

Library and Information Science and Sustainable Development: A Structured Literature Review

Abstract

Purpose – Awareness on and importance of sustainability in all aspects of our lives is becoming more and more important. The question arises, how – not if – scientists can contribute to a sustainable development. As information plays an important role for development, information scientists should be included in this debate. However, is there a sustainable information science or an information science of sustainability? This article attempts a mapping of publications in Library and Information Science (LIS) directly dealing with sustainability and sustainable development.

Design/methodology/approach – A structured literature review was conducted, enhanced by bibliometric analyses. For this purpose, 102 LIS journals and conferences were considered. We identified 81 publications dealing with sustainability and sustainable development and analyzed the concrete contents and methodological approaches of these.

Findings – A large proportion of articles could be found dealing with sustainable development and libraries. Other publications focus on information and communication technology or information systems. Only few articles deal with further topics like government, urban development or scientific output.

Research limitations/implications – Sustainability and sustainable development are complex topics. This work only considers literature whose title or keywords contain the string *sustainab**.

Originality/value – The presented work helps to get an overview on sustainability research and activities in the LIS field and additionally, potential research gaps may be identified. The authors call for more research in this area and concrete ideas to help develop a sustainable future.

Keywords Sustainability, Sustainable Development, Library and Information Science, Publications, Bibliometrics

Paper type Literature Review

Introduction

On January 1st, 2016, the Sustainable Development Goals (SDGs) of the United Nations went into effect. These 17 goals are intended to “end poverty, protect the planet and ensure prosperity for all” (United Nations, 2015, para. 1). A sustainable development can be described as a “development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (WCED, 1987, p. 37). Inspired by the triple bottom line (Elkington, 1997), three main dimensions of sustainable development can be identified: social, economic and environmental sustainability. Similarly, the SDGs include targets regarding different aspects of sustainability, from ending poverty to protecting the planet and improving education. Whereas prior formulations of similar goals – like the Millennium Development Goals – focused on advancements in developing countries, the SDGs demand involvement of all countries (United Nations, 2016). Hence, this is a matter for all of us. Today, we can already observe several initiatives supporting a sustainable development, like a growing interest in the sharing economy (Hamari, Sjöklint and Ukkonen, 2016). The question arises, how scientists can contribute to a sustainable development. Igbinovia (2017) emphasizes the importance of cross-disciplinary research in order to achieve the SDGs. Thereby, Library and Information Science (LIS) as a highly interdisciplinary field should not be excluded. And “since information forms an integral part of every development and innovation, sustainability should become a mainstream research topic within information studies” (Chowdhury, 2013, p. 617).

As information scientists, one way to support the SDGs can be to observe and report on their implementation. An example is the Open Knowledge Foundation’s 2030 watch. But there is more to it than mere observation. “The emerging challenge for information science is not only how to contribute to the

sustainable future debate, but also to debate the nature of a sustainable information science” (Spink, 1995b, p. 207).

Many scientists have already recognized a connection between their disciplines and various dimensions of sustainability. Some have discussed the concepts of “sustainable information” or “sustainable information science” (Nolin, 2010). Spink (1995b, p. 207) even argues that “[t]he Information explosion problem that has driven the field exists within the broader framework of the problem of sustaining development and subsequently humanity, but the problems of sustaining development may potentially present a new larger challenge for Information science”. It seems, however, that while the scientific interest in sustainability and sustainable development has been growing rapidly during the recent years (see Figure 2), publications with a LIS background remain relatively sparse. There exist some literature reviews on sustainability in LIS research, but to the knowledge of the authors none of them were both conducted systematically and meant to cover the whole LIS field as well. Existing structured literature reviews concentrate only on one aspect of LIS and sustainability, such as electronic governance (Estevez and Janowski, 2013), knowledge management (Evangelista and Durst, 2015) or information systems and sustainable supply chain management (de Camargo Fiorini and Jabbour, 2017).

Quental & Lourenço (2012) conducted a bibliometric analysis of over 3,000 Web of Science publications on sustainable development and sustainability science. In their study, 70% of the publications were dedicated to the discipline Environmental Science, around 12% were found in the field of urban studies, 11% in Economics and 1.7% in Computer Science. Library and Information Science does not appear though. Furthermore, Hassan, Haddawy and Zhu (2014) conducted a bibliometric study on sustainability and sustainable development in scientific literature in general. With this article, we aim at investigating the role of sustainability and sustainable development for LIS research. By means of a systematic literature review, existing foci and topics in this intersection will be identified. With the analysis, we explore gaps and possibilities to integrate this topic into LIS research agendas.

Methods

This article attempts a mapping of publications in LIS directly dealing with sustainability and sustainable development. Part of this is a bibliometric analysis of scholarly articles on sustainability and sustainable development. A structured literature review then focuses on the contents and methodological approaches of publications in the field of Library and Information Science. The presented work might not only help to get an overview over sustainability research and activities in the LIS field but additionally potential research gaps may be identified. The items included in the analysis were obtained from the Scopus database. Figure 1 describes the approach for attaining a set of articles for the analysis. As Scopus does not provide a subject area in the field Library and Information Science, the SCImago Journal Rank (SJR) was used in order to identify relevant sources (SCImago, 2007). As assumed by Leydesdorff (2009) the SJR can be used as an alternative to the Journal Impact Factor. Beside journal articles, conference proceedings can be included in the ranking. All sources in the first two quartiles were chosen, which added up to 102 items in February 2018.

In a next step, a Scopus search was conducted whereby all publications in these sources were retrieved whose title or keywords contain the string *sustainab**. With this, we made sure to include only articles that explicitly address the topic. Occurrences of the terms “sustainable” or “sustainability” in the abstract were not considered in the retrieval process as “those words are extremely common and can be used in a variety of contexts” (Quental and Lourenço, 2012, p. 364). Further, only research articles were considered, not e.g. editorials. Other keywords were not included in order to prevent bias towards one of the sub-dimensions or subtopics of sustainability. With this approach, 295 publications could be identified.

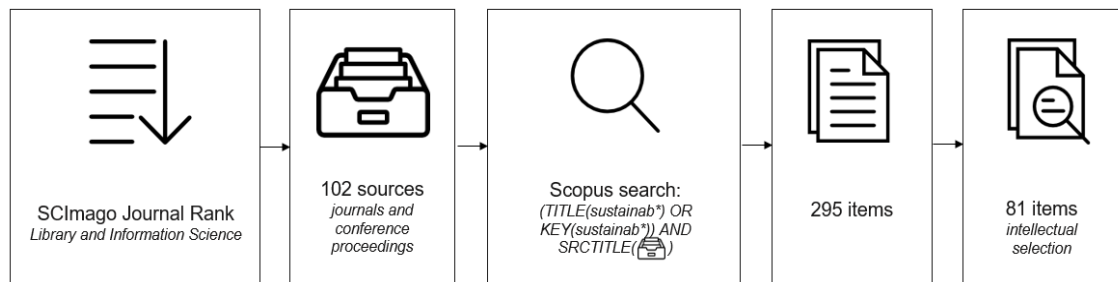


Figure 1. Methodological approach - Obtaining a set of articles for the analysis

PREPRINT

We checked all documents' titles and abstracts manually; irrelevant ones were excluded. For example, as the term "sustainability" can be used in many contexts, articles that did not cover one of the three dimensions mentioned before were deemed irrelevant for this review. In four cases, no full texts could be provided, so that in the end 81 publications remained for the analysis. We examined this set of documents by both, basic methods of bibliometrics and a structured literature review. Considering bibliometric indicators, metadata, keywords and citation information were used as provided by Scopus. Keyword networks were visualized with the help of VOSviewer (van Eck and Waltman, 2010). For the literature review, all publications were read. In each case we noted what dimension of sustainability (environmental, economic, social) was addressed. Furthermore, we listed the main topic, applied methods and addressed countries. For this process, in vivo coding was used, whereby the codes were summarized and conceptualized subsequently. Examples for the coding process can be found in Table 1.

Table 1. Examples for the coding process

Text excerpt	In vivo codes	Assigned dimension(s) of sustainability
"Thus, in order to achieve a sustainable development in any business sector we need to build systems and services that are economically, environmentally as well as socially sustainable" (Chowdhury, 2013, p. 603).	economically environmentally socially sustainable	Economic Environmental Social
"[W]e aim to develop a comprehensive research framework that places the fragmented Green IT/S literature in conversation with the more well-established environmental sustainability literatures in management, environmental psychology, and social marketing" (Jenkin, Webster and McShane, 2011, p. 18).	environmental sustainability	Environmental
Text excerpt	In vivo codes	Assigned thematic focus
"This paper sheds light on how library-building projects can be used not only to teach the public about green technologies and practices, but also inspire others to begin using similar techniques at home, at work, and in the community" (Barnes, 2012, p. 398).	library-building to teach the public green technologies and practices	Libraries and Archives
"For this reason, this study seeks to provide empirical evidence regarding the use made by local governments of their websites to disclose information about sustainability and to improve its transparency and credibility" (Tirado-Valencia <i>et al.</i> , 2016, p. 401).	local governments disclose information	Government
Text excerpt	In vivo codes	Assigned method
"The information required for this index was obtained by analysing the web sites of selected municipalities during May and June 2011. Content analysis is a fundamental technique for studying online information and is based on determining the presence or absence of certain information" (Cuadrado-Ballesteros, Frías-Aceituno and Martínez-Ferrero, 2014, p. 119).	analysing the web sites content analysis	Content analysis
"The data consist of responses obtained from 168 registered users of the service Sharetribe who were recruited via an official Sharetribe e-mail newsletter. [...] We measured each construct with four or five items that were all on a 7-point Likert scale" (Hamari, Sjöklint and Ukkonen, 2016, p. 2053).	responses obtained from 168 registered users 7-point Likert scale	Structured survey

Results

In total, we analyzed 81 publications, which are distributed over 37 sources (journals and conference proceedings). With each seven items, most articles were published in the journals *Government Information Quarterly*, *Scientometrics* and the *International Journal of Geographical Information Science*. This is followed by five articles in the *Journal of the Association for Information Science and Technology* and four

PREPRINT

articles in *Information, Communication and Society*. The articles are authored by 155 different persons, whereby Gobinda Chowdhury and Amanda Spink are the most frequent authors with five and three articles, respectively. While publications by Amanda Spink shape early thoughts on the intersection of sustainability and LIS research from 1995 to 1999, articles by Gobinda Chowdhury on this topic were published since 2010. In two theoretical articles, Spink discusses the general role of information science for a sustainable development (Spink, 1995b, 1999). Spink further emphasizes the need of consolidating research on sustainable development and digital libraries (Spink, 1995a). Chowdhury actually connects these topics. He especially focuses on the carbon footprint of the knowledge sector as well as sustainability of digital libraries and information services and proposes methods to measure environmental costs of digital libraries (Chowdhury, 2010, 2013, 2014, 2016). Chowdhury and Koya (2017) further conducted an analysis on four UN policy documents and the importance of information related concepts embedded in these. Considering the SDGs, information access and information sharing seem to be of particular importance.

Citations

Overall, publications received a mean value of 23.3 citations (Scopus) up until February, 28th whereas the median is 4. With a mode of 0 the distribution of citations is positively skewed. Five articles reached more than 100 citations (Table 2). The most cited work addresses the Information Systems community and demands more involvement in issues of environmental sustainability especially with regard to a new field energy informatics (Watson, Boudreau and Chen, 2010). The authors recommend an integration of environmental sustainability in research and teaching, but also address journals and associations of the Information Systems community to dedicate themselves to this topic. For example, conferences could be redesigned to be more environmentally friendly. In contrast, Jenkin, Webster and McShane (2011) concentrate on the organizational impact of green information technology and systems. The authors could only identify little research and awareness in this area and hope to motivate further interest in this subject. In their work, that has been cited 188 times, they developed a research framework for environmental sustainability with regard to information systems and technologies in organizations. Building blocks of this framework are motivating forces, sustainability initiatives, the overall environmental orientation and environmental impacts. Two further articles among the five most highly cited works were published in the *International Journal of Geographical Information Science*, both authored by Xia Li and Anthony G.O. Yeh (Yeh and Li, 1998; Li and Yeh, 2000). In these articles, they propose models for sustainable land development and sustainable urban development with the help of geographical information systems (GIS).

Table 2. Top five of the most highly cited articles

Authors	Article Title	Year	Source Title	Number of Citations
Watson R.T., Boudreau M.- C., Chen A.J.	Information systems and environmentally sustainable development: Energy informatics and new directions for the is community	2010	MIS Quarterly: Management Information Systems	500
Li X., Yeh A.G.-O.	Modelling sustainable urban development by the integration of constrained cellular automata and GIS	2000	International Journal of Geographical Information Science	332
Jenkin T.A., Webster J., McShane L.	An agenda for 'Green' information technology and systems research	2011	Information and Organization	188
Yeh A.G.-O., Li X.	Sustainable land development model for rapid growth areas using GIS	1998	International Journal of Geographical Information Science	107
Hamari J., Sjöklint M., Ukkonen A.	The sharing economy: Why people participate in collaborative consumption	2016	Journal of the Association for Information Science and Technology	104

PREPRINT

The most recent article among the top five cited articles addresses a different topic: the sharing economy and collaborative consumption (Hamari, Sjöklint and Ukkonen, 2016). The authors investigate consumer's motivations to take part in collaborative consumption. By means of a survey they analyze sustainability and enjoyment as intrinsic motivations as well as extrinsic motivations like reputation and economic benefits. Their results suggest that the sustainability of collaborative consumption is an important factor only for those consumers who deem ecological consumption important.

Publication Year

Going back in time, there are only a few early publications on sustainability in the LIS field (Figure 2). The first article was published in 1990 and addresses the role of GIS for sustainable development exemplified by the situation in Canada (Manning, 1990). The author claims that these systems have the potential to contribute to a sustainable development and help to understand the relations between environmental and economic issues. Two further articles were published in 1995, both authored by Amanda Spink. In one of them, the role of information science for a sustainable future is discussed (Spink, 1995b). Challenges like population growth and environmental degradation are considered as being relevant issues not only for social scientists and economists, but for information scientists as well. Suggested is, inter alia, the need of "different approaches to the collection, storage and dissemination of information to support regional agricultural and social self-reliance via community-based information services" (Spink, 1995b, p. 207). The other article specifies the discussion on sustainable development regarding digital libraries (Spink, 1995a). Again, it is argued that more interdisciplinary research should be conducted on sustainable development and digital libraries.

With twelve publications, a first peak is reached in 2010 (see Figure 2). Four of these were published in *Information, Communication and Society*. This journal published a special issue on sustainable development and ICT, which explains the increased number of articles in that year. Therein, Fuchs (2010) presents a theoretical framework to define a sustainable information society. Four approaches are discussed in this context: (1) Reductionism, which focuses on the role of ecology, economy and technology; (2) Projectionism, emphasizing political and cultural aspects; (3) Dualism, where several dimensions of sustainable development are interpreted independently of each other; (4) Dialectic, which includes different

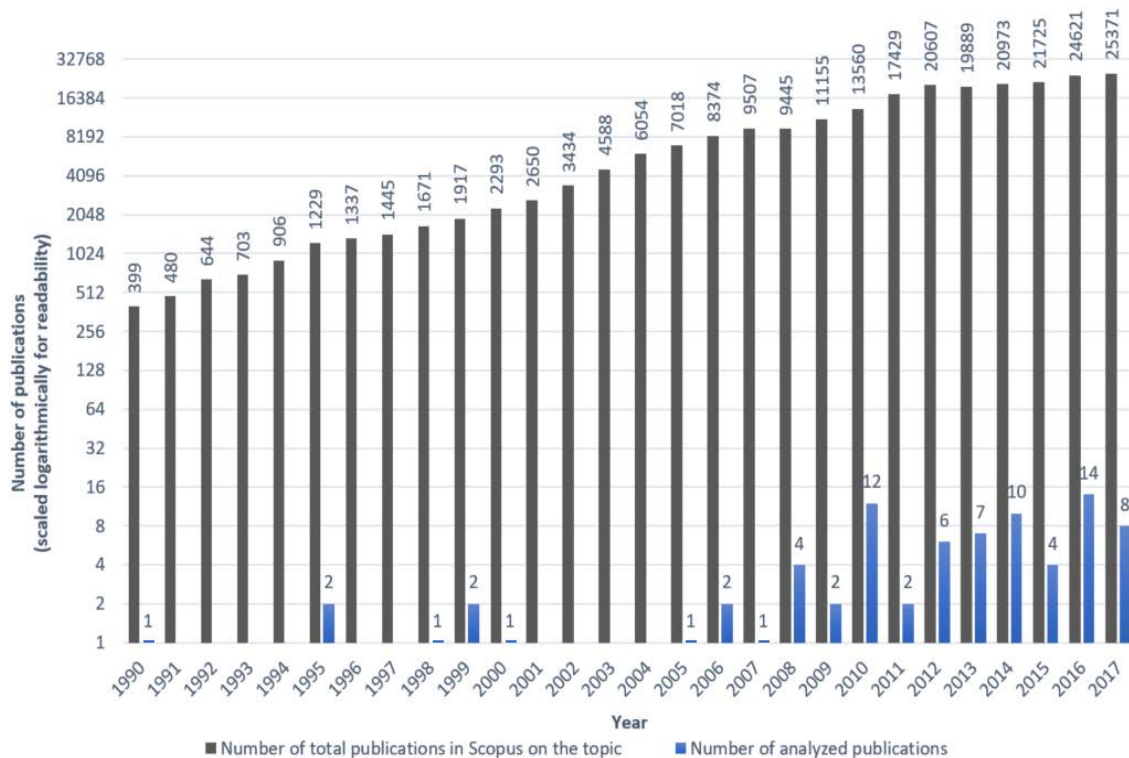


Figure 2. Number of total publications on sustainability in Scopus and number of analyzed articles per year

dimensions of sustainability with causal relations. The author claims that most definitions in the literature are of dualistic nature, but declares himself in favor of the dialectic approach, hence emphasizing interrelations of the different dimensions of sustainability.

In contrast to this theoretical work, Mitrea, Werner, and Greif (2010) perform an empirical study in the form of in-depth interviews and an online survey on the relations of sustainability and ICT development. One of the findings of this study is that sustainable developed ICT should be available for every member of society. Lanzarone and Zanzi (2010) focus on smart meters applied to monitor gas and water consumption. They report on a project in Italy, which aims at informing on and modifying personal consumption behavior. Lastly, Nugroho (2010) discusses the role of the internet for sustainable rural development in Indonesia. It is supposed, that non-governmental organizations make use of the internet and take part in social transformation, but still are dependent on direct interaction. Also, in 2016 an increased number of publications can be detected. The resolution on the SDGs one year before may be responsible for a reignited interest in the topic.

Compared to the amount of publications from the LIS fields, a huge increase of publications on sustainable development in general can be observed in the Scopus database (Figure 2, gray bars). Note that the y-axis is scaled logarithmically (base 2) for readability. That means, contrary to appearances, the increase of publications is not linear. Whereas in 1990, nearly 400 publications were indexed, the amount more than tripled only five years later. In 2017, even more than 25,000 documents were published. For the years 1990 to 2017 an average growth rate of 16.63% could be calculated.

Main Topics

Figure 3 shows the co-occurrences of the assigned keywords as provided by Scopus with clustering (the clusters are displayed in different colors). The map provides a first overview on the topics that are covered in the examined publications. A keyword's size reflects the number of its occurrences. The obvious keywords *sustainable development* and *sustainability* occur 31 and 19 times, respectively. The three dimensions of sustainability (environmental, economic and social) are represented as well. Besides this, some thematic foci can be detected. For example, *digital libraries* can be associated with all types of sustainability and has further links to terms like *environment* and *global warming*. Another cluster combines

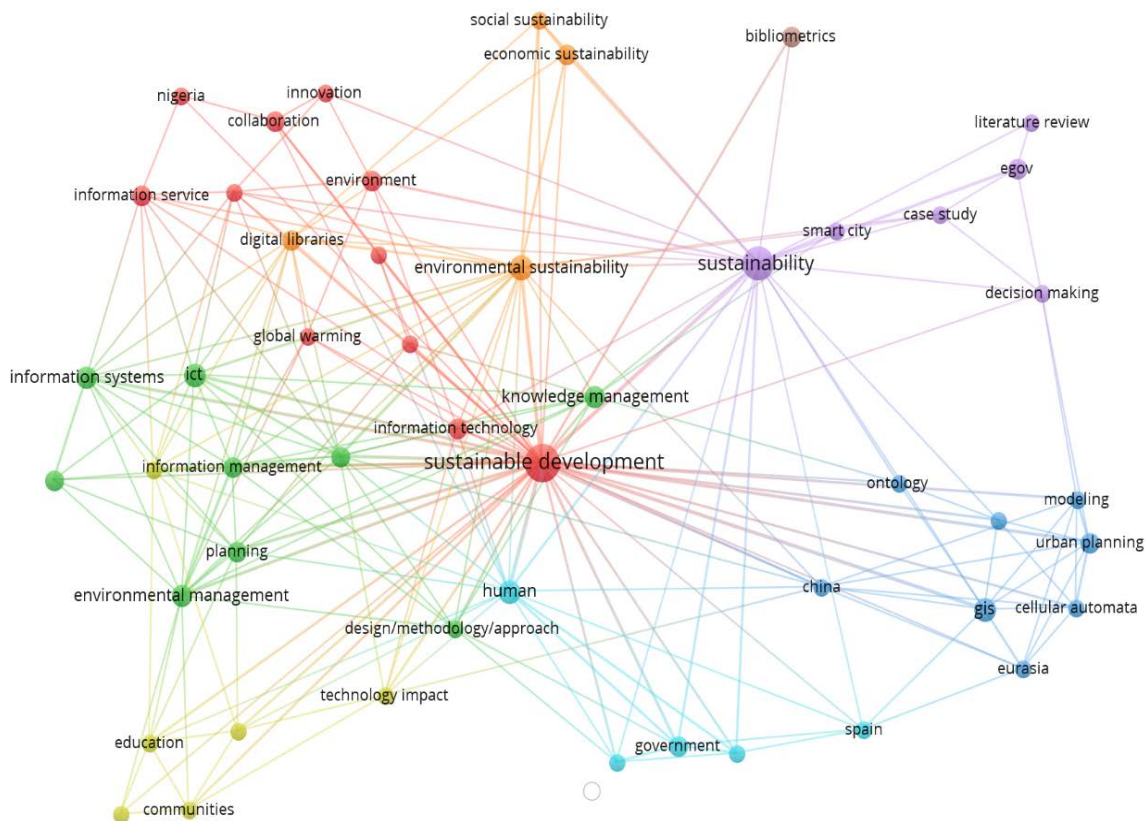


Figure 3. Keyword co-occurrence map in N=81 LIS articles on sustainability (The terms are based on the keywords provided by Scopus, the map was created using VOSviewer)

PREPRINT

the keywords *urban planning*, *cellular automata*, and geographic information systems (*gis*). The terms *government* and *websites* are neighboring as well as *smart city* and E-government (*egov*).

From the 81 analyzed publications, 68 could be related to environmental sustainability, 43 to economic and 45 to social sustainability. Taking a deeper look into the contents of publications, eight major topics or objects of investigation could be identified (Table 3). A majority of the analyzed publications focuses on libraries and archives (23%). From these, 16 address sustainability with regard to environmental aspects, while nine can be related to social and economic sustainability, respectively. Six articles discuss all three dimensions. Therein, different types of libraries are addressed. Nine publications focus on academic libraries, four on public and three on digital libraries. The remaining articles did not specify the library type. Nine articles are concerned with green libraries. Beside green buildings (Noon, 2008; Barnes, 2012; e.g., Afacan, 2017), topics like information dissemination for enhancing user awareness on environmental sustainability (Townsend, 2014) or education for sustainability (Jankowska, Smith and Buehler, 2014) are addressed. In another publication it is investigated how libraries can support in achieving the SDGs (Granda and Machin-Mastromatteo, 2016).

All but one of the 18 articles assigned to Information and Communication Technology (ICT) & Information Systems consider environmental aspects, whereas eight deal with economic and six with social sustainability. The subtopics here include ICT in developing countries (Thongmak, 2013), the sustainability of digital information services (Chowdhury, 2013), sustainability as a new dimension for evaluating information systems (Piotrowicz and Cuthbertson, 2009), and monitoring gas and water consumption through ICT in order to improve user awareness (Lanzarone and Zanzi, 2010).

Table 3. Main topics of LIS articles on sustainability (N = 81)

Number of publications	Focus	Topics
19	Libraries and Archives	green library buildings, information dissemination, user awareness, education, cross-disciplinary research of librarians, libraries and the SDGs
18	Information and Communication Technology & Information Systems	ICT in developing countries, smart metering, information system evaluation, digital information services, monitoring gas and water consumption
10	Government	open data, digital government, information dissemination, media pressure
7	Scientific Publications (Scientometrics)	sustainable development literature, sustainable energy research, ecodesign
7	Society	women's health, gender equality, learning society, information society, ecovillages, collaborative consumption
6	Geographical Information Systems & Urban Development	cellular automata, urban growth, planning tools
4	Research Institutes and Universities	universities, agricultural research institutes
3	Information Science	sustainable future, de-industrialization
7	Miscellaneous	food, waste disposal, carbon footprint, knowledge management

Among those publications focusing on governments, eight out of ten address all three types of sustainability at the same time, whereas the remaining two consider social and economic aspects or social and environmental facets. Popular topics are the information dissemination behavior of local governments,

PREPRINT

e.g. in relation to media pressure (Cuadrado-Ballesteros, Frías-Aceituno and Martínez-Ferrero, 2014) and open data (Zhang *et al.*, 2016). Publications focusing on the society address different subjects like gender discrimination and equality (Asokhia, 2009), the learning society of Latin America (Dudziak, 2007) or particular communities like ecovillages (Nathan, 2012). Most articles here are concerned with the social and environmental dimension of sustainability, only one publication also addressed economic sustainability. All publications on geographical information systems integrate environmental aspects of sustainability, only two also economic and social issues. For research institutes and universities on the other hand, all analyzed articles address the social component, only two the other dimensions.

From the analyzed articles, 39 used a literature review as methodological approach, from which six were being conducted in a structured fashion. Fourteen publications report about a case study, 15 further used in-depth (expert) interviews, nine a structured survey. Seven articles performed a bibliometric analysis, all being published in the journal *Scientometrics*. Content analysis was used in six cases. A literature review was particularly used in the context of libraries (eleven out of 19), ICT (twelve out of 18), society (four out of six) and Information Science (all three) as a research object. Considering analyses about governments, half of the studies used content analysis (five out of ten). All seven bibliometric studies obviously examined scientific publications.

Discussed Countries

Some articles concentrate their analysis on one or more location(s) or region(s), for example through a case study. In total, 16 countries are addressed, which are listed below, each with the number of assigned publications:

- | | | | |
|---------------------|-------------------|-----------------|--------------|
| • United States (6) | • Nigeria (5) | • Australia (4) | • China (4) |
| • Spain (4) | • Canada (2) | • Iran (2) | • Italy (2) |
| • Austria (1) | • England (1) | • Indonesia (1) | • Japan (1) |
| • Mexico (1) | • Puerto Rico (1) | • Sweden (1) | • Turkey (1) |

Most frequently mentioned are the United States. Three out of six publications address libraries in the US, whereby two articles report about a case study of a local library. Two publications about Nigeria are concerned with the information need of society, more precisely the dissemination of information on HIV/AIDS (Uhegbu and Okereke, 2006) and the emancipation of women through technological empowerment (Asokhia, 2009). Spain is mainly studied with regard to governmental institutions and their information dissemination. For three articles, content analysis of governmental websites was conducted. Brusca, Manes Rossi, and Aversano (2016) report on sustainability information dissemination by local governments in Spain and Italy. In both countries, the disclosure of financial, social and environmental information on websites seems to be relatively low. Cuadrado-Ballesteros, Frías-Aceituno, and Martínez-Ferrero (2014) are interested in the role of media pressure for online information dissemination of local governments in Spain. They found out, that media pressure leads to a reduced reporting on strategic and socioeconomic information. Navarro-Galera, Alcaraz-Quiles, and Ortiz-Rodríguez (2016) call for web-improvements in terms of an increasing volume of social, economic and environmental information published online by regional governments.

Discussion and Conclusion

Awareness on and importance of sustainability in all aspects of our lives is becoming more and more important. And as “we move towards ‘knowledge societies’ (...) the promises of information and media have increased manifold. This opens new horizons for every woman and man to exercise their rights to freedom of opinion, expression and access to information – to be actors in, and beneficiaries of, sustainable development” (Engida, 2015, p. 9).

This work reports on a review of literature regarding sustainability and sustainable development from the LIS community. While initially, 295 items from 102 sources were identified, only 81 articles were deemed as relevant for further analysis. These articles had to be from the LIS background and cover one of the three dimensions of sustainable development (social, economic and environmental sustainability). All articles were analyzed regarding top journals, top authors, citation count, publication year, topics and discussed countries.

While there have been a higher number of relevant publications during the last ten years, the productivity of LIS scholars does not reflect the topic’s rising prominence in the general scientific community. Peaks in the publication count over the years seem to be influenced by events such as the formulation of the SDGs or, for instance, and a special issue in a LIS related journal. Indeed, while

PREPRINT

sustainability is the responsibility of every human – and therefore every scientist – journals, institutions, associations and conference organizers can encourage individuals to make one's own contribution to this topic. They can offer spaces for scientific discussion and exchange between professionals. Examples are conferences offered by the International Federation of Library Associations and Institutions (IFLA) with mottos such as “Green Libraries – Together, for All” or “Green transformation for sustainable development”, as well as the European Conference on Information Literacy (ECIL) with the theme “Information Literacy in the Green Society” in 2015 which was planned to be a “green conference” itself. Amanda Spink was among the first ones discussing sustainability and sustainable development as a relevant research topic for LIS (Spink, 1995b, 1999), with our literature review, we showed that there is much potential for this topic regarding several thematic foci.

The thematic priorities in the analyzed publications are in particular libraries as well as ICT. Regarding the former, several articles were found mentioning green and sustainable library initiatives, information dissemination and education in sustainability aspects. Through concrete case studies, the libraries' effort in raising awareness of and enhancing a sustainable development is demonstrated. Thus, it becomes clear that the library can play a key role in achieving the SDGs. Obviously, challenges cannot be avoided within this context. “Although the overall aim of any business or development is to achieve sustainability in all its three forms, in reality it is a major challenge because often measures are taken for achieving one form of sustainability influence or affect the other forms of sustainability” (Chowdhury, 2014), which holds true for libraries as well. Future work should attempt to propose ideas and solutions for managing these challenges.

As the publications concerning ICT and information systems revealed, technological innovations show great potential to support a sustainable development as well. With the help of, for example, geographic information systems and smart meters it might be possible to raise awareness of sustainability issues and educate the society in this regard. Here, further research should be conducted with an enhanced focus on the effects of ICT on sustainable development in all its variants. Concrete ideas and guidelines would help to improve our understanding of the possibilities and challenges information system pose for sustainability.

Beside libraries and information systems, some publications were found regarding other topics like governments, society and urban development. Still, research can and should be expanded. Whereas topics like green libraries or green information technology seem to be already established, the debate should be expanded on further domains. In every field of information science, there is a way to support sustainable development and transform research sustainably. Furthermore, there possibly are many more aspects and sustainable information science research opportunities we cannot imagine yet. Right now, the applied methods should be expanded. While there are currently a lot of literature reviews and theoretical works, more empirical studies, practical solutions and evaluations are desirable. Additionally, sustainability should also find its rightful place in LIS education. Thereby “sustainability should be embedded in every aspect of data and information management teaching and research in iSchools and other university disciplines so that the graduates can make appropriate management, research, and professional contributions at the workplace in every business and industry towards achieving the SDGs” (Chowdhury and Koya, 2017, pp. 2135–2136).

The presented literature review helps to get an overview on sustainability research and activities in the LIS field. Additionally, potential research gaps may be identified. The thematic foci of existing research (Table 3) can be consulted for identifying potential intersections of LIS and sustainable development and help establish a research agenda. Future research could especially consider two facets: (1) education and opinion forming about sustainability as well as information dissemination of sustainability information (e.g., via social media or information systems), and (2) frameworks for measuring and evaluating sustainable development (e.g., through open data). For example, smart city research, which has become a mainstream topic in LIS, unites several aspects and topics detected in our study. Existing frameworks for research on the several subtopics of LIS and sustainability, such as the multilevel framework for environmentally sustainable information technology and systems research (Jenkin, Webster and McShane, 2011) or the agenda for green information retrieval research (Chowdhury, 2012) can also contribute to complete the picture and help to establish an overall research agenda. Further, the SDGs may act as a frame for conducting research on sustainable development.

Of course, this study has some limitations. Only those publications are included in the literature review that were published in a journal or conference proceeding related to the LIS field and listed by the SCImago rank. There may be further publications from information scientists published in related disciplines like Computer Science or the Social Sciences, which are not considered here. Furthermore, only conference papers and journal articles were analyzed, other document types (e.g., books) were not included. With the presented search strategy, only those research items were found that directly address sustainability or

PREPRINT

sustainable development in the article's title or via the keywords. Reality is more complicated. Most publications did not concentrate on only one dimension of sustainable development. This underlines that social, economic and environmental issues cannot be considered independently. When an attempt is made to improve one aspect of sustainability, others will be affected. Then again, there are many research projects which support sustainable development without ever mentioning it explicitly. Nonetheless, this work is an attempt at presenting a general overview on the current literature and topics regarding sustainable development in LIS research. Even if not exhaustive, it already accomplished its goal as soon as it helps other researchers to identify further research opportunities in sustainable information science. Agreeing with Chowdhury (2013, p. 617), who argues that "sustainability should become a mainstream research topic within information studies", we call for more research from LIS researchers on sustainable development.

References

- Afacan, Y. (2017) "Sustainable library buildings: Green design needs and interior architecture students' ideas for special collection rooms," *Journal of Academic Librarianship*. Elsevier, 43(5), pp. 375–383. doi: 10.1016/j.acalib.2017.07.002.
- Asokhia, M. O. (2009) "Emancipating women through technological empowerment: Aid to sustainable development," *Asian Journal of Information Technology*, 8(3), pp. 84–87.
- Barnes, L. L. (2012) "Green buildings as sustainability education tools," *Library Hi Tech*, 30(3), pp. 397–407. doi: 10.1108/07378831211266546.
- Brusca, I., Manes Rossi, F. and Aversano, N. (2016) "Online sustainability information in local governments in an austerity context," *Online Information Review*, 40(4), pp. 497–514. doi: 10.1108/OIR-05-2015-0161.
- de Camargo Fiorini, P. and Jabbour, C. J. C. (2017) "Information systems and sustainable supply chain management towards a more sustainable society: Where we are and where we are going," *International Journal of Information Management*. Elsevier Ltd, 37(4), pp. 241–249. doi: 10.1016/j.ijinfomgt.2016.12.004.
- Chowdhury, G. (2010) "Carbon footprint of the knowledge sector: what's the future?," *Journal of Documentation*, 66(6), pp. 934–946. doi: 10.1108/00220411011087878.
- Chowdhury, G. (2012) "An agenda for green information retrieval research," *Information Processing and Management*. Elsevier Ltd, 48(6), pp. 1067–1077. doi: 10.1016/j.ipm.2012.02.003.
- Chowdhury, G. (2013) "Sustainability of digital information services," *Journal of Documentation*, 69(5), pp. 602–622. doi: 10.1108/JD-08-2012-0104.
- Chowdhury, G. (2014) "Sustainability of digital libraries: A conceptual model and a research framework," *International Journal on Digital Libraries*, 14(3–4), pp. 181–195. doi: 10.1007/s00799-014-0116-0.
- Chowdhury, G. (2016) "How to Improve the Sustainability of Digital Libraries and Information Services?," *Journal of the Association for Information Science and Technology*, 67(10), pp. 2379–2391. doi: 10.1002/asi.23599.
- Chowdhury, G. and Koya, K. (2017) "Information practices for sustainability: Role of iSchools in achieving the UN Sustainable Development Goals (SDGs)," *Journal of the Association for Information Science and Technology*, 68(9), pp. 2128–2138.
- Cuadrado-Ballesteros, B., Frías-Aceituno, J. and Martínez-Ferrero, J. (2014) "The role of media pressure on the disclosure of sustainability information by local governments," *Online Information Review*, 38(1), pp. 114–135. doi: 10.1108/OIR-12-2012-0232.
- Dudziak, E. A. (2007) "Information Literacy and Lifelong Learning in Latin America: The challenge to build social sustainability," *Information Development*, 23(1), pp. 43–47. doi: 10.1177/0266666907075630.
- van Eck, N. J. and Waltman, L. (2010) "Software survey: VOSviewer, a computer program for bibliometric mapping," *Scientometrics*, 84(2), pp. 523–538. doi: 10.1007/s11192-009-0146-3.
- Elkington, J. (1997) *Cannibals with forks: The triple bottom line of 21st century*. North Mankota, MN: Capstone. doi: <http://doi.wiley.com/10.1002/tqem.3310080106>.
- Engida, G. (2015) "Foreword," in Singh, J. et al. (eds.) *Media and Information Literacy for the*

PREPRINT

- Sustainable Development Goals*. Göteborg: The International Clearinghouse on Children Youth and Media, pp. 9–11.
- Estevez, E. and Janowski, T. (2013) “Electronic governance for sustainable development - conceptual framework and state of research,” *Government Information Quarterly*. Elsevier Inc., 30(SUPPL. 1), pp. S94–S109. doi: 10.1016/j.giq.2012.11.001.
- Evangelista, P. and Durst, S. (2015) “Knowledge management in environmental sustainability practices of third-party logistics service providers,” *Vine*, 45(4), pp. 509–529. doi: 10.1108/VINE-02-2015-0012.
- Fuchs, C. (2010) “Theoretical foundations of defining the participatory, co-operative, sustainable information society,” *Information, Communication & Society*, 13(1), pp. 23–47. doi: 10.1080/13691180902801585.
- Granda, R. and Machin-Mastromatteo, J. D. (2016) “From Caracas to Lyon: A road toward sustainable development?,” *Information Development*, 32(2), pp. 216–218. doi: 10.1177/0266666915626830.
- Hamari, J., Sjöklint, M. and Ukkonen, A. (2016) “The sharing economy: Why people participate in collaborative consumption,” *Journal of the Association for Information Science and Technology*, 67(9), pp. 2047–2059.
- Hassan, S. U., Haddawy, P. and Zhu, J. (2014) “A bibliometric study of the world’s research activity in sustainable development and its sub-areas using scientific literature,” *Scientometrics*, 99(2), pp. 549–579. doi: 10.1007/s11192-013-1193-3.
- Igbinovia, M. O. (2017) “Librarians’ involvement in cross-disciplinary research and its implication for sustainable development goals (SDGs),” *Library Review*, 66(4/5), pp. 251–265. doi: 10.1108/LR-09-2016-0078.
- Jankowska, M. A., Smith, B. J. and Buehler, M. A. (2014) “Engagement of academic libraries and information science schools in creating curriculum for sustainability: An exploratory study,” *Journal of Academic Librarianship*. Elsevier Inc., 40(1), pp. 45–54. doi: 10.1016/j.acalib.2013.10.013.
- Jenkin, T. A., Webster, J. and McShane, L. (2011) “An agenda for ‘Green’ information technology and systems research,” *Information and Organization*. Elsevier Ltd, 21(1), pp. 17–40. doi: 10.1016/j.infoandorg.2010.09.003.
- Lanzarone, G. A. and Zanzi, A. (2010) “Monitoring gas and water consumption through icts for improved user awareness,” *Information, Communication & Society*, 13(1), pp. 121–135.
- Leydesdorff, L. (2009) “How are new citation-based journal indicators adding to the bibliometric toolbox?,” *Journal of the American Society for Information Science and Technology*, 60(7), pp. 1327–1336. doi: 10.1002/asi.
- Li, X. and Yeh, A. G. O. (2000) “Modelling sustainable urban development by the integration of constrained cellular automata and GIS,” *International Journal of Geographical Information Science*, 14(2), pp. 131–152. doi: 10.1080/136588100240886.
- Manning, E. W. (1990) “Geographic information systems and sustainable development,” *Government Information Quarterly*, 7(3), pp. 329–342.
- Mitreá, O., Werner, M. and Greif, H. (2010) “Sustainability ICT visions and their embedding in technology construction,” *Information, Communication & Society*, 13(1), pp. 48–67.
- Nathan, L. P. (2012) “Sustainable Information Practice: An Ethnographic Investigation,” *Journal of the Association for Information Science and Technology*, 63(11), pp. 2254–2268.
- Navarro-Galera, A., Alcaraz-Quiles, F. J. and Ortiz-Rodríguez, D. (2016) “Online dissemination of information on sustainability in regional governments. Effects of technological factors,” *Government Information Quarterly*. Elsevier Inc., 33(1), pp. 53–66. doi: 10.1016/j.giq.2015.12.003.
- Noon, P. (2008) “The lancaster library-building a sustainable library,” *LIBER Quarterly*, 18(2), pp. 129–136.
- Nugroho, Y. (2010) “NGOs, the internet and sustainable rural development: The case of Indonesia,” *Information, Communication & Society*, 13(1), pp. 88–120.
- Piotrowicz, W. and Cuthbertson, R. (2009) “Sustainability – a new dimension in information systems evaluation,” *Journal of Enterprise Information Management*, 22(5), pp. 492–503. doi: 10.1108/17410390910993509.
- Quental, N. and Lourenço, J. M. (2012) “References, authors, journals and scientific disciplines

PREPRINT

- underlying the sustainable development literature: A citation analysis,” *Scientometrics*, 90(2), pp. 361–381. doi: 10.1007/s11192-011-0533-4.
- SCImago (2007) *SCImago, SJR — SCImago Journal & Country Rank*. Available at: <http://www.scimagojr.com> (Accessed: February 1, 2018).
- Spink, A. (1995a) “Digital Libraries and Sustainable Development?,” *Proceedings of the 2nd Digital Libraries Conference*, pp. 1–7.
- Spink, A. (1995b) “Information and a sustainable future,” *Libri*, 45(3–4), pp. 203–208. doi: 10.1515/libr.1995.45.3-4.203.
- Spink, A. (1999) “Information science in sustainable development and de-industrialization,” *Information Research*, 5(1).
- Thongmak, M. (2013) “A systematic framework for sustainable ICTs in developing countries,” *International Journal of Information Technologies and Systems Approach*, 6(1), pp. 1–19. doi: 10.4018/jitsa.2013010101.
- Tirado-Valencia, P. *et al.* (2016) “Online sustainability information in European local governments,” *Online Information Review*, 40(3), pp. 400–415. doi: 10.1108/OIR-05-2015-0155.
- Townsend, A. K. (2014) “Environmental sustainability and libraries: facilitating user awareness,” *Library Hi Tech News*, 31(9), pp. 21–23. doi: 10.1108/LHTN-07-2014-0059.
- Uhegbu, A. N. and Okereke, C. I. (2006) “Decades of persistent ignorance towards sustainable dissemination of HIV/AIDS information among rural women in Imo State, Nigeria,” *Library Review*, 55(1), pp. 35–44. doi: 10.1108/00242530610641772.
- United Nations (2015) *Sustainable Development Goals*. Available at: <http://www.un.org/sustainabledevelopment/sustainable-development-goals/> (Accessed: January 5, 2018).
- United Nations (2016) *The Sustainable Development Agenda*. Available at: <http://www.un.org/sustainabledevelopment/development-agenda/> (Accessed: April 4, 2018).
- Watson, R. T., Boudreau, M.-C. and Chen, A. J. (2010) “Information systems and environmentally sustainable development: energy informatics and new directions for the is community,” *MIS Quarterly*, 34(1), pp. 23–38. doi: Article.
- WCED (1987) “Report on the World Commission on Environment and Development. Our Common Future,” pp. 1–247.
- Yeh, A. G.-O. and Li, X. (1998) “Sustainable land development model for rapid growth areas using GIS,” *International Journal of Geographical Information Science*, 12(2), pp. 169–189. doi: 10.1080/136588198241941.
- Zhang, J. *et al.* (2016) “Strengthening institutional-based trust for sustainable consumption: Lessons for smart disclosure,” *Government Information Quarterly*. Elsevier Inc., 33(3), pp. 552–561. doi: 10.1016/j.giq.2016.01.009.