The article reviews information-science-related activities in Slovenia as linked to information & communication technologies (ICT) instrumental in support to research and education. Some emphasis is placed on agriculture. Exploratory parallels are drawn with scientific information management in Serbia. Digital online library information system based on COBISS.SI (Co-operative Online Bibliographic System & Services) in the late 1980s has been joined by other utilities and is now a complement to SICRIS (Slovenian Current Research Information System) facilitating evaluation of research outcomes through metrics based on bibliographic and citation databases such as Web of Science or Scopus. End-users need to be educated in advanced competencies and skills for efficient work with such systems. Information behaviour of researchers as well as information literacy of students have been investigated through questionnaires and validated tests. In Serbia, these activities are facilitated through KoBSON (Konzorcijum biblioteka Srbiuje za objedinjenu nabavku) as well as COBISS.RS, under the Virtual Library of Serbia.

Keywords: information science, information literacy, research evaluation, citation databases, bibliometrics

1. Introduction

Advancement in ICT (Information & Communication Technologies) presents ever increasing challenges in the organization of information and knowledge. These involve technical as well as psychological dimensions. Scientific information systems must be designed sensibly taking into account users not sufficiently informed and trained to this end. Such systems proceed from the more traditional LIS (Library & Information Systems) structures. These now include many aspects relating to user behaviour. The contemporary ICT also offer a possibility for a more efficient evaluation of research. The many different dimension complement each other. Similarly as economics, information science issues are strongly interdisciplinary and combine disciplinary characteristics in a more strict sense (e.g. agriculture) as well as societal and other related features (e.g. literacy, behaviour, valuation, use of technology). Therefore, in international scientific information systems, such research is most frequently published in journals indexed to social sciences.

In our brief review we present selected issues which play a progressively more important role in academic world, tackling research as well as education. In the sense of education they target both the students and educators. The review is based on the development in Slovenia and focuses on some experiences in agricultural research and education. Some similar issues in Serbia are exploratively presented.

2. Library information system

It is important to begin with the libraries which are pioneering foundations of the contemporary digital scientific information systems. In Slovenia, the library information system is based on landmark developments in the 1980’ with the establishing of COBISS (Co-operative Online Bibliographic System & Services) operated by IZUM (Institute of Information Science) in Maribor (Seljak, 1994; Seljak, 1996)

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Although some academic and research libraries in Slovenia started using information-retrieval systems already in the early 1970s (Ambrozie and Zumer, 2015), COBISS was set up as a unified information system to manage and connect all libraries in the former Yugoslavia. This process was, for known reasons, interrupted in the early 1990s but was later relaunched. During all this period, COBISS has been universally used in Slovenia. COBISS and other information systems were early embraced also by agricultural libraries (Gec et al., 1987; Zorn-Pogorelc and Gorsic, 1992; Koler-Povh and Peteh, 2008) and have been later frequently employed in user studies which also included agricultural research (Vilar et al., 2012)

The overhauled new international portal COBISS.NET again includes many of the original members, now active in different countries. It facilitates exchange of records between separate COBISS systems, for example, in Serbia (Mazic, 2004) or Macedonia (Kostoska et al., 2014), and ensure online access on the same principles and procedures. Figure 1 shows, parallely, search page on the Slovenian and Serbian platforms. An agreement between Bosnia and Herzegovina, Montenegro, Macedonia, Slovenia and Serbia was signed in 2003 (Marta Seljak et al., 2004), and was also joined by the Bulgarian National Library in 2006 (Injac, 2011). More institutions from the area of the so called Western Balkans are expected to join in (Koler-Povh et al., 2014). In Serbia, an autonomous library information system is being developed on a platform COBISS.SR, under the Virtual Library of Serbia - VBS/VLS, which is based on online communication between the local computer systems and the central computer system at the National Library of Serbia (Stevanovic and Crnogorac, 2011). VBS also includes academic libraries (Zupan, 2012). COBISS has been, internationally, also assessed in relation to other similar information systems (Teddi, 1997). Some other bibliographic applications and activities have also been undertaken in the region, for example, the BISIS library software system developed at the University of Novi Sad in 1993 (Budimir and Surla, 2004), or Rastko, since 1994 a project to digitize cultural heritage of Serbia (Stokic-Simonic and Vuckovic, 2012). Similar activities in Slovenia are conducted through the dLib - Digital library of Slovenia (Savnik et al., 2012).

An efficient contemporary LIS now represents infinitely more than mere cataloguing and providing documents. An important dimension is a management of a subscription as well as smooth access (both institutional as well as remote) to e-resources. This is, in turn, interconnected with recording and evaluating national research, user studies and education, as well as scientometric or bibliometric assessments of agricultural journals in subscription databases (Sauperl and Spanring, 1990; Bradac et al., 1996; Bartol, 2009).

Figure 1: Search interface on COBISS.SI (Slovenia) and COBISS.RS (Serbia)

3. Information portals

COBISS - as a national LIS backbone - serves as portal to different specialized proprietary information products, for example, Impact factor database of the Journal Citation Reports (JCR) in Web of Science/Web of Knowledge/Science Citation Index (WOS Thomson Reuters), or Source Normalized Impact per Paper (SNIP) in Scopus (Elsevier). Other establishments are also instrumental as aggregators.

of information and portals of access, for example, the National and University Library of Slovenia (NUK/Narodna in univerzitetna knjiznica) which in 2004 established remote access to information sources (through licence agreements from publishers), using EZproxy software, and authentication and authorization system for all participating institutions (Vodeb, 2006). The portal Mreznik by NUK is complemented by the portal DiKUL (Digitalna knjiznica Univerze v Ljubljani/Digital Library of the University of Ljubljana) managed by the Central Technological Library at the University of Ljubljana (CTK/Centralna tehniška knjižnica), and its respective consortial coordination of international scientific literature (Pusnik et al., 2015).

Only a general national availability provides a possibility for advanced analysis of such resources, for example, in agriculture-related bibliometric studies (Bartol, 2012). In Serbia, similar structural activities are conducted through the Consortium of Libraries of Serbia for Coordinated Acquisition (a.k.a. unified acquisition) or KoBSON (Konzorcijum biblioteka Srbije za objedinjenu nabavku) (Kosanovic, 2010; Timotijevic et al., 2013). Similarly to Slovenian information portals, the introduction of KoBSON has brought about an increasing publishing of Serbian authors in high-quality journals (Filipi-Matutinovic and Kosanovic, 2007). Figure 2 shows excerpts from Slovenian MREZNIK and DiKUL, and Serbian KoBSON search portals.

**Figure 2: Portal and access to information services at Mreznik (National and University Library of Slovenia), DiKUL (Digital Library of the University of Ljubljana, Central Technological Library), and KoBSON, (Consortium of Libraries of Serbia for Coordinated Acquisition)**

### 4. Research evaluation

Efficient national information-monitoring systems are of utmost importance for the purposes of transparent research evaluation, especially in the environments of nationally-funded research through national agencies. In this sense, the above mentioned LIS-based services play an essential role (Demsar and Juznic, 2014). This evaluation is in Slovenia governed by SICRIS or Slovenian CRIS (Current Research Information System) which is an essential part of the grants/decision process and funds allocation through the Slovenian Research Agency (ARRS/Javna agencija za raziskovalno dejavnost Republike Slovenije), (Juznic et al., 2010). The system has been used in the evaluation of different fields of science or research disciplines, including agriculture or agricultural/biotechnical sciences (Bartol et al., 2014). Such research needs to take into account possible differences among the fields of science in terms of citation patterns (Peclin et al., 2012). The research is facilitated through the automated matching algorithms and linking between the WoS records and COBISS (Cobib) and SICRIS which was established more than a decade ago (Curk et al., 2006).

Evaluation is essentially based on WOS-linked records but has been recently also provided for Scopus, especially for the assessment of the humanities, and social sciences which are represented in Scopus.
somewhat better. A new effort to monitor the scientific production by Slovenian authors has just been presented: a new COBISS/SciMet portal. These initial activities have been documented on IZUM/COBISS social networking website (Budimir, 2016) and are preceded by the utility "Nasi v WoS in Scopus" which calculates and shows publications and citations (cites) of Slovenian authors in both databases (Pusnik et al., 2015). Efforts are in the course to make research more widely accessible, through the so called open-access initiatives which promote international visibility of full-text articles. All four Slovenian universities are in the process of establishing the same procedures for submissions, through the respective institutional repositories (Ojstersek et al., 2014).

In Serbia, a similar utility has been provided through the service "Nasi u WoS" (BIS Kosanovic, 2010) although integration of services has been slower (Mitrovic et al., 2013). Still, along with Slovenia, Serbia is one of the few countries with functional national citation monitoring integrated into national research evaluation policy, where, however, national and regional journals still play an important role, especially in social sciences (Pajic, 2015). At this point we should note that many authors question the metrics conducted on citation databases. It may not always be an appropriate indicator of research activities in some disciplines, especially humanistic sciences (Kovacevic, 2016). The so-called 'citatocracy' may hamper researchers in disseminating research results in the context of a more general interest (Pavlin et al., 2013).

Thus, besides WOS- and Scopus-related research, some authors also evaluated national research through other databases, using, for example, CAB Abstracts database or other databases in other to assess the publishing patterns in agricultural or other research (Bartol, 2010). Such local publishing, however, has a limited international scientific influence what was shown on a Medline/PubMed-related research (Spiroski and Gogusev, 2010).

In SICRIS system, appropriate international standards are used, such as classifications as well as EU recommendations (CERIF – Common European Research Information Format). OECD-Frascati-related mapping is used for the grouping of scientific fields. CERIF compatible research management systems are also used around the region, for example, CRIS UNS which has been developing since 2008 at the University of Novi Sad (Nikolic et al., 2015).

Based on the availability of citation databases, advanced bibliometric/scientometric evaluations of international scientific literature have become possible. Such research was conducted, for example, on the model of fibre crops (Bartol and Mackiewicz-Talarczyk, 2015), and nanoscience and nanotechnologies (Bartol and Stopar, 2015; Stopar et al., 2016). In Serbia, similar bibliometrics also focused on nanoscience (Joksimovic et al., 2014) or national patents where the subject of agricultural chemicals was included (Kutlaca, 1998).

5. ICT user studies

Information & Communication Technologies are invariably in the service of research, development, and education so it is necessary to know the utilization patterns. User studies may address different issues, such as the practices of collecting and gathering information in a more strict sense or the more general levels of different information competencies and skills. In Slovenia, such studies have tackled, for example, information behaviour of researchers as well as information literacy of students. Information literacy studies focus on students rather than researchers. Information literacy (IL) is an 'umbrella' term which frequently stands for other different terms, such as information competencies/skills, search competencies/skills, etc. To some extent, it also involves computer literacy/competencies/skills as these are inseparably linked to efficient uses of contemporary scholarly information systems. In this context, the terms digital literacy/competencies/skills can also be used. Some other related 'literacies' are also pertinent, for example, archival literacy which has been investigated on a sample of Slovenian and Bosnian archivists (Vilar and Sauperl, 2014).

5.1 Information behaviour

A recent study investigated information behaviour of Slovenian researchers with regard to the use of sources, organization of work, collaboration, publishing, etc. (Vilar et al., 2015). The research also included agricultural scientists. A web-survey was employed involving Liker-type questions. The researchers have also tackled some more novel patterns, for example the participation in social
networking or blogs, which is among other issues addressed by the so-called altmetrics or alternative citation impact metrics. The outcomes show, however, that scientists have not embraced very strongly these non-traditional information resources. Previously, a related research found that the participants from different academic areas have different requirements and hold different perceptions (Vilar and Zumer, 2008). User studies in Slovenia also targeted student reading preferences (Zabukovec and Vilar 2015), and also non-academic communities, for example, information needs and information seeking habits of rural population (Vodeb, 2013). In this sense, the transfer of knowledge from the faculties to practice is not always satisfactory (Knezevic-Hocevar and Cernic-Istenic, 2014).

In a Serbian user-study, a behaviour pattern analysis addressed different learning styles using collaborative modules (Blagojevic and Milosevic, 2013). Another user study in Serbia explored online search behaviour and addressed some limitations of easy-to-use and "all-inclusive" web search engines where users, particularly scholars, do not know if they have thoroughly explored a research problem (Pajic, 2014). It is thus of utmost importance that users acquire expert information competencies. At this point it can be added that more emphasis should also be put on user education regarding data and communication security (Zoranovic, 2014).

5.2 Information literacy

Most such studies investigate the students, very frequently in relation to information literacy. It is important to know their competencies as they will, in the course of studies, receive different assignments and will thus need to look for respective information. There has been no internationally accepted course of instruction to this end. Important information-literacy (IL) competencies in higher education and research are provided through libraries (Novljan 2002; Slopar et al. 2008; Petermanec and Mulej 2008, Petermanec and Srot 2014). On many instances, it has been suggested that such education should be provided through credit-bearing courses.

An early information literacy study assessed students from the Biotechnical faculty (Juvan et al., 2006). A more recent such study involved students from different faculties. The study employed a validated information literacy test (ILT) aimed for higher education, in online environment (1ka - free, open source web survey software). Figure 3 shows examples of two such questions both in Slovenian and English version. ILT has been developed specifically for this purpose and is based on internationally acknowledged Information Literacy Competency Standards for Higher Education by the ACRL (Association of College & Research Libraries) of the ALA (American Library Association). The study found that the students were less successful in advanced database search strategies, and in topics related to intellectual property and ethics (Boh-Podgornik et al., 2015). The study was complemented by another study which demonstrated that present-day students which are frequently referred to as 'digital natives' are not necessarily information-literate. Paradoxically, the use of some popular ICT devices may even have a negative impact on the levels of such literacy (Sorgo et al., 2016). Perhaps, the use of such devices distracts students from education-related activities. Computer literacy and information literacy have also been juxtaposed by Volcic and Erjavec (2008).

In Serbia, students’ research skills have been investigated at the Faculty of Philosophy, University of Novi Sad, Serbia, based on a questionnaire with multiple choice items (Topalov and Radic-Bojanic, 2013). The research established that the high self-perception of the students’ search ability is not substantiated in practice. Results in the aforementioned Slovenian study also displayed similar students’ deficiencies. The authors of both experiments thus emphasize the need to educate students in information competencies which is also a conclusion by Matutinovic (2012). To this end, Bogdanovic (2014) calls for the introduction of information resources, such as KoBSON, Web of Science, Science Direct etc., in classroom teaching, also with the aim of modernizing the teaching process. Namely, information, also agriculture-related, can be scattered across many different databases requiring very different search procedures (Bartol, 2012) which requires advanced search competencies. Some other studies have proposed additional methods, for example, in order to assess importance of different internet sources of information for students (Srdjevic et al., 2013)
5.3 Capacity building of educators and researchers

The insufficient level of information literacy is not only a challenge in academic environments. The problem is more general and involves agricultural practice and respective weak usage of ICT technologies accompanied by insufficient support by ICT instructors (Zoranovic and Potkonjak, 2010). This issues, however, are related to advisory extension services and is principally linked to the education of extension officers who should have received information skills during their study process. Sometimes, educators themselves possess deficient skills. Sometimes, they may live and work in less privileged surroundings with a limited access to information resources. In the field of agricultural sciences, the FAO (Food and Agriculture Organization of the United Nations) has thus developed a capacity building program AGORA (Access to Global Online Research in Agriculture). The aim is to provide free or low cost access to scientific journals for less developed countries (Ochs et al., 2004). This initiative has been accompanied by user-training activities. The training has frequently involved strong train-the-trainers (information professionals and librarians) component (Bartol, 2013). Capacity building of experts and professionals fosters the needed top-down approaches, which is why training-the-trainers is so important (Spiranec and Pejova, 2010) especially in less privileged regions, such as South-East Europe. An information specialist from Slovenia was also involved in these activities in several countries of the Eastern Europe, as well as the regions of Caucasus and Central Asia. Here it is worth noting that information literacy of educators is frequently not sufficiently appreciated by their respective institutions. For example, Radovanovic et al. (2015) conclude that the educational culture neither rewards nor facilitates digital literacy for educators in such a way that maintains their credibility and their authority on the subject matter being taught. We can, in many respects, corroborate such experiences.

6. Conclusions

This review seeks to provide elementary examination of the principal stakeholders involved in the process of publishing, collecting, organizing and evaluating scientific information in Slovenia - with some highlights on agriculture. Some parallels with the development in Serbia are also drawn. In the sciences, the final outcome of a research is invariably reflected and evaluated through publications. The publications must be presented in such a way that can be easily found. The presentation, and subsequent use, can only be achieved through higher-level information skill by authors as well as users.

On account of length-limitations, the review has only been able to tackle this subject matter in an exploratory way. We have mostly focused on papers which were published in journals or proceedings. Other relevant documents may exist. Authors who are active in this area of scientific research are thus encouraged to present the valuable information through more formal resources and thus propagate these supporting activities which are an indispensable complement to disciplinary scientific work. The end-users, on the other hand, should embrace the habit of lifelong learning in the domain of Information &
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