

## SEMANTIC DESCRIPTION OF THE ORGANIZATIONAL KNOWLEDGE RESOURCES - SELECTED ASPECTS OF SECURITY

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**Abstract:** The paper proposes the use of semantic modeling to describe the organizational knowledge resources. Key concepts related to semantic representation of knowledge in the form of ontology were also presented. The study indicated opportunities for creating new business models based on the organizational knowledge resources formalized in ontologies (ontology providers, organizations that certify knowledge available in the form of ontologies and clients using paid knowledge resources in ontology in order to automate certain areas of their activity. The investigations were presented in light of safety mechanisms whose implementation is necessary when using a semantic approach in describing the organizational knowledge resources and creating new business models based on this approach, including mechanisms for protecting information and knowledge from unauthorized access, certificates that describe the level of trust and the design of a secure user interface. The focus was also on the fact that the formalization of organizational knowledge resources and its representation in an electronic form (ontologies) poses a major challenge for knowledge engineers and leads to the necessity to cooperate in research on the borderline of management and IT sciences.

**Keywords:** organizational knowledge resources, semantic modeling, ontology, safety

### 1. INTRODUCTION

Knowledge is a significant factor of production that must be managed. This applies first of all to those economic organizations which produce and process knowledge. Knowledge management in an organization determines its competitive position within the global economy markets. It concerns not only the knowledge resources but also the processes related to gathering, localizing, developing, transferring, using and storing the knowledge necessary for the organization to reach its objectives. One of the crucial fields for the design and implementation of the organizational knowledge management is a technological dimension. It is necessary to provide some useful IT tools in this area. Information technologies are becoming increasing more effective,

and they are gradually being adapted in the field of knowledge management as well. An interesting solution is a possibility to use the semantic technologies when describing the organizational knowledge resources, especially the Semantic Web standards (Berners-Lee et al., 2001). Its functioning is based on the use of IT knowledge resources - considering their semantic description in a form of ontology. The purpose of this study was formulated bearing the above-mentioned observations in mind. It is an attempt to answer the following research questions based on the performed literature studies:

- *What is the presence and the future of use of semantic technologies to describe the knowledge resources of economic organizations?*
- *What changes in the business models' structures will be allowed by the semantic description of the knowledge resources of economic organizations?*
- *What are the major security problems in terms of semantic technologies adopted to describe the knowledge resources in economic organizations?*

## **2. SEMANTIC MODELING AND SECURITY OF KNOWLEDGE RESOURCES FORMALIZATION - LITERATURE STUDIES**

The problems of knowledge management in an organization can be seen from two perspectives: the organizational one (as a concept for organizational management) and the procedural one (as a process, where IT technologies play a highly important role). The procedural aspect is focused on the management of formal knowledge (meaning the knowledge that undergoes computer processing) (Niedbał, et al., 2018). Deliberations presented in this paper cover the procedural aspect of knowledge management. The notion of formalization and digitalization of knowledge resources is a part of an organization's operation, similarly as in the case of such terms as globalization or Industry 4.0. When it comes to the digital economy, we can observe a trend for automation and substitution of human work with that of machinery (both hardware and software solutions). Conversational commerce or customer information service may pose some examples where software solutions are applied with great success (in a form of so-called conversational bots). The issue of semantic description of organizational knowledge resources occur in this context as well.

A significant problem in modeling of for example knowledge processes or resources are the differences in how they are seen by the organization's managers and IT specialists. These are the differences between a business and technological perspective. The use of semantic representation of knowledge may bring an opportunity to level those differences (Goluchowski and Smolarek, 2014).

A basic notion in the management of formal knowledge is development of ontology as a common layer of terms for managers and computer programs (Cardoso,et al., 2008; Goczyła, 2011). In this way, the computer programs are capable of reading and interpreting content with consideration of its semantics. In the IT field, the ontology means formal representation of a given domain of knowledge, composed of sets of notions and relations between them. Often adopted if the definition of ontology proposed by T.R. Gruber: "ontology is a formal (computer readable), explicit (types of adopted terms and restrictions are explicitly specified) determination of shared conceptualization (the ontology includes the generally accepted knowledge)" (Stanek et al., 2008). It is assumed that the basis for recording of knowledge in a form of ontology are the following languages: *XML (EXtensible Markup Language)*, *UML*

(*Unified Modeling Language*), *RDF* (*Resource Description Framework*) and *OWL* (*Ontology Web Language*).

From the IT perspective on knowledge, its general specification distinguishes its two types: declarative knowledge (definitions, classifications, description of terms, roles, relations) and procedural knowledge (description of processes and strategies of conduct, methods, algorithms). Knowledge, considered in the category of an organizational resource, may adopt various shapes (Ruggles, 1997), namely procedural knowledge, catalog knowledge, experience-based knowledge. Furthermore, there are also other forms of knowledge: instrumental knowledge, scalar knowledge, relational knowledge and situational knowledge (Koźmiński, 2005). Organizational knowledge can be expressed in a form of business rules, meaning agreed principles of conduct, a certain type of restrictions imposed on the organization's operation. A collection of such principles usually functions as undisclosed knowledge, related to particular employees in the organization. It is therefore recommended to obtain and record this knowledge in a form of principles (Gołuchowski and Smolarek, 2014). Any business principles may be described semantically in the following languages: *SWRL* (*The Semantic Web Rule Language*), *RuleML* (*Rule Markup Language*), *RIF* (*Rule Interchange Format*).

The literature of the subject does not provide a clear position on whether a concept of the Semantic Web and description of the knowledge resources in a form of ontology will succeed or not. The opinions are very different - there are some both enthusiastic and skeptic beliefs (Anderson and Rainie, 2010; Target, 2018).

Four stages can be distinguished in development of semantic technologies related to implementation of the Semantic Web (Target, 2018):

- 1st stage (2001-2005) - W3C (*World Wide Web Consortium*) published a series of standards defining the semantic technologies - among others the *RDF* language standard. It is intended to describe a resource with a phrase composed of three elements - so-called triplets: of subject, predicate (quality) and object (value).
- 2nd stage begun in 2006 with development of extensive datasets described in the *RDF* format. An example here is the *DBpedia* dataset - a large repository of *RDF* triplets extracted from the Wikipedia articles.
- 3rd stage - related to emergence of a new data exchange format in 2008 - *JSON* (*JavaScript Object Notation*). There were some works undertaken, intended to develop some mechanisms for integration of *RDF* and *JSON* (Sporny, 2014). They resulted in *JSDON-LD* (*JSON Linked Data*) to appear in 2010.
- 4th stage, currently in progress, is characterized by a certain shift in direction of the developmental works. W3C is working on semantic technologies under a slogan "Data Activity" (Archer, 2014).

The availability of standards developed by W3C contributed to development of an ecosystem comprising of various tools delivered by various providers. Here we can mention, among others, database engines (e.g. GraphDB), ontology editors, tagging tools, semantic search engines. When it comes to the security mechanism in using the semantically described knowledge resources, they are similar to those employed in the Semantic Web solutions. They are mainly based on existing standards, first of all on the infrastructure of a public key and certification. The *RDF* documents may be signed by authors, hence allowing the applications to authenticate the information they have. There are currently some works being carried out over advanced

techniques of securing and integrating those applications in the languages the ontology is defined in.

Of course the use of the Semantic Web standards in computerization of the organizational knowledge resources does not mean that these resources will be available for all users of the Internet. There would be adequate access authorization and authentication maintained (Ekelhart et al., 2007). All safety standards and security mechanisms should be adhered to (including software, hardware, organizational and legal safeguards). However, it should be noted that such an approach refers to all IT solutions applied in organizations. Furthermore, the literature of the subject challenges the possibility to formally describe the knowledge resources in languages other than English, and some concerns are raised regarding the problem of false metadata and mistrust (Anderson and Rainie, 2010).

Semantic modeling and formalization of organizational knowledge may not only be intended to facilitate the process of knowledge management but also, in a broader perspective, to develop a semantic organization. There is a term "Semantic Enterprise" functioning in the literature of the subject - meaning an organization which uses and offers resources (products/services) described in a form of ontology (Mandal and Sen, 2013).

#### **4. RESEARCH QUESTIONS IN THE LIGHT OF USING THE SEMANTIC TECHNOLOGIES - DISCUSSION**

The performed literature studies allow for an attempt to answer the research question presented in the introduction to this paper:

- *What is the presence and the future of use of semantic technologies to describe the knowledge resources of economic organizations?* The 2001 concept of semantic description of knowledge resources and development of the Semantic Web has evolved. Currently, so-called *Linked Open Data (LOD)* and *Semantic Metadata* are used. Google employs the semantic technologies mainly in the search mechanisms, adopting the *JSON-LD* data format. Facebook uses the *OpenGraph* protocol. When it comes to the future of semantic technologies in description of knowledge resources, it is hard to give an unambiguous answer. Plenty of solutions in this field have been developed in the last dozen or so years, but there are some voices telling that different approaches to creation of tools based on these technologies are not integrated (d'Aquin, 2018). It can be stated that a lot of *REST APIs* (Representational State Transfer Application Programming Interfaces) available currently prove implementation of the Semantic Web concept to some extent.

An example of description of knowledge resources with new semantic technologies may be the EU Open Data Portal. It provides access to data compiled by the European Union institutions and bodies. These data may be used for both commercial and non-commercial purposes. The published data include, among others: geographical, geopolitical and financial data, statistics, legal acts, environmental, transport and scientific research data. The Portal provides a standard catalog giving easier access to the EU open data, presents lists of applications and web tools making use of those data, the terminal of the SPARQL query editor, access to REST API (a message format for the contents of both queries and responses is JSON).

- *What changes in the business models' structures will be allowed by the semantic description of the knowledge resources of economic organizations?* Taking the professional web portals into account (of the organizations and their products or services), it is assumed that they will be organized in a form consistent with the adopted ontologies. The organizations which will not do so will significantly weaken their market position. Knowledge representation in a form of an ontology is the core of the concept to create new business models - e.g. of ontology providers (their task will be to create, maintain and improve ontology in a given field and to publish the gathered knowledge resources against a charge), organizations certifying the knowledge gathered in the form of ontology, customers using the knowledge resources gathered in an ontology against a charge in order to automate the selected areas of their operations (Pawełoszek, 2013).

The advantage of using the semantic modeling is integration of processes between various organizations and within one organization. It is especially important in the context of implementing the cooperation-oriented management (with organizational structures of an organic nature). Integration is more difficult without a common ontology due to the use of different terms and standards.

- *What are the major security problems in terms of semantic technologies adopted to describe the knowledge resources in economic organizations?*

Safe implementation of semantic technologies in description of the organizational knowledge resources, and afterwards their use and sharing require some cryptographic solutions (regarding certification and digital signatures), covering the majority of technological layers of the Semantic Web. A web portal having the knowledge resources described in a form of ontology requires appropriate national or international certificates (attesting the trust level). This would certainly pose one of the factors in competitiveness of an enterprise owing such a portal. No high-quality standards ensuring the safe use of semantic technologies is the main barrier for their broad use in business practice - first of all the standards related to certification and trusting mechanisms.

### **3. CONCLUSION**

Digital transformation of the economy changes the reality, which the enterprise operates in. There are many situations, when human work is aided or frequently even substituted by IT solutions. However, regardless of whether this is the human work or the substitute algorithms which is under consideration, there is a need for a formalized form of knowledge. If the first case, it allows to transfer and share the knowledge, and in the second - to have it processed by a computer.

The use of the semantic description of organizational resources allows to begin digitalization of the organizational knowledge - understood in the context of access to electronic resources by computer programs "with understanding". Significant role in the success of this undertaking is played by implementation of particular layers of the Semantic Web. These is some extensive work to be done by IT specialists and organizations (among others W3C) which support development of those technologies. Development of the Semantic Web will cause gradual transition from the era of information to the era of knowledge management. This may become a source of numerous innovations, but also various types of security breaches in the employed solutions. Securing the information from unauthorized access is a crucial challenge to be faced by the Semantic Web creators. Development of ontology (and its

representation in an electronic format), and resulting computerization of organizational knowledge resources must be related to adequate authorization of access and authentication. In the case of practical application of semantic technologies in cooperation-oriented organizations, it is highly significant to adhere to all safety standards and security mechanisms (including hardware, software, organizational and legal safeguards).

## REFERENCES

- Anderson, J., Rainie, L., 2010. *The Fate of the Semantic Web*. <http://pewinternet.org/Reports/2010/Semantic-Web/Main-Findings.aspx?r=1>
- Archer, P., 2014. *Data Activity Statement*, <https://www.w3.org/2013/data/Activity.html>
- Berners-Lee, T., Hendler, J., Lassila, O., 2001. *The Semantic Web*. Scientific American.
- Cardoso, J., Lytras, M., Hepp, M. 2008. *The Future of The Semantic Web For Enterprises*. In: The Semantic Web: Real-World Applications from Industry, Springer, Heidelberg, Germany, 3-15
- d'Aquin, M., 2018. *Semantic web technologies to build intelligent applications*. <https://2018.semantics.cc/semantic-web-technologies-build-intelligent-applications>
- Ekelhart, A., Fenz, S., Tjoa, A.M., Weippl, E.R., 2007. *Security Issues for the Use of Semantic Web in E-Commerce*. In: Abramowicz, W. (eds) Business Information Systems. BIS 2007. Lecture Notes in Computer Science, 4439, Springer, Berlin, Heidelberg, 1-13. DOI: [https://doi.org/10.1007/978-3-540-72035-5\\_1](https://doi.org/10.1007/978-3-540-72035-5_1)
- EU Open Data Portal*, <http://data.europa.eu/euodp/en/home>
- Goczyła, K., 2011. *Ontologie w systemach informatycznych*. Exit, Warszawa.
- Gołuchowski, J., Smolarek, M. (red.), 2014. *Semantyczne modelowanie organizacji*. Difin, Warszawa.
- Koźmiński, A. K., 2005. *Zarządzanie w warunkach niepewności*. PWN, Warszawa.
- Mandal, K., Sen, T., 2013. *Semantic Enterprise: A Step Toward Agent-Driven* <http://www.cognizant.com/insightswhitepapers/Semantic-Enterprise-A-Step-Toward-Agent-Driven-Integration.pdf>
- Niedbał, R., Wrzalik, A., Sokołowski, A., 2018. *Modelowanie semantyczne w zarządzaniu wiedzą organizacji*. Marketing i Rynek, 9, 703-713.
- Pawełoszek, I., 2013. *Technologie semantycznego Internetu w kreowaniu przedsiębiorczości nowej ery*, [w:] Nowicki, A., Jelonek, D., (red.), *Wiedza i technologie informacyjne w kierowaniu przedsiębiorczości*, WZ PCz, Częstochowa, 29-37.
- Ruggles, R. L., (Ed.) 1997. *Knowledge Management Tools*. Butterworth-Heinemann, Boston.
- Sporny, M., 2014. *The Origins of JSON-LD*. <http://manu.sporny.org/2014/json-ld-origins/>
- Stanek, S., Sroka, H., Paprzycki, M., Ganzha, M. (red.), 2008. *Rozwój informatycznych systemów wieloagentowych w środowiskach społeczno-gospodarczych*. Placet, Warszawa.
- Target, S., 2018. *Whatever Happened to the Semantic Web?* <https://twobithistory.org/2018/05/27/semantic-web.html>