor-Network Theory. *In*: INTERNATIONAL CONFERENCE ON COMPUTACIONAL ASPECTS OF SOCIAL NETWORKS, 4.*(CASoN)*. IEEE, 2012. p. 87-92.

PEDRO, Rosa. Sobre redes e controvérsias: ferramentas para compor cartografias psicossociais. *Teoria ator-rede e psicologia*, v. 1, 2010.

REYNOLDS, Dave; SHABAJEE, Paul; CAYZER, Steve. Semantic information portals. *In*: INTERNATIONAL WORLD WILDE WEB CONFERENCE ON ALTERNATE TRACK PAPERS & POSTERS, 13. *Proceedings […]* 2004. p. 290-291. 2004

ROSENFELD, L.; MORVILLE, Peter; ARANGO, J. *Information architecture*: for the web and beyond. 4th ed. Sebastopol, CA: O'Reilly Media, Inc, 20125.

SHARMA, Abhishek. Nanotechnology Ontology: Semantic Access to Information in the Nano World. *DESIDOC Journal of Library & Information Technology*, v. 36, n. 1, 2016.

SPYNS, P. *et al*. OntoWeb: a semantic w*eb* community portal. *In*: INTERNATIONAL CONFERENCE ON PRACTICAL ASPECTS OF KNOWLEDGE MANAGEMENT, 4, 2002, Austria. *Proceedings [...]* Austria, 2002. p. 298-302.

STALLINGS, William. *Arquitetura e organização de computadores*. São Paulo: Pearson, 2010.

TAHMASEBI, Amir M. *et al*. Automatic normalization of anatomical phrases in radiology reports using unsupervised learning. *Journal of digital imaging*, v. 32, n. 1, p. 6-18, 2019.

TELNOV, Victor. Semantic Web and search Agents for Russian higher education. A pilot project. *In*: *CEUR Workshop Proc. 1536. Selected Papers of the XVII Int. Conf. on Data Analytics and Management in Data Intensive Domains (DAMDID/RCDL 2015)***.** Obninsk, Russia, 2015. p. 195-204.

TERRA, Jose Cláudio; BAX, Marcello Peixoto. Portais corporativos: instrumento de gestão de informação e de conhecimento. IN: Isis Paim(Org.) *A Gestão da informação e do conhecimento*. Belo Horizonte, Escola de Ciência da Informação, 2003. p. 33-53

WIMMER, Hayden; YOON, Victoria; RADA, Roy. Integrating knowledge sources: an ontological approach. *International Journal of Knowledge Management (IJKM)*, v. 9, n. 1, p. 60-75, 2013.

WORLD WIDE WEB- W3C. Standards. Disponível em http://www.w3.org/standards/. Acesso em: 13. Mar. 2020.

ZARRI, Gian Piero. Conceptual and content-based annotation of (multimedia) documents. *Multimedia tools and applications*, v. 72, n. 3, p. 2359-2391, 2014.