LIBRARY AND INFORMATION SCIENCE VIS-À-VIS WEB SCIENCE IN THE LIGHT OF THE OECD FIELDS OF SCIENCE AND TECHNOLOGY CLASSIFICATION

Marta GRABOWSKA[1],

[1] *Prof. UW dr hab. , Centre for Europe, University of Warsaw, Poland*

Abstract

Aims: The paper focuses on the methodological frames of Library and Information Sciences vis-à-vis Web Science in the light of the OECD Fields of Science and Technology Classification. The roots of Library Science and Information Science in Humanities and Social Sciences are described. The technological revolution which took place during and after World War II enabled the development of a new mathematics- and engineering-oriented environment for information. On this basis such new research areas like Web Science emerged. It led to a change towards an interdisciplinary character of Information Science. Method: The OECD Fields of Science and Technology Classification was analysed from the point of view of the Library and Information Science's place in this classification.

Solutions: In the OECD Fields of Science and Technology Classification Library Science has its independent place within Social Sciences while Information Science is dispersed between three main sections. It confirms the interdisciplinary character of Information Science and sets up its name as a superior covering traditional Information Science and all of new mathematics- and engineering- based research areas dealing with information. Although the name Web Science is not mentioned in this classification, we can assume that it is a sub-discipline of Information Science in the light of the OECD classification. Polish implications are mentioned.

Keywords: Library Science, Information Science, Web Science, Internet Science, the OECD Fields of Science and Technology Classification

1 Origins of Library Science, Documentatology and Information Science

If we begin our discussion on Library Science as the oldest of the three mentioned in the title – its roots will originate from Humanities and Social Sciences. This approach draws frames and indicates the main topic of its research: that is a cultural heritage of human beings as social beings registered in library documents collected, described, organized, preserved and made available for all human beings in order to disseminate its content through the communication process. Its strong and independent position has been based on its own paradigm, that is the bibliographic method understood

either traditionally like formulated by Gabriel Naudė (1600-1653) - the author of *Advice on Establishing a Library* (1627) [1] and Joachim Lelewel (1786-1861) - the author of *Two Bibliographic Books 2 vol. (1823-1826)* [2] or represented by international bibliographic standards applied today. The relationship of Library Science to other disciplines covers primarily such auxiliary fields like: history, language and literature studies, psychology or statistics. Basically, they all have its methodological roots in Humanities and Social Sciences. Thus, inductive reasoning has prevailed in the whole area of research including Library Science.[3]

The concept of culture (lat. *colere*) can be understood either narrower as a set of ideas norms and values or broadly including civilization (i.e. technological development). At present civilization is usually included into a general concept of culture. Science (knowledge) is also a part of culture defined in its broader sense but it is regarded as an autonomous part of culture of which the scope covers the sphere of application of research methods.[4]

Running a library named librarianship is a practical aspect of Library Science. Forms of documents collected in libraries have been changing and we are not going to discuss this topic here. But whatever a document has been - it has always consisted with a carrier (medium) and a human thought registered on it as an element of cultural heritage. Forms of carriers and thoughts registered this are two different things as carriers can change while thoughts can stay unchanged or *vice versa*. This approach allowed us to separate a carrier (medium) and a thought what led us subsequently from the concept of document to the concept of information (although it should be pointed out that information can't exist without a carrier). Information Science preceded by Documentation or Documentology was born on this basis especially in the sphere of the transmission of human knowledge and it is Paul Otlet (1868-1944)[5] who deserves the credit for it. Information itself is elastic, resilient, i.e. the same thought can be expressed with various codes (in different natural or artificial languages) or by applying a properly constructed metalanguage. Documentology was developed in the second part of the XIX century in relation to the fast growth of knowledge and scientific publications mainly scientific journals.[6] It turned an attention of bibliographers of that time into the mentioned autonomous part of culture i.e. science (knowledge) and a need of its fast dissemination. New forms of carriers which could fastened transmission and dissemination of human knowledge in recorded form and to process information in more flexible way became a crucial point in the development of Documentology. Still, however, the roots of Documentology and farther on of the new born Information Science originated from Humanities and Social Sciences and they applied the similar paradigm and way of thinking as Library Science. This approach to Information Science is expressed in the Tefco Saracevic's definition: "*More specifically, information science is a field of professional practice and scientific inquiry addressing the effective communication of information and information objects, particularly knowledge records, among humans in the context of social, organizational, and individual need for and use of information*". [7]

2 The technological revolution

World War II brought a deep change in technologies. The famous story on the German ciphering machine ENIGMA used by German army during the II World War[8] marked the new era in the sphere of information. Despite former methodological location of Information Science within Humanities and Social Sciences and the prevailing model of inductive reasoning being applied – a new methodological environment within mathematics, engineering and computer science enabled to perceive information as a subject of research from another angle and to build the information theory based on the deductive model of reasoning.

The circumstances of this change had no connection neither to the mentioned above methodological orientation of Library Science, Documentology and Information Science nor to researchers who had been involved in its development. Shortly before the II World War three famous Polish mathematicians and cryptologists: Henryk Zygalski (1908-1978). Marian Rejewski (1905-1980) and Jerzy Różycki (1909-1942) plus one Polish engineer Maksymilian Ciężki (1898-1951) broke the ENIGMA code. In order to break this complicated cipher mathematics-based methods were applied and not linguistic methods as it usually had been done before. This crucial change opened the door to a new approach to information. This discovery was conveyed through France to England, where British authorities created the ENIGMA deciphering center in Bletchley Park (about 60 miles in due North from London). This hidden center was active through the whole World War II never being discovered by Germans. Famous British mathematicians including Alan Turing (1912-1954) worked there during the War and it helped Aliant to win battles on Atlantic Ocean and the Battle of Britain. Specialists say that having a key to the ENIGMA code it helped to shorten the War for 2-3 years. In such circumstances, unexpectedly, information became a subject of mathematics-based research paradigm and, as it was mentioned above, it was the entirely independent process from this what was going on with Library Science, Documentology and Information Science perceived traditionally with its methodological roots in Humanities and Social Sciences.

To fasten the decipherment of messages being obtained from the secret radio watch in Bletchley Park - Alan Turing built up a machine named Colossus [9] which has evolved later on to the form which we know at present as a computer. This technology conveyed to the United States after the War led to the concept of the mathematical theory of information and the development of ICT by such scientists like Ralph Hartley (1888-1970), Claude E. Shannon (1916-2001), Warren Weaver (1894-1973), Norbert Wiener (1894-1964). This theory of information was formulated on the basis of mathematical and statistical methods including the theory of probability and stochastic (random) processes. [10]

In the "*International Encyclopedia of the Social & Behavioral Sciences we can find the following definition: "Information theory is the mathematical*

treatment of the concepts, parameters and rules governing the transmission of messages through communication systems. It was founded by Claude Shannon toward the middle of the twentieth century and had since then evolved into a vigorous branch of mathematics fostering the development of other scientific fields…".[11] This approach fostered the development of such new disciplines like informatics, electronics and telecommunications and created a new environment for information whereas information itself began to operate on new types of carriers i.e. electronic carriers in the form of electronic documents. Also, new measures of information appeared like ban and decyban (Ralph Hartley and Alan Turing), entropia (C.E. Shannon) and negentropia (E.Schrὸdinger 1887-1961 and L. Brillouin 1889-1969) and presently used bit or shannon (from the name of C.E. Shannon who created this term) and bytes (Werner Buchholtz 1922-). The new type of communication process based on W3C standards, network and hypertext protocols led to a development of Internet - the platform on which the World Wide Web was built. All this enabled to broaden both the scope of information processed (not only knowledge but the whole universe of information) and to extend the communication process (covering the whole world). This new circumstances created so called Internet and Web Science which, however, didn't replace entirely the former Information Science in its traditional form. The question remains if we should consider Web Science and developed also Internet Science as new and independent sciences or we should include it to Information Science and to consider the last one as the interdisciplinary science.

In this point perhaps a short clarification is needed relating to Web Science *vis-á-vis* Internet Science. They both have their roots in mathematics- and engineering-based methodology although they differ by its scope. And certainly they are not the only areas which have emerged from this new environment. In fact, we are not going here to consider in depth differences between them but we can say only that Internet Science, which became a platform for the development of Web Science focuses more on technical issues like hardware design, access technologies and content delivery while Web Science emphasizes more on its semantic, information retrieval and social networking issues. More details on this topic can be found in relation to the European Union's ENIS [12] project, from the paper *A Disciplinary Analysis of Internet Science"* by Clare J. Hooper, Bruna Neves and Georgeta Bordea [13].

If we consider Information Science as an interdisciplinary science undoubtedly Harold Borko's definition would be the most accurate. He formulates it as follows: *"Information Science is that discipline that investigates the properties and behavior of information, the forces governing the flow of information, and the means of processing information for optimum accessibility and usability. It is concerned with that body of knowledge relating to the origination, collection, organization, storage, retrieval, interpretation, transmission, transformation, and utilization of information. This includes the investigation of information representations in both natural and artificial systems, the use of codes for efficient message transmission, and the study of information*

processing devices and techniques such as computers and their programming systems. It is an interdisciplinary science_derived from and related to such fields as mathematics, logic, linguistics, psychology, computer technology, operations research, the graphic arts, communications, management, and other similar fields. It has both a pure science component, which inquiries into the subject without regard to its application, and an applied science component, which develops services and products." [14] Such approach to Information Science as Harold Borko defined we can find also in the *OECD Fields of Science and Technology Classification.*

3 Library and Information Science in the light of the OECD Fields of Science and Technology Classification

In relation to the reform of the higher education sector carried out during last two years in Poland, the new bill was laid down by the Polish Parliament in 2018 *(Higher Education and Science Act*) [15]. Within this reform the *OECD* (The Organization for Economic Co-operation and Development) *Fields of Science and Technology Classification* is recommended as the key scheme for structural changes in universities and other higher research and education bodies in order to strengthen mutual relationships between research, education and economy. This change has an impact on a place of Library and Information Science in higher education units in the country.

The *OECD Fields of Science and Technology Classification* [16] *consists with five basic sections:*

1. Natural Sciences
2. Engineering and Technology
3. Medical and Health Sciences
4. Agricultural Sciences
5. **Social Sciences**
6. Humanities

Within the section nr 5 Social Sciences the following disciplines are enumerated:

5.1.Psychology

5.2.Economics and business

5.3.Educational sciences

5.4.Sociology

5.5.Law

5.6.Political Science

5.7.Social and economic geography

5.8.Media and Communications

5.9.Other social sciences

Within the section **5.8 Media and Communication** there are:

5.8.a Journalism

5.8.b Information **Science (social aspects)**

5.8.c Library Science

5.8.d Media and Communications

Both Library Science and Information Science are included in this section, however, Library Science is perceived here as one of the Social Sciences (not Humanities any more) and is enumerated separately and perceived as an independent from Information Science certainly considering its strong methodological basis (bibliography, bibliographic standards) and well defined area of practice (library). What relates Information Science (perceived here as one of the Social Sciences, too) only its social aspects are mentioned here suggesting another location for its mathematics- and engineering- based part. This other part of Information Science we can find in the general section nr 1. Natural Sciences.

1. Natural Sciences

1.1.Mathematics

1.2.Computer science and informatics (information science)

1.2.a Computer science (algorithms), informatics (information science) and bioinformatics (computer equipmentbelongs to 2.2. while social aspects belong to 5.8)

1.3.Physical sciences

1.4.Chemical sciences

1.5.Earth and related environmental sciences

1.6.Biological Sciences

1.7.Other natural sciences

The location of the other part of Information Science in sections 1.2.and 1.2.a shows clearly its roots in mathematics. Additional reference mentioned in point nr 2.1.a to section 2.2. of the *OECD Classification* let us farther on through the general section nr **2. Engineering and Technology** which consists with the following areas:

2. 1.Civil engineering

2. 2.Electrical engineering, electronics, computer engineering

2. 3.Mechanical engineering

2. 4.Chemical engineering

2. 5. Materials engineering

2. 6.Medical engineering

2. 7.Environmental engineering

2. 8.Environmental biotechnology

2. 9. Industrial biotechnology

2.10.Nanotechnology

to the section nr **2.2. The Electrical engineering, electronics, computer engineering**, which covers six areas each being a subject of interest of this part of Information Science:

2.2.a Electrical engineering and electronics

2.2.b Robotics and automation

2.2.c Automation control systems

2.2.d Engineering and communications systems

2.2.e Telecommunications

2.2.f Computer equipment and computer architecture

From this what was mentioned above we can assume that according to the *OECD Fields of Sciences and Technology Classification,* Library Science and social aspects of Information Science belong to Social Sciences. Information Science is perceived here as an interdisciplinary science covering under this name also its mathematics-based and engineering-oriented part. Web Science (and Internet Science) emerged from mathematical theory of information but it is being strongly pointed out by such famous researches as Tim Berners-Lee or Ben Schneiderman that Web Science (and Internet Science) are not able to exist and function properly as an independent sciences without of its Social Sciences support.

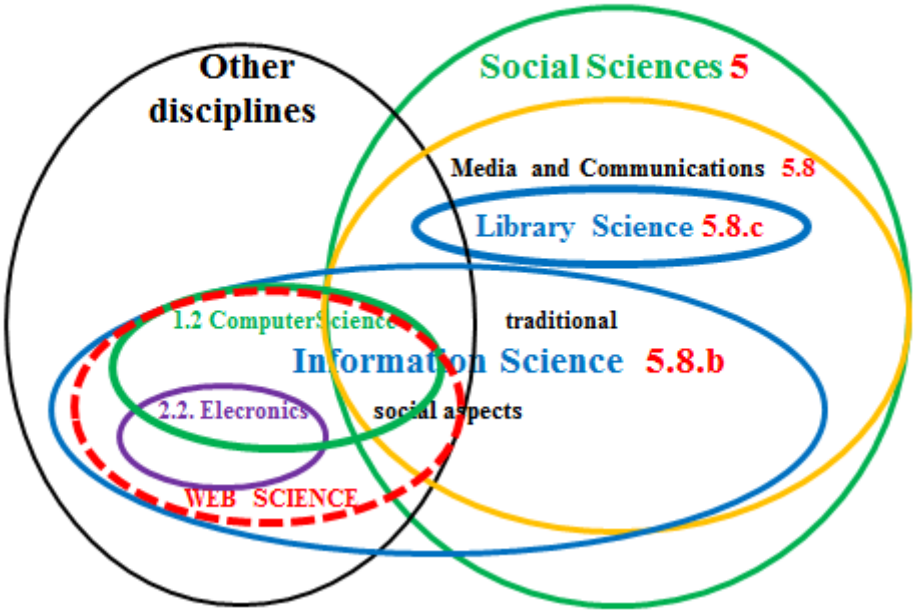
Tim Berners-Lee says: "*Web Science must coordinate engineering with a social agenda, policy with technical constraints and possibilities, analysis with synthesis – it is inherently*

interdisciplinary…. …engineering needs to go hand in hand with a social process of negotiation" [17]*.* Ben Shneiderman says*: "Web Science is processing the information available on the Web in similar terms to those applied to natural environment*… [18]

Thus, in case of Web Science (and Internet Science) the story begins from another angle, i.e. from information theory but requires also the methodological support of Social Sciences without which it can't function properly.

Below the project of the scheme of Library Science, Information Science and Web Science according to the *OECD Fields of Science and Technology Classification* is presented.

Library Science and Information Science *vis-á-vis* Web Science in the light of the *OECD Fields of Science and Technology Classification*



Source: The scheme created by the Author on the basis of the *OECD Fields of Science and Technology Classification*

Conclusions:

According to the *OECD Fields of Science and Technology Classification* there are two separate sciences: Library Science and Information Science. Library Science relies on its own paradigm as one of the Social Sciences (and certainly Information Science is one of its auxiliary sciences). Information Science is dispersed between Social Sciences, Natural Sciences (mathematics) and Engineering and Technology. The first part, earliest of the three, operates on the basis of the methodology of Social Sciences while the last two parts emerged later on being built on the basis of the mathematical theory of information. While the first part can still function independently ("traditional" Information Science) being also a support for the other two parts, the last two parts still can't exist without a support of the first one. The question remains, of course, if and when the last two parts of Information Science would begin to operate without a support of the first one? It seems, that the autonomous robots are already the outpost of this phenomenon…

Meanwhile, the *OECD Classification* confirms the interdisciplinary character of Information Science and its superior name for the whole research area of information having regard presumably on its historical priority. Although,

names Web Science and Internet Science are not mentioned in the *OECD Classification* but *per se* we can consider them as its sub-disciplines.

References:

[1] Ajdukiewicz K., *Zarys logiki*. Warszawa: Państwowe Zakłady Wydawnictw Szkolnych, 1960

[2] Barker Ch., *Cultural Studies. Theory and Practice*. London**:** Sage Publications**,** 2003

[3] Barnes-Lee T., Hall W., Hendler J.A., *A Framework for Web Science*. Boston Delft: Now Publishers Inc. 2006 s. 3-4 [online] [access: 20 June 2019] https://books.google.pl/books?id=VIC4pjOu2vwC&printsec=frontcover&hl=pl&source=gbs_ge_summary_r&cad=0#v=onepage&q&f=false

[4] Borko H., *Information Science*. *What is it?* "American Documentation" 19 (1), 3-5 1968 p. 3 [online] [access: 20 June 2019] https://pl.scribd.com/document/81459529/Borko-H-Information-Science-What-is-It

[5] Chirikjian G. S., *Stochastic models, Information Theory, and Lie Groups*. Vol. 1. Boston, Basel, Berlin: Birkhäuser, 2009

[6] Copeland E.J., *Colossus: the secrets of Bletchley Park's codebreaking computers.* Oxford: Oxford University Press cop., 2010

[7] Dembowska M., *Nauka o informacji naukowej (Informatologia*). *Organizacja i problematyka badań w Polsce.* Warszawa: Inst. Inf. Nauk. Tech. i Ekonom. 1991 (Seria: *Informacja Naukowa*)

[8] *Fields of Science and Technology* [online][access: 20 June 209] https://en.wikipedia.org/wiki/Fields_of_Science_and_Technology

[9] Hooper, C.J., Neves B., Bordea G., *A Disciplinary Analysis of Internet Science*. [In:] Tiropanis T., Vakali A., Sartori L., Burnap P. (Eds.). *Internet Science. Second International Conference INSCI 2015. Brussels, Belgium, May 27-29, 2015. Proceedings.* Springer International Publishing AG, Switzerland (Springer-Science-Business Media), 2015 s.63-77 (*Lecture Notes in Computer Science* 9089)

[10] Inglis F., *Culture.* Cambridge: Polity Press, 2004

[11] Lelewel J., Bandtkie J. S., *Bibliograficznych ksiąg dwoje*. Warszawa: Wydawnictwa Artystyczne i Filmowe, 1980

[12] Martignon L., *Information Theory*. [In:] *International Encyclopedia of the Social & Behavioral Sciences*, Elsevier, 2001 p. 7476-7480 [online] [access: 20 June 2019] https://www.sciencedirect.com/science/article/pii/B0080430767006082

[13] Narodowe Centrum Badań i Rozwoju, *Wykaz dziedzin nauki i techniki według OECD* [online] [access: 20.06.2019]

https://www.ncbr.gov.pl/fileadmin/user_upload/import/tt_content/files/2_wykaz_dziedzin_nauki_i_technik_wedlug_klasyfikacji_oecd.pdf

[14] Naudé G., Taylor A., *Advice on establishing a library*. Berkeley: University of California Press, 1978

[15] *Network of Excellence in Internet Science*. [In:] European Commission. Cordis. EU research results [online] [access: 20 June 2019] https://cordis.europa.eu/project/rcn/101725/factsheet/en

[16] Otlet P., *Traité de documentation: livre sur le livre: thėorie et practique*. Liege: Centre de lecture publique de la Communauté française de Belgique, 1989

[17] Rakus-Andersson, E., *The Polish Brains Behind the Breaking of the Enigma Code Before and During the Second World War.* Berlin-Heidelberg-New York: Springer-verlag, 2003

[18] Saracevic T., *Information Science*. [In:] Bates m.J., Maack M.N. (Eds.) *Encyclopedia of Library and Information Science.* New York: Taylor & Francis. pp. 2570-258M. [online] [access 20 June 2019] https://tefkos.comminfo.rutgers.edu/SaracevicInformationScienceELIS2009.pdf

[19] Schneiderman B., *Web Science.* „Communications of the ACM" 2007 50 (6) s.25

[20] *Ustawa z dnia 20 lipca 2018 r. – Prawo o szkolnictwie wyższym i nauce.* Dz. U. 2018 poz. 1668