

## Semantic Web services and applications in Journalism

### Abstract

Through the years numerous changes in the field of World Wide Web have affected the news industry and journalism. Technological developments in the structure of the Web and in its use have challenged well established journalistic practices and workflows. This progress strengthened on the one hand journalists' performance in terms of information and variety of sources but on the other hand it undermined it in terms of functionality. For this reason not only media organizations but also journalists started to search, test and experimented with advanced technologies and smart web applications in real life scenarios. Specifically the Semantic Web (or Web 3.0.) and its features are gradually becoming trends because of the efficient ways they provide in data exploitation. Although it may not be clearly perceived, low level Semantic Web technologies are already being used today. Moreover the cooperation and convergence of media pioneers with technological giants and startups which specialize in the development and implementation of Semantic Web technologies are characterizing the landscape today. This paper aims to offer an analysis of the available semantic services, applications and tools in the context of journalism. The analysis will include a presentation of them followed by a short description so that a documentation of their specifications can take place. By offering a comprehensive examination of specific applications and tools adopted by global media organizations, the paper seeks to detect and define the existing use of Semantic Web technologies.

**Keywords:** Journalism, Semantic Web, Semantic Web services, Semantic Web applications, Semantic analysis tools

### 1. Introduction

Through the years, the simplicity, availability, reachability and reduced exploitation costs have made the Web one of the most common platforms for information publishing and dissemination. However most of the information is published as unstructured text that is made available to a general audience by means of Web pages (In, Frasincar, Borsje, Hogenboom, 2011). For certain professional and academic circles such as journalism and media industry this status is problematic. In today's exploding Web landscape, where vast amounts of information (documents, images, audio, videos etc) is produced every day from various sources across the world, professional journalists often finds it difficult to retrieve specific and detailed information or form a comprehensive view about a complicated topic. Journalists on the one hand welcome the abundance of information in the Web because they understand its dynamics and the potential benefits from its exploitation. But on the other hand, the full exploitation is not feasible due to the lack of an efficient infrastructure where they could discover, acquire and quickly analyze the information needed. This occurs because they have to navigate in a network of unstructured interconnected forms of

information (Kuck, 2004). With its evolution and consolidation all Web data will be structured and accompanied by their meaning, releasing multiple perspectives of usage.

Despite its advantages, firstly in terms of generation and distribution of information and secondly in cooperation and interaction of users through collaborative platforms, the current Web needs to be extended. The desirable extension will come with the full development of the Semantic Web (SW). After being mainly a research topic in Academia, SW and its technologies have now reached an inflection point in the market (Dau, 2011). It is already considered that SW technologies are gradually becoming trends because of the facilities and solutions they provide to many professional areas. The various applications and services which emerge from the use of SW technologies can benefit numerous business sectors (Bartussek et al 2018, Hoppe et al 2016). Journalism and media industry are this paper's two areas of interest. The presentation of SW's theoretical background along with the objectives from the use of SW technologies followed by the analysis of two real world use cases, aims to investigate, detect and define how, when and why journalism and media industry are affected.

### **Theoretical background of the Semantic Web**

Due to the fact that not everybody is familiar with the concept of SW we provide brief definitions of the term in the context of journalism. These definitions are neither intended to be complete nor perfectly consistent with scientific definitions. They are intended to introduce the reader in a new era where advanced web technologies intersect with the working fields of journalism and media industry.

Since the beginning, the central idea of the World Wide Web was to link as many things through as many links and from as many sources as possible (Berners-Lee, 1989). This statement proves more or less that since the World Wide Web was conceived as an idea and publicized, the core of SW's philosophy as it was later known, was already inherited. According to Tim Berners – Lee's article in journal Scientific American, the SW is an extension of the current Web in which information is given well-defined meaning, better enabling computers and people to work in cooperation (Berners-Lee et al., 2001). Simply put it attempts to give meaning and transform the Web information in a way that both humans and machines will understand and interpret in the same way. One of the most targeted interpretations came from Daniel Dardailler, member of the World Wide Web Consortium, who noted that the term SW is used to identify a Web where the information structure transmits its meaning, allowing data exchange, definition and reuse of lexical terms by any person or community of users. This could be very helpful for a journalist because it makes it more efficient to find, share and combine knowledge with others easily (Pomonis, 2010).

Moreover the current Web is a Web of documents. In the near future and with the development of SW we will be talking about a Web of data, where every piece of data will be accompanied by its semantics and its relations with the others will be fully clarified. As a result the interconnection of concepts rather than just documents will be feasible (Choudhury, 2014). As Antoniou et al. (2012) point out SW is an Internet service with advanced technological features. These features relate with the aim of defining ways to allow Web information to be used by computers not only for display purposes but also for interoperability and integration between systems and applications (Cardoso, Hepp, Lytras 2007). SW is driving the evolution of the current Web by enabling machines to understand and respond to complex human requests based on their meaning. Such an understanding requires that the relevant information sources be semantically structured (Choudhury, 2014).

In addition, SW facilitates not only the automation of service to service and machine to machine interaction but also the communication between individuals. This is the point where journalism and

news industry link with SW technologies. Where an efficient and enhanced cooperation between humans, machines and services can take place resulting to the establishment of contemporary workflows. Such a technological advancement will resolve many issues of usability for journalists which will definitely have a significant impact on their daily routines (Saridou, Panagiotidis, Tsipas & Veglis, 2018).

## 2. Objectives of Semantic Web technologies in journalism

Over the last few years it became rapidly obvious that SW technologies have a lot to offer in terms of correctness, and completeness. In particular given that SW transforms document-oriented to data-oriented Web, it offers numerous benefits for data intensive industries that are bound to the Web and its related applications (Perera et al., 2017). Despite the plethora of the later used by media professionals in the current Web, SW's technological framework attempts to go a step further by providing more efficient solutions (Panagiotidis & Veglis, 2015). For example it is able to improve data management, support accessibility of mobile internet, stimulate creativity and innovation, encourage factor of globalization phenomena and help to organize collaboration in social web (Choudhury, 2014). Also SW technologies are more and more considered as a key technology to resolve problems of interoperability and integration within the heterogeneous world of ubiquitously interconnected systems with respect to the nature of components, standards, data formats, protocols, etc. (Cardoso, Hepp, Lytras 2007). Furthermore within the concept of SW and based on the available options, journalist profession is led to a higher functional level in which he/she can efficiently cooperate with machines on exploiting pieces of information from various sources (Saridou, Panagiotidis, Tsipas & Veglis, 2018). For example, the adoption of SW philosophy can help the evolution of journalism due to its aggregation features, regarding the advanced ability of collecting information (Heravi, Boran & Breslin, 2012).

Most organizations have already realized that the use of SW technologies is a promising candidate solution for the partial automation of their workflows. For this reason they experiment by incorporating SW technologies into their day-to-day work aiming at various objectives. In order to understand these objectives more clearly we categorized them in three distinct levels. Depending on the objective, the levels are:

- Level 1: Data,
- Level 2: Information
- Level 3: Content

The classification of the objectives and their placement under these specific levels could have been made in various ways due to the fact that most of them are related and some maybe overlap others. However we choose to proceed with this classification in order to investigate them from a specific point of view. In the first level, Data are treated as abstract information (raw data). Subsequently, the second level includes tools that deal with information in terms of acquiring (at a higher from the level of data), managing, and processing. Finally in the third level there are tools that work with content and methods that it can be best exploited. The distinction between the second and the third level was made on the basis that content is separated from the information since it is already published or ready to be published.

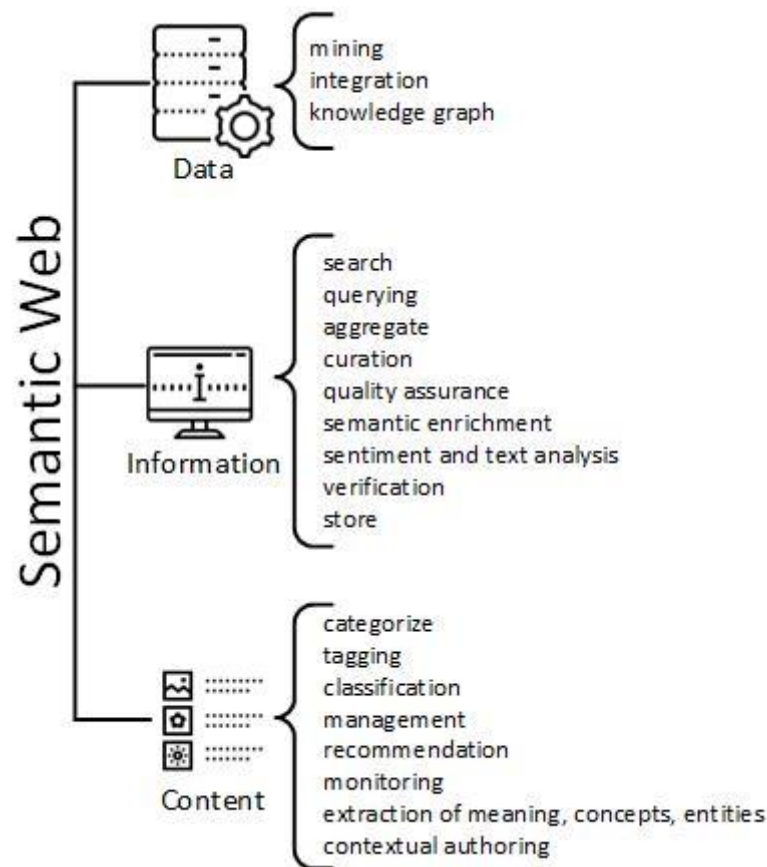


Figure 1: Objectives achieved in the SW context

Based on the previous discussion it is clear that multiple semantic oriented actions beneficial for journalism and news industry can take place in the current dynamically changing work environment. Figure 1 can be seen as a list of contents for the production of semantic platforms, tools, applications and services of journalistic use.

### 3. Use of Knowledge Graphs in media organizations

Although it may not be clearly perceived but leading media organizations like BBC - British Broadcasting Co (Raimond, Scott, Oliver, Sinclair, Smethurst, 2010), New York Times, Thomson Reuters (Curry, Edward & Freitas, Andre & O’Riáin, Sean, 2010), NRK - Norwegian National Broadcaster (Engels, ESIS, Tønnesen, 2007), Agence France Press, AP - Associated Press (Underwood, 2019) and many others are already using low level SW technologies. Their substantial help in distinct workflows and multiple tasks indicate not only their capacity but also their large number and wide range. In other words semantics can help enterprises upgrade their products, for example a platform which displays content, in a smart way so that the needed information will no longer be buried under piles of irrelevant information. Getting the right information at the right time is one of the demands of the digitalization process (Bartussek et al 2018). Today there is a plethora of semantic applications, services and tools for consideration to boost either the efficiency of a media organization (corporate level) or the editorial productivity of a journalist (fieldwork level). This study deals with both the aforementioned categories but only from the Knowledge Graphs

(KGs) point of view which lately has become a trend amongst media organizations (Elsevier, 2017, Zaino, 2017/2018).

An organization's competitive edge depends on asking complex questions across distributed data. Graphs are the only representation that can efficiently model, explore, and query data in today's challenging data landscape (Stardog, 2019). In May 2012, Google enhanced its search engine by adding the Knowledge Graph (KG). Since then there has been a growing appreciation of KGs (Zaino, 2018) which was displayed not only by the multiple scenarios of usage from companies but also by the large variety of term's interpretations. Yahoo!, Microsoft, Facebook and many other large Web companies are developing rich KGs, which define, structure, and link hundreds of millions of entities to enhance search, to provide better advertising match, to improve the answers of their artificial personal assistants etc (Bernstein et al, 2016). In addition KGs have driven the functionality of a new generation of applications in many other domains like data governance, healthcare, movie streaming, gambling, taxi services in order to understand better their customer's needs and be more proactive.

Also considerable research into KGs has been carried out in recent years in the Semantic Web community, thus a variety of partially contradicting definitions and descriptions has emerged. Lisa Ehrlinger and Wolfram Wöß imprinted thoroughly this diversity in their table of selected definitions of KGs (Ehrlinger and Wöß, 2016). Nonetheless, in this point we should only mention Google engineer Amit Singhal's blog entry in which he stressed that a KG enables a user to search for things, people or places that Google knows about and instantly get information that's relevant to his/her query (Singhal, 2012). Given that a professional in news industry uses the Google Search this would be very useful, cost and time effective. For this reason the analysis of KGs will take place in the context of journalism and it will include a short presentation of them followed by a description of their specifications.

### **The case of BBC - British Broadcasting Co**

BBC, as one of the most pioneering media organizations, constitutes a characteristic use case of the KG. Since 2010 the largest broadcasting organisation in the world has been experimenting with SW technologies (Kobilarov G. et al. 2009, Raimond et al. 2010). It started with the need to interlink and connect in a meaningful way the organization's large volumes of content published in its numerous websites, in order for a user to locate easily items of interest. BBC's new approach of publishing and managing content was powered by semantic technology and implemented in this case by Ontotext's GraphDB. A family of high efficient databases with multiple processing capabilities such as aggregation, transformation, manipulation, leverage, visualization, integration, interconnection, share and protection of data ("Graph Database Free Download", n.d.). It seems that databases are the preferred choice of big enterprise organizations because of their community and commercial support on many tasks. Maybe the most important feature of GraphDB, as a set of graph databases which hold knowledge inside, is that it can integrate knowledge with other knowledge bases across the world ("What is a Knowledge base," n.d., para.16) and perform semantic inferencing at scale, allowing users to derive new semantic facts from existing facts. In other words it can handle massive loads of linked data cloud datasets and perform queries and inferencing in real time (Ontotext, 2018) helping a journalist to overcome a few obstacles by automating some parts of the investigation process and by providing comprehensive knowledge on a topic. GraphDB's environment is demonstrated in figure 2 (Ontotext, 2018).

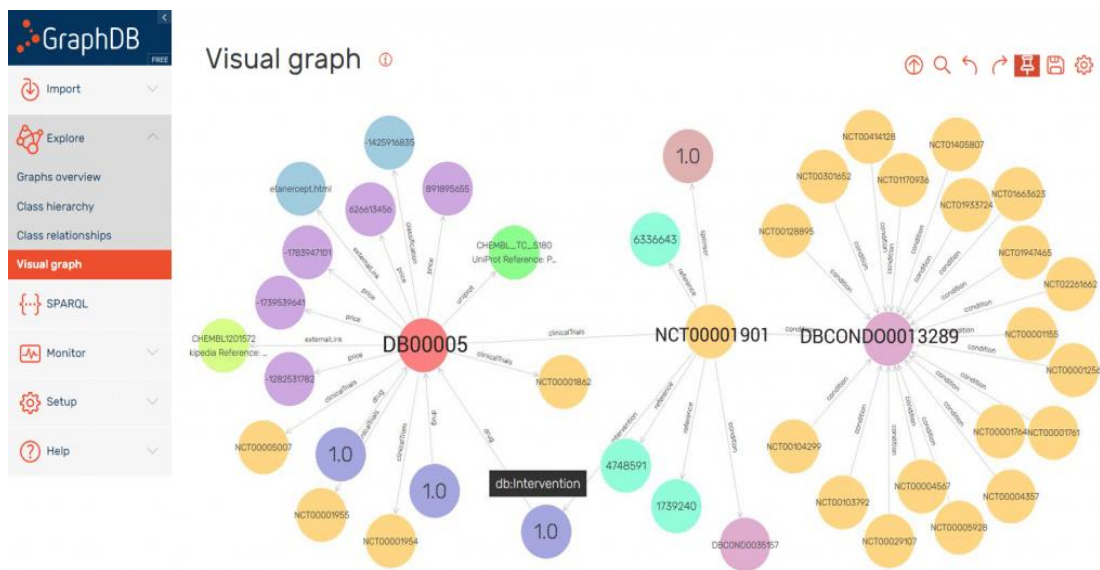


Figure 2: Visualize your data and their relationships. Retrieved from: <https://www.ontotext.com/products/graphdb/>

The visual graph sector is the one that draws our attention due to the various opportunities it offers. After a journalist installs GraphDB and imports his data for querying or performs a query in the company's databases, he/she has the opportunity to visualize information graphically. The visualization which is one of the most beneficial aspects of GraphDB includes nodes. Every node in the graph represents pieces of information like text or image which can be displayed in a side panel. GraphDB's usage value is located in the ability to explore multiple instances and discover interesting relationships between nodes, that wouldn't be able to reach otherwise. Journalists and media organizations can use it, each for different purpose and get fruitful answers.

Practically through the use of GraphDB, BBC was able to realize the semantic technology framework suggested by the Bulgarian software company, the so called Dynamic Semantic Publishing (DSP). In particular this framework was used for the coverage of 2010 FIFA World Cup and after its success for 2012 Olympics as well. Very briefly the term DSP refers to a set of technologies that enable the semantic enrichment (i.e. adding well-defined, machine-readable information to various content types) of content and power the automated aggregation and presentation of interlinked pieces of data. Thus DSP framework offered a cost effective way to quickly and accurately generate large volumes of timely content about the matches, groups, teams and players without relying on journalists. This way BBC achieved the desired efficiencies in content creation and curation (Ontotext, 2015). Additionally BBC is one of the first organizations to use linked data, a strategy for connecting online content which helped not only to deliver its highly successful Olympics coverage ("Linked data," 2017) but also to transform its static content management system into a dynamic one. Currently BBC is using GraphDB as a core metadata engine for the content in their sport section.

### The case of Reuters

Another use case of KG implementation in a media organization was the one of Reuters, the world's largest international multimedia news provider. In 2016 the organization partnered with semantic technology company Graphiq, to provide news publishers with a wide range of free

interactive and contextually rich data visualizations across a spectrum of topics including entertainment, sports and news (Latar, 2018, Underwood, 2019). According to Bo Rosser, Global Head of Text and Data products for Reuters News Agency, the orientation of publishers towards the discovery of ways to engage their audiences by providing them visual context on data – driven news stories led the agency to search for and cooperate with a suitable provider (Reuters collaborates, 2016). The most prominent solution for Reuters was Graphiq services. More detailed, Graphiq is a semantic web company which since 2010 is gathering the world’s deepest and most authoritative public, private and proprietary databases. All Graphiq products (Graphiq Search, Feed, Plugins, library of data visualizations) are base their functionalities on mining data from the company’s repositories which are always updated by its constantly working algorithms. For this reason it has the ability to serve visual representations of information to all professional and non – professional online creators and consumers including researchers, publishers, journalists and corporate employees. Graphiq’s supply of interactive data visualisations is shown in figures 3 and 4.

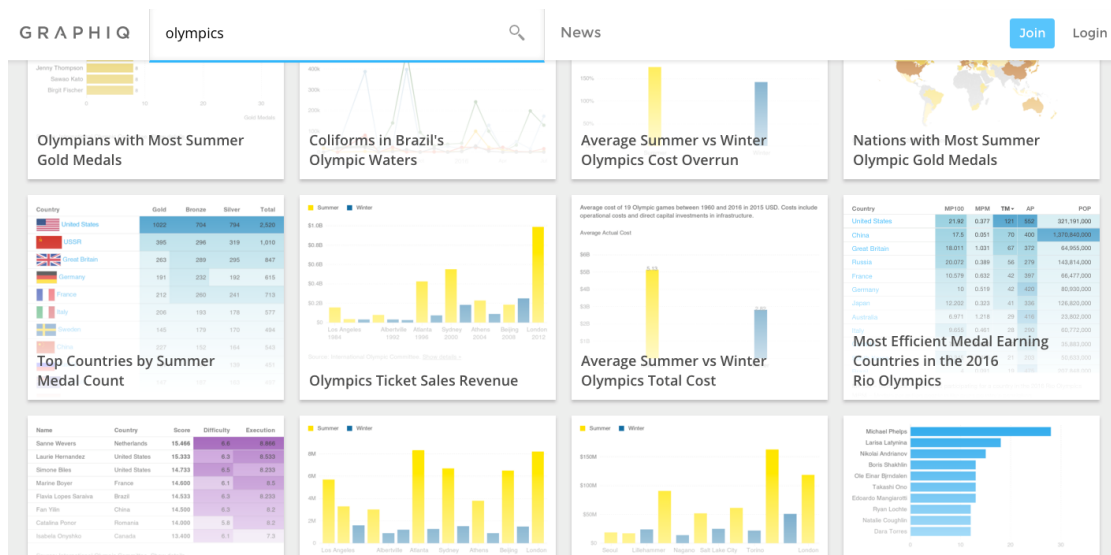


Figure 3: Sample data visualizations of Olympics topics from Graphiq.com. Retrieved from: <https://blog.allmyfaves.com/weekly-faves/graphiq-embeddable-visualization-library/>

As it is obvious in figure 3 after typing “Olympics” in the subject area certain results came up. In this example Graphiq provides basic information about the games. The value from its use for journalists is located in the increase of validity and engagement to their articles. The same applies for figure 4 in which we can see the results from a query about health care in the United States.

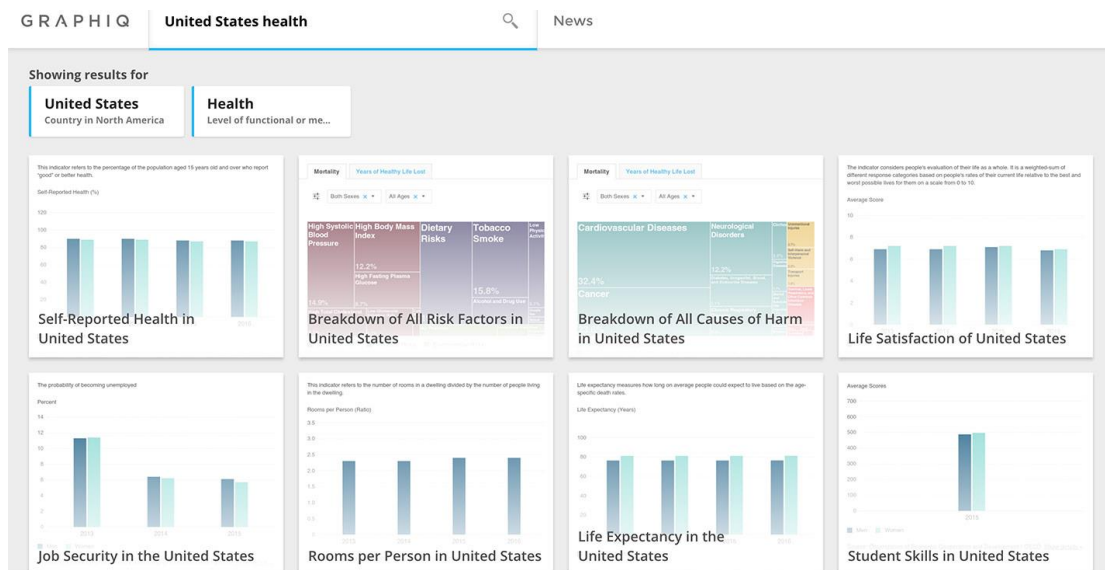


Figure 4: Sample of data visualizations of health care topics from Graphiq.com. Retrieved from: <https://vizworld.com/2016/08/reuters-collaborates-with-graphiq-to-deliver-interactive-data-visualizations-to-publishers/>

Overall, Grpahiq provides access to its library of 10B+ interactive visualizations (Rodriguez, 2016), produces paired interactives with Reuters text stories and multimedia packages (Reuters collaborates, 2016) and displays much more rich and connected information than anyone ever could with a simple table or chart. (Underwood, 2019). Having seen the benefits of SW technology through the KG's, Reuters launched in 2017 a new interactive platform with semantic capabilities designed by journalists for journalists, the Reuters Connect.

#### 4. Conclusion

This paper has studied the issue of SW services and applications usage by media organizations and journalists. The aim of the study was threefold. First to highlight the dynamics of SW technology by stating its theoretical background. Second to estimate its value by identifying, categorizing and visualizing the objectives from its use. Third to showcase a semantic product like KG by documenting two use cases.

Through the analysis we tried to investigate, detect and define how, when and why journalism and media industry are affected by the SW technologies. After a thorough investigation of SW's theoretical background the study concluded that its environment along with its technologies has the capacity to provide various smart solutions. Analysing and visualising the objectives from the use of them we were able to recognise and point out three different action levels for a professional in the SW context. This led us to the conclusion that in such a technologically advanced environment he/she has various modernization options of his/her workflow in terms of automation and functionality. The greatest proof for the establishment of contemporary workflows powered by SW technologies such as KG's came with the documentation of two cases. In our effort to answer the remaining questions raised by this study and reach to one of the most important conclusions, we demonstrated and listed the KG's specifications used by the BBC and the Reuters. Our study concluded that KG can reshape journalistic practices and media industry's content management systems in an unprecedented way. Their orientation towards visualise data gathered from different



sources and present additional relevant information enable the extraction of meaningful conclusions.

Taking into consideration that the use of platforms, applications and services in the context of current Web technology constitute an integral part of pioneering news organisation's workflows, motivate us to think positive about the future. Although nowadays semantic technologies and techniques have been implemented and adopted by only a few media organizations (Brandtzaeg et al., 2016) there is a tendency towards that direction. Meaning, if their need to discover more and more effective working methods of managing pieces of information through the use of Web technologies led them so far, the adoption of SW's technologies is expected in the near future.

Future extensions of this work should include a more detailed research in the convergence between global media organizations and technological giants with emphasis to the development and implementation of other semantic services such as semantic search, semantic verification and semantic news production.

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## 6. References

- Antoniou G., Groth, P., van Harmelen, F. & Hoekstra, R. (2012). *A Semantic Web Primer Hardcover*. 3rd ed. Cambridge, Massachusetts: The MIT Press
- Bartussek, W., Bense, H., Hoppe, T., Humm, B., Reibold, A., Schade, U., Siegel, M., Walsh, P. (2018). *Introduction to Semantic Applications*. In *Semantic Applications - Methodology, Technology, Corporate Use*, Chapter: 1, Publisher: Springer Vieweg, Editors: Thomas Hoppe, Bernhard Humm, Anatol Reibold, pp.1-12. DOI 10.1007/978-3-662-55433-3\_1.
- Berners-Lee T. (1989). *Information management: A proposal*. Technical report. Genève, CERN. Retrieved from <http://cds.cern.ch/record/1405411/files/ARCH-WWW-4-010.pdf>
- Berners-Lee T., Hendler J., Lassila O. (2001). The semantic web. *Scientific American*, Vol. 284, No. 5, pp. 28–37.
- Bernstein, A., Hendler, J. & Noy, N. (2016). *A New Look at the Semantic Web Communications of the ACM*, September 2016, 59 (9), pp. 35-37, DOI: 10.1145/2890489
- Brandtzaeg, P. B., Lüders, M., Spangenberg, J., Rath-Wiggings, L., & Følstad, A. (2016). Emerging journalistic verification practices concerning social media. *Journalism Practice*, 10(3), 323-342.

- Cardoso, J., Hepp M., Lytras M., (2007). *Real world applications of semantic web technology and ontologies*. Retrieved from <https://jorge-cardoso.github.io/publications/Papers/BC-2008-021-Springer-Real-World-Apps-Introduction.pdf>
- Choudhury N. (2014). World Wide Web and Its Journey from Web 1.0 to Web 4.0, *International Journal of Computer Science and Information Technologies (IJCSIT)*, 5 (6), pp 8096-8100.
- Curry, E., Freitas, A., O’Riáin, S. (2010). *The Role of Community-Driven Data Curation for Enterprises*. In Wood D. (eds) *Linking Enterprise Data*, pp.25-47. Springer, Boston, MA. DOI: 10.1007/978-1-4419-7665-9\_2.
- Dau, F., (2011). *Semantic Technologies for Enterprises. From book Conceptual structures for discovering knowledge*. In 19th international conference on conceptual structures, ICCS 2011, Derby, UK, Proceedings (pp.1-18). DOI 10.1007/978-3-642-22688-5\_1.
- Ehrlinger, L. & Wöß, W. (2016). *Towards a Definition of Knowledge Graphs*. In Joint Proceedings of the Posters and Demos Track of 12th International Conference on Semantic Systems - SEMANTiCS2016 and 1st International Workshop on Semantic Change & Evolving Semantics (SuCESS16). At: Leipzig, Germany. Volume: 1695 <http://ceur-ws.org/Vol-1695/paper4.pdf>
- Elsevier Announces the Winner of the 2017 Semantic Web Challenge - IBM Socrates was awarded the prestigious AI prize at International Semantic Web Conference. (2017) [Press Release]. Retrieved from: <https://www.elsevier.com/about/press-releases/science-and-technology/elsevier-announces-the-winner-of-the-2017-semantic-web-challenge>
- Engels, R., ESIS, Tønnesen, J.R (2007). *A Digital Music Archive (DMA) for the Norwegian National Broadcaster (NRK) using Semantic. Semantic Web Use Cases and Case Studies*. Retrieved from: <https://www.w3.org/2001/sw/sweo/public/UseCases/NRK/NRK.pdf>
- Frasincar, F., Jethro, B. & Hogenboom, F. (2011). *Personalizing News Services Using Semantic Web Technologies*. In *E-Business Applications for Product Development and Competitive Growth*, pp.261-289. DOI: 10.4018/978-1-60960-132-4.ch013.
- Georgiev, G., Popov, B., Osenova, P., & Dimitrov, M. (n.d). *Adaptive Semantic Publishing*. Ontotext AD, Bulgaria. [White Paper]. Retrieved from: <https://pdfs.semanticscholar.org/ab9f/9bcceb1554b2cdbdb12fb42b956ac8bdab5c.pdf>
- Graph Database Free Download - Ontotext GraphDB. (n.d.). [Blog post]. Retrieved from <https://www.ontotext.com/products/graphdb/>
- Heravi, B. R., Boran, M., & Breslin, J. (2012). *Towards social semantic journalism*. In: Sixth International AAAI Conference on Weblogs and Social Media. [online] Dublin: AAAI Press, 14-17.
- Hoppe, T., Humm, B., Schade, U. et al. *Informatik Spektrum* (2016). Corporate Semantic Web – Applications, *Technology, Methodology*. 39 (1), pp 57–63. Springer Berlin Heidelberg. <https://doi.org/10.1007/s00287-015-0939-0>
- Kobilarov G. et al. (2009) *Media Meets Semantic Web – How the BBC Uses DBpedia and Linked Data to Make Connections*. In: Aroyo L. et al. (eds) *The Semantic Web: Research and Applications*. ESWC 2009. Lecture Notes in Computer Science, vol 5554. Springer, Berlin, Heidelberg.
- Kuck, G. (2004). Tim Berners-Lee's Semantic Web. *SA Journal of Information Management*, 6(1).
- Latar, L.N. (2018). *Robot journalism: Can Human Journalism Survive?* In book: *Robot Journalism*. DOI: 10.1142/9789813237346\_0003
- Linked data and the semantic web (2017). [Blog Post]. Retrieved from: <https://www.bbc.co.uk/academy/en/articles/art20130724121658626>
- Ontotext (2015). *Smarter Content with a Dynamic Semantic Publishing Platform [White Paper]* Retrieved from: [https://www.londonbookfair.co.uk/\\_novadocuments/324329?v=636215461842200000](https://www.londonbookfair.co.uk/_novadocuments/324329?v=636215461842200000)

- Ontotext (2018). GraphDB Free Documentation. Release 8.8. Retrieved from: <file:///C:/Users/user/Downloads/GraphDB-Free.pdf>
- Panagiotidis K. & Veglis A. (2015). (In Greek) The evolution of journalism: From blogs to social networking and Semantic Web. *Communication Issues*, 10(20-21): 149-168.
- Perera, R., Nand, P., Bacic, B., Yang, W. H., Seki, K., & Burget, R. (2017). *Semantic Web Today: From Oil Rigs to Panama Papers*. arXiv preprint arXiv:1711.01518.
- Raimond Y., Scott T., Oliver S., Sinclair P., Smethurst M. (2010). *Use of Semantic Web technologies on the BBC Web Sites*. In Wood D. (eds) *Linking Enterprise Data*, pp 263-283. Springer, Boston, MA. DOI: [https://doi.org/10.1007/978-1-4419-7665-9\\_13](https://doi.org/10.1007/978-1-4419-7665-9_13)
- Reuters collaborates with Graphiq to deliver suite of interactive data visualizations to publishers (2016). [Press Release]. Retrieved from: <https://www.thomsonreuters.com/en/press-releases/2016/august/reuters-graphiq-interactive-data-visualizations.html>
- Rodriguez, S. (2016). Meet the A.I. Startup That's Whipping Up Infographics for Thousands of Newspapers in the U.S. - Graphiq has a growing database of more than 10 billion interactive charts and graphs." Inc.com. [Blog Entry]. Retrieved from: <https://www.inc.com/salvador-rodriguez/graphiq-ap-visualizations.html>
- Saridou T., Panagiotidis K., Tsipas N., & Veglis A. (2018). Semantic Tools for Participatory Journalism. *Journal of Media Critiques*, Vol 4, No 14: 281 – 294. DOI: 10.17349/jmc118221.
- Singhal, Amit (May 16, 2012). *Introducing the Knowledge Graph: Things, Not Strings*. Google Official Blog. Retrieved 12/3/2019. <https://googleblog.blogspot.com/2012/05/introducing-knowledge-graph-things-not.html>
- Stardog (2019, March 7). *Graph Identified as Top Technology Trend for 2019*. [Press release]. Retrieved from <https://www.businesswire.com/news/home/20190307005668/en/>
- Underwood, C. (2019). *Automated Journalism – AI Applications at New York Times, Reuters, and Other Media Giants* [Blog Post]. Retrieved from: <https://emerj.com/ai-sector-overviews/automated-journalism-applications/>
- Van de Weghe, T. (2018). *10 things about AI every newsroom should know. Preparing your newsroom for the artificial intelligence revolution*. [Blog Post]. Retrieved from: <https://medium.com/jsk-class-of-2019/10-things-about-ai-every-newsroom-should-know-19745dac8ad7>
- What is a Knowledge Base? (n.d.). [Blog post]. Retrieved from <https://www.ontotext.com/knowledgehub/fundamentals/what-is-a-knowledge-base/>
- Zaino, J. (2017). *Semantic Web and Semantic Technology Trends in 2018*. Retrieved from: <https://www.dataversity.net/semantic-technology-semantic-web-trends-2018/>
- Zaino, J. (2018). *Semantic Web and Semantic Technology Trends in 2019*. Retrieved from: <https://www.dataversity.net/semantic-web-semantic-technology-trends-2019/>