hhu Heinrich Heine
Universität
Düsseldorf

Urban Governance for Sustainable Development: Information Dissemination, Open Data, and Citizen Participation

Inaugural-Dissertation
zur Erlangung des Doktorgrades der Philosophie (Dr. phil.)
durch die Philosophische Fakultät der
Heinrich-Heine-Universität Düsseldorf

vorgelegt von
Christine Meschede

Düsseldorf Juni 2020

Abteilung für Informationswissenschaft

Heinrich-Heine-Universität Düsseldorf

D61

Gedruckt mit der Genehmigung der

Philosophischen Fakultät der

Heinrich-Heine-Universität Düsseldorf

Gutachter:

1. Prof. Wolfgang G. Stock

2. Prof. Gerhard Reichmann

Tag der mündlichen Prüfung: 03.12.2020

Acknowledgements

First of all, I would like to express my sincere gratitude to my supervisor Prof. Dr. Wolfgang G. Stock for his continuous support, the thoughtful comments and recommendations on this dissertation. I would also like to thank my second advisor, Prof. Dr. Gerhard Reichmann, for his support during the development of this thesis. I am also thankful to the Department of Information Science and all its member's staff for all the considerate guidance. Especially, I thank my co-authors for fruitful discussions and the great team work. I can also not forget to thank my family and friends for all the unconditional support in this very intense time.

Eidesstaatliche Versicherung

Ich versichere an Eides Statt, dass diese Dissertation von mir selbständig und ohne unzulässige fremde Hilfe unter Beachtung der ‚der Ordnung über die Grundsätze zur Sicherung guter wissenschaftlicher Praxis an der Heinrich-Heine-Universität Düsseldorf' erstellt worden ist.

Contents

x

List of Tables

List of Figures

1 Introduction

1.1 Information Science and Sustainable Development

Addressing the concept of sustainable development is not a novel idea among the Information Science community. In 1995, Spink (1995a, 1995b) recognized challenges like global population growth and environmental degradation as issues within the scope of responsibility of Information Science. She describes the field as a post-modern discipline driven by the problem of the information explosion, which has gained increasing importance in a period of economic growth and scientific development. But a changing society demands changes in the field of Information Science as well and poses an enormous challenge:

> "The 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" (Spink, 1995b, p. 207).

Information Science is concerned with information and knowledge from different viewpoints. Information can be viewed within a cognitive framework; it is also an important resource for organizations and society. Spink (1999) argues that for each viewpoint, Information Science has to contribute to determining the information resources that a city, region, or society needs for sustainable development:

> "What information resources or technologies can sustain different levels of societies and shifts between different levels of societies? Information science must look beyond the technical to encompass social theory and the societal level issues of sustainable development" (Spink, 1999, para. 22).

Nolin (2010) argues that a decade after Spinks call for a discussion of sustainable development in Information Science, no progress of this new research area is observable. He calls for further research on sustainable development from the Information Science community. Furthermore, he

proposes to distinguish between two subareas: *Information for Sustainable Development* and *Development of Sustainable Information*. Whereas the first area includes

1. the creation of equal access to information for everyone,

2. the adequate gathering and structuring of indicators on sustainable development,

3. the enabling of participation through various media and institutions,

the second idea of a *Development of Sustainable Information* concentrates on technological aspects and sustainable production, distribution, and conservation of information, for example, by developing energy-efficient information technology (Nolin, 2010).

Chowdhury (2013, p. 617) argues that "sustainability should become a mainstream research topic within information studies". However, hitherto little effort is apparent to consolidate sustainability and sustainable development in Information Science. There are some niches in which environmental sustainability has found its rightful place, for example, in research on green libraries or green Information and Communication Technology (ICT). Beyond that, a holistic view on sustainable development from an Information Science perspective is still missing. "[R]esearch within information science has been scattered among the various dimensions of sustainable development, very rarely dealing with the core concept itself" (Nolin, 2010, para. 49).

With this thesis, I am contributing to embedding sustainable development as a research topic within the field of Information Science. Thereby, I will concentrate on Nolin's definition of *Information for Sustainable Development*. To begin with, the following section 1.2 defines sustainable development and elaborates on the historical evolution of the concept. In section 1.3, I will concentrate on urban governance for sustainable development, which constitutes the focus of this thesis. Derived from the theoretical background, section 1.4 presents the research questions for this work and, in section 1.5, the remaining chapters of this thesis are outlined.

1.2   Defining Sustainable Development

Today, the most common definition of sustainable development quotes the 'Brundtland report' entitled 'Our Common Future'. It was published in 1987 by the World Commission on Environment and Development (WCED), at that time being chaired by the former Norwegian Prime

Minister Gro Harlem Brundtland. The aim of the commission and the Brundtland report was to strengthen united global efforts towards sustainable development. Therein, sustainable development is defined as a "development that meets the needs of the present without compromising the ability of future generations to meet their own need" (WCED, 1987, p. 37). Thus, this widely adapted definition focuses on the inter-generational idea of sustainable development and entails a strong normative view on development (Sachs, 2015).

Yet, the definition does not define the concrete meaning and scope of development. Today, three main components of sustainable development are determined: economic growth, social development, and environmental protection. This view has been adopted in 2002 during the UN World Summit on Sustainable Development (WSSD) in Johannesburg (Hens & Nath, 2005) and has since then been widely accepted.

Sustainability and sustainable development are frequently equated. However, these concepts are not synonymous. The term sustainability can likewise refer to environmental, economic, or social sustainability and is thus coined by a similar threefold division as the term sustainable development. The difference between the two concepts lies in the corresponding phase of progress. While sustainability is a desired final state, incorporating environmental, economic, and social achievements, we can regard sustainable development as a strategy towards this state, or the "pathway to sustainability" (Circular Ecology, 2019).

In forestry literature, we can find references to sustainability already since the 18th century. The idea was to sustain resources, thus production capacity, and to pass it to future generations. It then took some time until other economic sectors began to adopt the concept of sustainability. In the US, the 'Multiple Use - Sustained Yield Act' of 1960 defined five categories to be sustained: timber, fish and wildlife, outdoor recreation, range and fodder, and watershed protection (Wiersum, 1995).

In 1972, the UN Conference on the Human Environment in Stockholm led to a global operationalization of sustainability by defining principles for environmental protection, human rights, and development. Though, the phrase sustainable development has not been used therein (Sachs, 2015). In the 'World Conservation Strategy' published in 1980 by the International Union for Conservation of Nature (IUCN, 1980), we can find the first official use of the concept of sustainable development, which the Brundtland report picked up and popularized.

Since then, several initiatives embedded sustainable development in their agendas. Above all, the United Nations, as an intergovernmental organization, plays a significant role in promoting global sustainable development. In 2000, the UN initiated an action plan to eradicate extreme poverty, providing universal primary education, and ensuring environmental sustainability by 2015 - the Millennium Development Goals (MDGs). In total, eight goals address different dimensions of sustainable development (United Nations, 2015b).

With the expiring date in 2015, the UN adopted the Sustainable Development Goals (SDGs) as the successor of the MDGs within the Agenda 2030 (United Nations, 2015c). The number of goals increased to 17, depicted in Figure 1.1. The new set of goals acknowledges that the aim of combining economic growth with social inclusion and environmental protection has not been met yet, especially with a globally growing population. Besides, the SDGs are intended to be action-oriented and universally applicable to every country of the world. Unlike in the MDGs, rich countries do not only serve as supporters of developing countries in striving for development but have to endeavor to achieve sustainable development themselves. For this purpose, the 17 goals entail 169 more concrete targets that can differ due to national circumstances. Countries commit themselves to report on their progress towards the SDGs on the base of agreed-upon indicators (Sachs, 2015).

Figure 1.1: Sustainable Development Goals (United Nations, 2015c)

The SDGs are the most recent, global action plan on sustainable development and address several current challenges. To achieve sustainable development, Sachs (2015) argues that we need a sixth Kondratieff of technological change - a wave of sustainable technologies. Mainka (2018) supports the idea of a sixth Kondratieff resulting in a smart society that includes sustainability and empowered citizens. The Kondratieff waves describe phases in economic life (Kondratieff, 1935). Each wave consists of intervals alternating between advancement and economic crisis, dating back to the Industrial Revolution. Mostly, five waves are distinguished, marked by different innovations: (1) steam engine, textile industry; (2) railway, steel; (3) electrification, chemicals; (4) automobiles, petrochemicals, and (5) information technology (Nefiodow & Nefiodow, 2014).

Besides technological change, Sachs (2015, p. 3) also adds a fourth dimension to sustainable development, which he regards as essential: "To achieve the economic, social, and environmental objectives of the SDGs, a fourth objective must also be achieved: good governance". The demand for a sixth Kondratieff of sustainable technologies goes in line with Nolin's notion of *Development of Sustainable Information*. In contrast, the call for good governance supports the idea of *Information for Sustainable Development*. In this thesis, I will hence concentrate on different actors and instruments of governance for sustainable development, described in the following section.

1.3 Urban Governance for Sustainable Development

Governance describes processes that go beyond established political top-down approaches of governing a country, a district, or a municipality. These processes hence do not only include governments but also companies and civil society (Meadowcroft, 2004). In this context, participation in decision-making processes plays an increasing role (McDermott, 2010). When concentrating on governance for sustainable development, the same principles apply "because it aims at pro-active changes of individual actors' and firms' behaviours at different levels. By necessity, it must involve lower levels of policy-making and those actors in policy formulation and implementation" (Bleischwitz, 2003, p. 5). Furthermore, "[s]ustainable development has been identified as an important area of focus for business leaders, governments, universities, non-government organisations (NGOs) and the media" (Annan-Diab & Molinari, 2017, p. 73). Similarly, governance for sustainable development has grown immensely in the past years, and several national sustainable development strategies were adopted (Quental, Lourenço, & Da Silva, 2011).

Governance for sustainable development is of particular importance at the city level. More than half of the world's population is living in cities. The UN further estimates that by 2050 the number of urban residents will grow even more to 68 percent (United Nations, 2019). "Prosperous, healthy, and resilient cities are going to be a core challenge of sustainable development" (Sachs, 2015, p. 55). Before the release of the SDGs, urbanists and economists called for a city-specific SDG. Richard Florida even argued that cities should be at the core of the goals. "It is cities, not nations, that are the fundamental economic, political, and social organizing units of our time" (Florida, 2014, para. 6). For this reason, the SDGs also entail an "Urban Sustainable Development Goal (USDG)" (Klopp & Petretta, 2017) - SDG 11 entitled "sustainable cities and communities". During the third UN Conference on Housing (Habitat III) in 2016, the new Urban Agenda was adopted, which provides a guideline for future urban development. In particular, it refers to SDG 11, and thus further highlights the role of cities for sustainable development (United Nations, 2016a). On the one hand, cities are responsible for several problems related to sustainable development; for example, they are the main contributors to carbon dioxide. On the other hand, urban policies can provide opportunities to face such challenges.

Urban governance for sustainable development involves different actors at the local level and can be implemented by various instruments and tools. Combining these with the parts of *Information for Sustainable Development* according to Nolin (2010), i.e. (1) the creation of equal access to information for everyone, (2) the adequate gathering and structuring of indicators on sustainable development, (3) the enabling of participation through various media and institutions, I will consider three main elements of urban governance for sustainable development in this thesis: information dissemination, open data, and citizen participation.

1.3.1 Information Dissemination

The idea of creating equal access to information for everyone is a central task of Information Science. "After all, organising knowledge and retrieving information and communicating it to people, to users, are all subjects, that can be described as core aspects of the field" (Haider, 2014, p. 80). Information, knowledge, and education are essential for development. Chowdhury and Koya (2017) performed an analysis of four key UN policy documents on sustainable development (including the SDGs with the Agenda 2030) and the stated significance of information-related

concepts embedded in these. In all four documents, information access and information sharing were considered as the most appearing concepts, followed by building databases, information skills, and scientific/research information.

In urban areas, different actors disseminate information concerning sustainable development in general, and the SDGs in particular. Today, many cities transform into smart cities or informational cities, i.e., prototypical cities of the knowledge society (Stock, 2011). A smart city can be conceptualized "as an icon of a sustainable and livable city" (Chourabi et al., 2012, p. 2289). According to Corbett and Mellouli (2017), smart sustainable cities can contribute to the SDGs by an integrated information ecosystem. Thereby, an improvement of aspects like participation, equity, and mobility can be achieved (Bibri & Krogstie, 2017). Politics and administration in the form of e-governance and e-government are building blocks in this process (Barth et al., 2017). For example, through official websites, a city can disseminate information and encourage transparency. But not only websites are an essential tool for disseminating information, mobile applications are also a further possibility to convey information by governmental agencies, leading to m-government. Through enabling location-based services, citizens can get immediate access to several specific government information (Carroll & Ganoe, 2009).

Another important actor providing information access for a wide range of citizens is the public library, which is usually open for everyone. Public libraries all over the world offer places to enhancing awareness and conveying information on sustainability by providing resources and learning tools (Miller, 2010). Libraries further contribute to teaching information literacy skills (Forsyth, 2005; Henkel, 2015; Henkel & Stock, 2016), which can enhance sustainability in manifold ways, e.g., by supporting more informed decisions on environmental issues (Kurbanoğlu & Boustany, 2014). Libraries are part of an information provision system and meet educational expectations (Marcum, 2009). The UN Agenda 2030 (United Nations, 2015d) also addresses libraries as educational institutions and encourages them to make a valuable contribution to achieving the SDGs.

1.3.2   Open Data

Besides disseminating information on sustainable development, assessing the progress individual countries, regions, or municipalities make towards sustainability is an ongoing challenge. To

measure the progress on the targets of the SDGs, the Inter-agency and Expert Group on SDG Indicators (IAEG-SDGs) developed a global indicator framework. They classified each indicator into three tiers depending on the methodological performance and availability of data (United Nations Statistics Division, 2017). Currently, more than 200 indicators exist to determine the progress towards achieving the goals, but the list is continuously reviewed and revised. Besides defining what to measure within the framework, it is essential to figure out how to measure it (Hák, Janoušková, & Moldan, 2016). A crucial aspect of defining the current status concerning the targets is the availability of sufficient information. Klopp and Petretta (2017) argue that an ongoing challenge for the SDGs is the limited availability of public urban data. Open data, i.e., data that is machine-readable, as well as available and reusable by everyone, can be a useful tool for the adequate gathering of indicators on sustainable development.

Open data further plays a growing role in urban governance. Citizens are increasingly aware of the environment they live in and want to participate in its shaping (Chiesura, 2004). ICT can act as a facilitator of social participation and can contribute to empowering citizens through collecting, processing, and presenting the information contained in open datasets (Lusa, Dos Santos Rabello, & Cervi, 2015). Open data can thereby be present in the form of official statistics, sensor-based data, and user-generated content (López-de Ipiña, Vanhecke, Peña, De Nies, & Mannens, 2013). Opening datasets at the city level can also contribute to innovations and value-added city services (Ojo, Curry, & Zeleti, 2015) and thus facilitate sustainable development. For example, real-time data from sensors can monitor the air quality and thereby enhance awareness on environmental issues in the city.

1.3.3   Citizen Participation

Democratic governance is not limited to top-down concepts, but also entails bottom-up approaches of including citizens into decisions and policy-making, thus fostering transparency, participation, and collaboration (McDermott, 2010). Similarly, the process of adopting sustainable development strategies should include the involvement of different stakeholders (Meadowcroft, 2007). The SDGs emphasize the role of participation with target 16.7 to "ensure responsive, inclusive, participatory and representative decision-making at all levels" (United Nations, 2015a). Interestingly, citizens have also been involved in the process of developing the SDGs (Fox &

Stoett, 2016). Besides, according to Sriskandarajah (2018, p. 302), the goals "will not be achieved without significant public awareness and engagement".

Participation processes can result in further advantages on the part of the citizens, such as achieving education and democratic skills, and to some extend, gaining control over the policy process. Governments may benefit by learning from the citizens; by building trust and making better-informed decisions (Irving & Stransbury, 2004). Local governments can improve sustainable development initiatives by collaborating with citizens (Hawkins & Wang, 2012). According to Meadowcroft (2004), citizen participation is of particular importance for sustainable development as the concept is normatively charged and represents a changing society with increasing social and environmental interactions.

Citizen participation cannot only be a useful tool for developing sustainable development strategies, but also for creating meaningful applications concerning sustainability. Some municipalities host hackathons (hacker marathons) and invite citizens and further stakeholders to work together on innovative apps (Baraniuk, 2013; Briscoe & Mulligan, 2014; DiFranzo et al., 2011). Often, the output of these events are mobile applications to solve urban problems.

1.4 Research Questions

Based on the theoretical considerations elucidated above, the following research questions will form the foundation of this thesis:

	Information Science and Sustainable Development
RQ 1	What is the current status of Information Science research on sustainable development?

	Information Dissemination
RQ 2.a	What channels are appropriate for local governments to disseminating information regarding sustainable development?
RQ 2.b	To what extend and in which way can public libraries disseminate information regarding sustainable development?

Open Data

RQ 3.a	To what extend can open urban data be applied for measuring progress on local sustainable development?
RQ 3.b	To what extend can open urban data be applied to fostering citizen services concerning sustainable development?

Citizen Participation

RQ 4.a	How can citizen participation be applied to developing citizen services concerning sustainable urban development?
RQ 4.b	In what ways does citizen participation contribute to fostering sustainable urban development?

For answering these research questions, eight research articles are building the core of this thesis. The following section will give an outline of these.

1.5   Synopsis

The following chapters comprise eight articles (Chapter 2-9). The thesis starts with two journal articles (Chapter 2 and Chapter 3) prefacing the concept of sustainable development in the context of scientific research in general as well as Library and Information Science (LIS) in particular. While Chapter 2 provides a broad and quantitative overview of research from multiple disciplines addressing the SDGs, Chapter 3 allows a more specific view on sustainable development research from an Information Science perspective.

Chapter 2 presents a bibliometric overview of scientific articles addressing the SDGs directly in their title, keywords, or abstract. For this purpose, 4,593 research articles from the scientific databases Web of Science and Scopus published between 2015 and 2019 were assessed by bibliometric means. With goal 17, the SDGs stress the importance of partnerships. International, as well as interdisciplinary collaboration, is today regarded as crucial for achieving progress on the goals. The article hence assesses the current state of existing research on the 17 goals. The analysis includes the corresponding sources, research areas, affiliated countries, thematic foci, and

the availability of funding acknowledgments. The results suggest that most research addressing the SDGs is located in the research areas Life Sciences & Biomedicine and Social Sciences. The most predominant SDG addressed by the analyzed research articles is SDG 3, focusing on "good health and well-being", whereas variations can be detected by research from authors affiliated in different countries. Nearly 37% of all articles are considered as international publications, i.e., as being co-authored by authors from affiliations of multiple countries. Transnational collaboration can hence still be expanded. Furthermore, a relatively high share of open access articles contributes to the idea of general knowledge sharing for the SDGs. The original article has been published in the journal *Sustainability*:

Meschede, C. (2020). The Sustainable Development Goals in Scientific Literature: A Bibliometric Overview at the Meta-Level. *Sustainability, 12*(11), 1-14, `https://doi.org/10.3390/su12114461`.

Chapter 3 completes the overview of sustainable development in scientific research by examining the topic from a Library and Information Science (LIS) perspective with a systematic literature review. The article attempts a mapping of publications in LIS directly dealing with sustainability and sustainable development and thus helps to identify existing topics and research foci. For this purpose, 102 LIS journals and conferences listed by the SCImago Journal Rank (SJR) were considered. We identified 81 publications dealing with sustainability and sustainable development. All articles were read and coded concerning the main topic, applied methods, and addressed countries. The results show that a large proportion of articles are dealing with sustainable development and libraries. Other publications focus on information and communication technology or information systems. Some articles are addressing further topics like governments, open data, information dissemination, urban development or scientific output. The article presented in Chapter 3 has been published in *Journal of Documentation*:

Meschede, C., & Henkel, M. (2019). Library and Information Science and Sustainable Development: A Structured Literature Review. *Journal of Documentation, 75*(6), 1356-1369. `https://doi.org/10.1108/JD-02-2019-0021`

The following chapters concentrate on sustainable development and the SDGs from different perspectives. These perspectives are strongly linked to the topics revealed in the literature review presented in Chapter 3. The role of information dissemination by local governments is stressed in

Chapter 4. The article deals with information on the SDGs published on the official websites of 15 German cities. As the Association of German Cities recommended an official commitment to the SDGs of all cities, it is investigated which cities report about their commitment to the SDGs on their official websites. Besides, thematic foci of information concerning the 17 goals published on these websites and the role of partnerships and citizen participation, as stated by the cities, are analyzed. For this purpose, a content analysis of the official websites was conducted. The results show that the SDGs found their way into several German cities and their corresponding governmental websites. The most prevalent topics linked to the 17 goals are education, climate protection, fair trade, energy, and mobility. The cities have different strategies in informing about the goals, and most cities emphasize the role of citizen participation and partnerships on their websites. The article has been published in *Aslib Journal of Information Management*:

Meschede, C. (2019). Information Dissemination Related to the Sustainable Development Goals on German Local Governmental Websites. *Aslib Journal of Information Management, 71*(3), 440-455. `https://doi.org/10.1108/AJIM-08-2018-0195`

Cities do not only disseminate information via their official website but also via mobile applications. Chapter 5 hence deals with mobile applications based on open urban data. For the article, we analyzed 471 apps of 24 metropolitan regions all over the world. We developed a typology of these applications, including embedded topics and features, available operating systems, and types of developers. The detected topics captured by the typology are strongly related to the SDGs. For example, 90 of the 471 applications address public transportation, while an expansion of public transport is embedded in SDG 11 (sustainable cities and communities). SDG 4 (quality education) is linked to apps providing educational elements concerning schools and universities (27 apps) or the corresponding city (73 apps). Moreover, several apps address health information (23 apps) or provide health advice (19 apps), which can be connected to SDG 3 (good health and well-being). Some further apps provide information on public safety (15 apps), which is linked to SDG 16 (peace, justice and strong institutions). The article has been presented at the *iConference 2015* and has been published in the corresponding conference proceedings:

Mainka, A., Hartmann, S., Meschede, C., & Stock, W. G. (2015). Mobile Application Services Based Upon Open Urban Government Data. In *iConference 2015 Proceedings, Newport Beach, CA March 24-27, 2015* (pp. 1-15). Urbana, IL: IDEALS.

To actively promote the development of mobile applications based on government data, some cities host hackathons (hacker marathons). Chapter 6 reports on an investigation about the open urban government data and hackathon movement and thus builds on the previous Chapter 5. The article presents challenges, like legal or political issues, that prevent municipalities from opening datasets and the relevance of these challenges in three exemplary European cities. Besides the challenges of opening datasets, we analyzed the interaction of open data and hackathons. Some cities host competitions to develop applications based on open datasets, which create added value for citizens. In addition to using existing datasets, creating open data by oneself has an enormous potential to foster citizen participation. At the city level, several initiatives contribute to enhancing participation and similarly to providing information on sustainable development. For example, some citizens collaboratively build particulate matter sensors on their own for measuring the air quality in their city. The article presented in Chapter 6 has originally been published as a book chapter:

Mainka, A., Hartmann, S., Meschede, C., & Stock, W. G. (2015). Open Government: Transforming Data into Value-added City Services. In M. Foth, M. Brynskov, & T. Ojala (Eds.), *Citizen's Right to the Digital City. Urban Interfaces, Activism, and Placemaking* (pp. 199-214). Singapore: Springer.

Apart from disseminating information on sustainable development, it is also important to measure progress towards the SDGs. The crucial point is the availability of sufficient, comparable information. Hence, open urban data can play a key role in measuring the progress on the city level. Several measurement tools assess the coverage of open data. In this article, we propose the use of open government data to make the achievement of SDGs measurable easily and transparently. For this purpose, a mapping of the open data categories to the SDGs is presented. Furthermore, we argue that the SDGs need to be tackled, particularly at the city level. To analyze the current applicability of open data for measuring progress on the SDGs, we provide a case study on German open data portals and the embedded data categories and datasets. The results suggest that further standardization is needed to be able to use open data for comparing cities and their progress towards the SDGs. The original article has been presented on the *20th Annual International Conference on Digital Government Research* and has been published in the corresponding conference proceedings:

Meschede, C., & Siebenlist, T. (2019). Open Urban Data and the Sustainable Development Goals. In *Proceedings of the 20th Annual International Conference on Digital Government Research, June 18-20, 2019, Dubai, UAE.* New York, NY: ACM.

Citizen participation is not limited to hackathons and the processing of open datasets. Some cities count on further citizen participation formats for developing their sustainable development strategies. Since the publication of the SDGs, several national, regional, and local sustainable development strategies have been adopted. A sustainable development strategy can serve as a political control instrument and management tool. Chapter 8 reports on a case study of the pilot project "Global Sustainable Municipalities". The goal was to assess the current status of the use of citizen participation formats for adopting a local sustainable development strategy, as there exist manifold ways of consulting civil society. Moreover, the chapter presents a model of citizen participation approaches during different phases of adopting a sustainable development strategy and assesses the corresponding levels of decision-making power on the part of partic-ipating citizens. The results show that most municipalities count on participation mainly in the implementation phase of the strategy, less during its development. Most approaches aim at sharing information on the sustainable development strategy with the broad public. Several mu-nicipalities include citizen participation as a goal itself in their sustainable development strategy. This approach is in line with SDG 16 and its target 16.7 to ensure inclusive, participatory, and representative decision-making at all levels. These results show that municipalities are aware of the significance of including civil society into decision-making and sustainable development. The corresponding article of Chapter 8 has been published in *Journal of Urban Science*:

Meschede, C., & Mainka, A. (2020). Including Citizen Participation Formats for Drafting and Implementing Local Sustainable Development Strategies. *Journal of Urban Science, 4*(1), 1-19. `https://doi.org/10.3390/urbansci4010013`

Urban governance for sustainable development includes several actors and institutions. Public libraries, as a part of the municipal government, provide information and education for everyone and promote universal literacy. Thereby, libraries mainly contribute to SDG 4 (quality educa-tion). Through delivering books and other media on specific topics, public libraries can further contribute to conveying information on diverse issues concerning sustainable development. Chap-ter 9 reports on a study about public libraries acting as promoters of environmental sustainability

through providing media, tools, and organizing events. We analyzed German public libraries by assessing the libraries' collection as well as creating a questionnaire, asking librarians to evaluate the current situation in their library. The results show that many libraries promote environmental sustainability by highlighting books and other media on several subtopics through special conventions or shelves. Energy meters were the most frequently mentioned tools provided to sensitize to the topic. Furthermore, libraries organize several information events. Therefore, partnerships with other organizations and schools are of utmost importance, which supports SDG 17 (partnerships for the goals). Hence, public libraries, as places accessible for every citizen, have the potential to raise awareness on topics like environmental sustainability and can act as essential partnering institutions for the SDGs. The original article on libraries as promoters of environmental sustainability has been published in *Journal of the International Federation of Library Associations and Institutions*:

Beutelspacher, L., & Meschede, C. (2020). Libraries as Promoters of Environmental Sustainability. Collections, Tools and Events. *IFLA Journal* (online first). `https://doi.org/10.1177/0340035220912513`

References

Annan-Diab, F., & Molinari, C. (2017). Interdisciplinarity: Practical Approach to Advancing Education for Sustainability and for the Sustainable Development Goals. *International Journal of Management Education*, *15*(2), 73–83. doi: 10.1016/j.ijme.2017.03.006

Baraniuk, C. (2013). The Civic Hackers Reshaping Your Government. *New Scientist*, *218*(2923), 36–39. doi: 10.1016/S0262-4079(13)61625-5

Barth, J., Fietkiewicz, K. J., Mainka, A., Gremm, J., Meschede, C., Hartmann, S., & Stock, W. G. (2017). Informational Urbanism. A Conceptual Framework of Smart Cities. In *Proceedings of the 50th Hawaii International Conference on System Sciences, HICSS 2017, Waikoloa, HI, January 4-7, 2017* (pp. 2814–2823). Washington, DC: IEEE Computer Society.

Bibri, S. E., & Krogstie, J. (2017). Smart Sustainable Cities of the Future: An Extensive Interdisciplinary Literature Review. *Sustainable Cities and Society*, *31*, 183–212. doi: 10.1016/j.scs.2017.02.016

Bleischwitz, R. (2003). Governance of Sustainable Development. Towards Synergies between Corporate and Political Governance Strategies. *Wuppertal Papers*(132), 1–39. Retrieved from `https://ideas.repec.org/p/zbw/wuppap/132.html`

Briscoe, G., & Mulligan, C. (2014). *Digital Innovation: The Hackathon Phenomenon.* London, UK: Creative Works London.

Carroll, J. M., & Ganoe, C. H. (2009). Supporting Community with Location-sensitive Mobile Applications. In M. Foth (Ed.), *Handbook of Research on Urban Informatics: The Practice and Promise of the Real-Time City* (pp. 339–352). Hershey, PA: IGI Global.

Chiesura, A. (2004). The Role of Urban Parks for the Sustainable City. *Landscape and Urban Planning*, *68*(1), 129–138. doi: 10.1016/j.landurbplan.2003.08.003

Chourabi, H., Nam, T., Walker, S., Gil-Garcia, J. R., Mellouli, S., Nahon, K., . . . Scholl, H. J. (2012). Understanding Smart Cities: An Integrative Framework. In *Proceedings of the 45th Hawaii International Conference on System Sciences, HICSS 2012, Wailea, HI, January 7-10, 2012* (pp. 2289–2297). Washington, DC: IEEE Computer Society.

Chowdhury, G. (2013). Sustainability of Digital Information Services. *Journal of Documentation*, *69*(5), 602–622. doi: 10.1108/JD-08-2012-0104

Chowdhury, G., & 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), 2128–2138. doi: 10.1002/asi.23825

Circular Ecology. (2019). *Sustainability and Sustainable Development Guide.* Retrieved July 23, 2019, from `http://www.circularecology.com/sustainability-and-sustainable -development.html`

Corbett, J., & Mellouli, S. (2017). Winning the SDG Battle in Cities: How an Integrated Information Ecosystem Can Contribute to the Achievement of the 2030 Sustainable Development Goals. *Information Systems Journal*, *27*(4), 427–461. doi: 10.1111/isj.12138

DiFranzo, D., Graves, A., Erickson, J. S., Ding, L., Michaelis, J., Lebo, T., & Hendler, J. (2011). The Web is My Back-end: Creating Mashups With Linked Open Government Data. In D. Wood (Ed.), *Linking Government Data* (pp. 205–219). New York, NY: Springer Science + Business Media.

Florida, R. (2014). *11 Reasons the UN Should Make Cities the Focus of Its Forthcoming Sustainable Development Goals.* Retrieved April 4, 2020, from

```
https://www.citylab.com/life/2014/04/11-reasons-un-should-make-cities-focus
-its-new-sustainable-development-goals/8896/
```

Forsyth, E. (2005). Public Libraries and the Millennium Development Goals. *The IFLA Journal*, *31*(4), 315–323. doi: 10.1177/0340035205061389

Fox, O., & Stoett, P. (2016). Citizen Participation in UN Sustainable Development Goals. *Global Governance*, *22*(4), 555–574. doi: 10.1163/19426720-02204007

Haider, J. (2014). How Library and Information Science Can Save the World and Why to Care. *LIBREAS. Library Ideas*, *25*, 80–91. doi: 10.18452/9065

Hák, T., Janoušková, S., & Moldan, B. (2016). Sustainable Development Goals: A Need for Relevant Indicators. *Ecological Indicators*, *60*, 565–573. doi: 10.1016/j.ecolind.2015.08.003

Hawkins, C. V., & Wang, X. H. (2012). Sustainable Development Governance: Citizen Participation and Support Networks in Local Sustainability Initiatives. *Public Works Management and Policy*, *17*(1), 7–29. doi: 10.1177/1087724X11429045

Henkel, M. (2015). Educators of the Information Society: Information Literacy Instruction in Canadian Informational Cities. *Journal of Systemics, Cybernetics and Informatics*, *13*(3), 22–27.

Henkel, M., & Stock, W. G. (2016). "We have big plans." - Information Literacy Instruction in Academic and Public Libraries in the United States of America. In *Proceedings of the 2nd International Conference on Library and Information Science, July 12-14, 2016, Kyoto, Japan* (p. 159-175). Taipeh, Taiwan: International Business Academics Consortium.

Hens, L., & Nath, B. (2005). *The World Summit on Sustainable Development. The Johannesburg Conference.* Dordrecht, Netherlands: Springer.

Irving, R. A., & Stransbury, J. (2004). Citizen Participation in Decision Making: Is It Worth the Effort? *Public Administration Review*, *64*(1), 55–65. doi: 10.1007/s10694-015-0526-6

IUCN. (1980). *World Conservation Strategy - Living Resource Conservation for Sustainable Development.* Gland, Switzerland: IUCN.

Klopp, J. M., & Petretta, D. L. (2017). The Urban Sustainable Development Goal: Indicators, Complexity and the Politics of Measuring Cities. *Cities*, *63*, 92–97. doi: 10.1016/j.cities.2016.12.019

Kondratieff, N. D. (1935). The Long Waves in Economic Life. *The Review of Economic Statistics*, *17*(6), 105–115. doi: 10.2307/1928486

Kurbanoğlu, S., & Boustany, J. (2014). From Green Libraries to Green Information Literacy. In S. Kurbanoğlu, S. Špiranec, E. Grassian, D. Mizrachi, & R. Catts (Eds.), *Information Literacy. Lifelong Learning and Digital Citizenship in the 21st Century. Proceedings of the 2nd European Conference on Information Literacy, ECIL 2014, Dubrovnik, Croatia, October 20-23, 2014* (pp. 47–58). Basel, Switzerland: Springer Nature.

López-de Ipiña, D., Vanhecke, S., Peña, O., De Nies, T., & Mannens, E. (2013). Citizen-Centric Linked Data Apps for Smart Cities. In *Ubiquitous Computing and Ambient Intelligence. Context-Awareness and Context-Driven Interaction. Proceedings of the 7th International Conference, UCAmI 2013, Carrillo, Costa Rica, December 2-6, 2013* (Vol. 8276, pp. 70–77). Berlin/Heidelberg, Germany: Springer LNCS, volume 8276.

Lusa, D. A., Dos Santos Rabello, R., & Cervi, C. R. (2015). Open Smart City View - An Architecture for Open Government Data Manipulation and Presentation at City Level. In *Proceedings of the 14th International Conference on WWW/INTERNET 2015, Maynooth, Ireland, October 24-26, 2015* (pp. 119–126). Maynooth, Ireland: IADIS.

Mainka, A. (2018). *Smart World Cities in the 21st century.* Berlin/Boston: De Gruyter Saur.

Marcum, J. W. (2009, 5). Design for Sustainability. *The Bottom Line*, *22*(1), 9–12. doi: 10.1108/08880450910955378

McDermott, P. (2010). Building Open Government. *Government Information Quarterly*, *27*(4), 401–413. doi: 10.1016/j.giq.2010.07.002

Meadowcroft, J. (2004). Participation and Sustainable Development: Modes of Citizen, Community and Organisational Involvement. In W. Lafferty (Ed.), *Governance for Sustainable Development: The Challenge of Adapting Form to Function* (pp. 162–190). Cheltenhan, UK; Northampton, MA: Edward Elgar.

Meadowcroft, J. (2007). National Sustainable Development Strategies: Features, Challenges and Reflexivity. *European Environment*, *17*(3), 152–163. doi: 10.1002/eet.450

Miller, K. (2010). *Public Libraries Going Green.* Chicago, IL: American Library Association.

Nefiodow, L., & Nefiodow, S. (2014). *The Sixth Kondratieff. The New Long Wave in Global Economy.* North Charleston, SC: CreateSpace Intependent Publishing.

Nolin, J. (2010). Sustainable Information and Information Science. *Information Research - An International Electronic Journal*, *15*(2), paper 431. Retrieved from `http://informationr.net/ir/15-2/paper431.html`

Ojo, A., Curry, E., & Zeleti, F. A. (2015). A Tale of Open Data Innovations in Five Smart Cities. In *Proceedings of the 48th Hawaii International Conference on System Sciences, HICSS 2015, Kauai, HI, January 5-8, 2015* (pp. 2326–2335). Washington, DC: IEEE Computer Society.

Quental, N., Lourenço, J. M., & Da Silva, F. N. (2011). Sustainable Development Policy: Goals, Targets and Political Cycles. *Sustainable Development*, *19*(1), 15–29. doi: 10.1002/sd.416

Sachs, J. D. (2015). *The Age of Sustainable Development.* New York, NY; Chichester, UK: Columbia University Press.

Spink, A. (1995a). Digital Libraries and Sustainable Development? In *Proceedings of Digital Libraries, DL '95, Austin, TX, June 11-13, 1995* (pp. 1–7). College Station, TX: Tamu.

Spink, A. (1995b). Information and a Sustainable Future. *Libri*, *45*(3-4), 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), 1–9. Retrieved from `http://informationr.net/ir/5-1/paper65.html`

Sriskandarajah, D. (2018). A People's Agenda: Citizen Participation and the SDGs. In R. Desai, H. Kato, H. Kharas, & J. McArthur (Eds.), *From Summits to Solutions: Innovations in Implementing the Sustainable Development Goals* (pp. 302–317). Washington, DC: Brookings Institution Press.

Stock, W. G. (2011). Informational Cities: Analysis and Construction of Cities in the Knowledge Society. *Journal of the American Society for Information Science and Technology*, *62*(5), 963–986. doi: 10.1002/asi.21506

United Nations. (2015a). *Goal 16: Promote Just, Peaceful and Inclusive Societies.* Retrieved October 13, 2019, from `https://www.un.org/sustainabledevelopment/peace-justice/`

United Nations. (2015b). *Millennium Development Goals.* Retrieved April 4, 2020, from `https://www.un.org/millenniumgoals/`

United Nations. (2015c). *Sustainable Development Goals.* Retrieved January 5, 2018, from `http://www.un.org/sustainabledevelopment/sustainable-development-goals/`

United Nations. (2015d). *Transforming Our World: The 2030 Agenda for Sustainable Development.* Retrieved January 8, 2019, from `https://sustainabledevelopment.un.org/content/documents/21252030AgendaforSustainableDevelopmentweb.pdf`

United Nations. (2016). *The New Urban Agenda.* Retrieved March 3, 2020, from `http://habitat3.org/the-new-urban-agenda`

United Nations. (2019). *World Urbanization Prospects: The 2018 Revision.* New York, NY: United Nations. Retrieved August 1, 2018, from `https://population.un.org/wup/Publications/Files/WUP2018-Report.pdf`

United Nations Statistics Division. (2017). *IAEG-SDGs. Inter-Agency Expert Group on SDG Indicators.* Retrieved October 1, 2018, from `https://unstats.un.org/sdgs/iaeg-sdgs/`

WCED. (1987). *Report on the World Commission on Environment and Development. Our Common Future.* Oxford, UK: Oxford University Press. Retrieved August 5, 2018, from `http://www.un-documents.net/our-common-future.pdf`

Wiersum, K. F. (1995). 200 Years of Sustainability in Forestry: Lessons from History. *Environmental Management*, *19*(3), 321–329. doi: 10.1007/BF02471975

2 The Sustainable Development Goals in Scientific Literature: A Bibliometric Overview at the Meta-Level

2.1 Introduction

In 2015, the United Nations adopted 17 Sustainable Development Goals (SDGs) within the Agenda 2030, thus making an attempt towards ending poverty, protecting the planet and ensuring prosperity for all (United Nations, 2015c). With these goals the United Nations aim at promoting sustainable development regarding all its manifestations, i.e., environmental, economic, and social dimensions (Table 2.1). The most common definition of sustainable development describes it 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). Rather than focusing on development in developing countries, the Agenda 2030 demands action of all countries. Each goal is further substantiated in concrete targets and corresponding measurable indicators, summing up to 169 targets and more than 200 indicators which can be modified among different countries, regions, or municipalities. SDG 17, "Partnerships for the goals" can be regarded as a meta-goal for implementing the SDGs. Global partnerships as well as international and transnational research are essential for contributing to a sustainable development (Leal Filho et al., 2018; Salvia, Leal Filho, Brandli, & Griebeler, 2019). Several initiatives support collaboration on sustainable development in general and the SDGs in particular. For example, the *Partnerships for SDGs online platform* (`https://sustainabledevelopment.un.org/partnerships/`) provides a registry for sharing knowledge and expertise for the SDGs among different stakeholders. Besides international cooperation, the SDGs cannot be achieved without multi- and interdisciplinary research due to its complexity. "The success of the SDGs is directly related to the strengthened collaboration of its actors. In this sense, the scientific community helps in the translation of the global goals into practical national and local levels agendas" (Salvia et al., 2019, p. 843). The Aurora Universities Network coordinates an initiative to map research output to the SDGs. Within a survey, researchers were requested to assign their research to the SDGs (`https://aurora-network.global/project/sdg-analysis-bibliometrics-relevance/`), which helps in identifying collaborators and relevant research output.

Table 2.1: UN Sustainable Development Goals (United Nations, 2015c)

SDG	Title
1	No poverty
2	Zero hunger
3	Good health and well-being
4	Quality education
5	Gender equality
6	Clean water and sanitation
7	Affordable and clean energy
8	Decent work and economic growth
9	Industry, innovation and infrastructure
10	Reduced inequalities
11	Sustainable cities and communities
12	Responsible consumption and production
13	Climate action
14	Life below water
15	Life on land
16	Peace, justice and strong institutions
17	Partnerships for the goals

Research which supports the SDGs can assume different forms. In particular, two forms can be distinguished:

1. Research that supports the progress towards particular targets of the SDGs without necessarily referring to the SDGs (e.g., research on poverty alleviation or climate change without reference to its contributions on the SDGs)

2. Research that directly refers to the SDGs (e.g., meta-research that is concerned with the overall political agenda behind the SDGs, or, studies that work towards particular targets but still mention the overall contribution to the SDGs)

This article seeks to assess current research on the SDGs that directly refers to the goals. By doing so, we contribute to the assessment of the current status of research on the SDGs and demonstrate research gaps as well as potential for further collaboration which is essential for achieving progress towards the goals. "If knowledge production occurs along existing disciplinary lines, we risk losing the relationships that are so important to understanding the legitimacy and potential of the SDGs" (Halvorsen, Ibsen, Evans, & Penderis, 2017, p. 5). Making use of existing knowledge and research is an essential prerequisite for producing further knowledge. Mapping existing research on the SDGs can be a first step to achieve this goal considering sustainable

development. Research that directly refers to the SDGs facilitates knowledge sharing on the goals as it is easier to identify relevant work. However, it should be noted that this study only analyzes a comparably small amount of articles at the meta-level, as we focus on articles explicitly mentioning the SDGs. With other queries, further research items relevant to the goals are available, but here the focus is on articles directly addressing them. Thereby comparisons can be made to existing approaches.

Some even argue that a reclassification of academic fields is necessary if the SDGs are taken seriously, whereby academics are required to operate across disciplines (Halvorsen, 2017). Similarly, Education for Sustainable Development (ESD) requires interdisciplinary approaches (Annan-Diab & Molinari, 2017). Cooperation among different countries is another crucial aspect of collaboration that is necessary for achieving progress towards the SDGs, especially when considering the global scope of the goals. For example, North-South collaboration can be beneficial for knowledge sharing; in particular, countries with limited funding possibilities for research can benefit from potential financial resources resulting from collaborations (Mago, 2017).

With this article, we aim at presenting an overview on research directly addressing the SDGs and thus facilitating knowledge sharing among countries and academic fields. The following section will provide relevant literature for this article and the corresponding analysis. After that, the methodological approach is described, followed by a presentation of the results. Finally, the results will be discussed in the last section.

2.2   Literature Review

There are some qualitative as well as quantitative studies examining research regarding sustainable development. In order to assess research trends with regard to the SDGs, Salvia et al. (2019) conducted a survey with 266 experts from different countries. The survey aimed at identifying those SDGs that are addressed by the experts. In North America, the most mentioned goals were - in descending order - SDG 11, 13, 15 and 4, whereas European experts concentrated on SDGs 4, 11, 12 and 13. In contrast, SDGs 13, 4, 11 and 15 were predominant in Asia.

Another approach was used by Körfgen et al. (2018). They also directly addressed the 17 SDGs, but created a complex search string for each of the SDGs using an iterative approach in order to

quantitatively analyze research with regard to each SDG. These search strings were then used to identify relevant publications from 13 Austrian universities in order to assess the focus areas of SDGs related research in Austria. By far the strongest representation among the SDGs is SDG 4 on quality education. Overall, social and economic goals seem to be better represented than environmental goals due to this study.

There are some further quantitative bibliometric studies aiming at mapping research regarding sustainable development in general or the SDGs in particular, especially with regard to the represented countries publishing research on sustainable development. A general bibliometric study on international research regarding sustainable development was performed by Hassan, Haddawy, and Zhu (2014). They used a collection of keyword terms addressing sustainable development and its subareas and performed their query on the Scopus database. Their findings show that overall research on sustainable development is lead by the US in terms of publication numbers and citations. With regard to different subtopics, other countries could be identified as predominant, e.g. climate change (UK), renewable energy (China) or forestry (Finland).

In contrast to the approach of collecting several keyword terms on the subareas of sustainable development, Zhu and Hua (2017) used the phrase "sustainable development" as a search term in the Web of Science (WoS) database and analyzed research from 1987 to 2015 by bibliometric means. They assessed the references, keywords, countries and categories of nearly 60,000 publications. In their study, most journals of the corresponding articles were located in the US, UK or the Netherlands. Again, publications from the US were the most predominant in terms of citations, whereas most publications in the analyzed set were from China. Similarly, Olawumi and Chan (2018) analyzed more than 2,000 articles from 1991-2016 on sustainable development embedded in Web of Science Core Collection. Most journals in their study originated from the US, China, UK and Canada. The main research topics that could be identified were sustainable urban development, sustainable indicators and impact, water management, environmental assessment, strategy, public policy and monitoring, cost-benefit analysis, stakeholders' participation, campus sustainability at universities and human ecology.

In general, most quantitative bibliometric studies concentrate on analyzing documents from one database such as Scopus or WoS. However, the coverage between different databases can differ tremendously (Gavel & Iselid, 2008; Mongeon & Paul-Hus, 2016). When using the WoS Core

Collection, further attention should be drawn to the corresponding institutional subscriptions used for the analysis, because it leads to differences in the resulting hits (W. Liu, 2019). Furthermore, Scopus and WoS show an over-representation of documents from English language journals (Archambault, Vignola-Gagne, Côté, Larivière, & Gingras, 2006; Mongeon & Paul-Hus, 2016; Vera-Baceta, Thelwall, & Kousha, 2019) and seem to introduce biases by favouring research in the Natural Sciences, Engineering and Biomedical Research (Mongeon & Paul-Hus, 2016). Still, these databases remain the main multidisciplinary sources for bibliometric analyses.

The above studies analyzed thematic foci of different countries. When analyzing publication output, international collaboration between the countries is of particular interest. With SDG 17, the importance of partnerships for achieving progress towards the SDGs is stressed. In general, international collaboration in science is growing (Glänzel, 2001; Ribeiro, Rapini, Silva, & Albuquerque, 2018; Wagner, Whetsell, & Leydesdorff, 2017). Some studies analyzed the relation between international collaboration and research impact, whereby a small positive effect of international co-authorship on citations could be detected (Leydesdorff, Bornmann, & Wagner, 2019). International collaboration further seems to be associated with international funding (Morillo, 2019).

Considering these findings, we analyzed more than 4,500 publications from Web of Science Core Collection and Scopus published between 2015 and 2019, assessing corresponding research areas and sources, countries and international collaboration, thematic foci as well as funding acknowledgements. The following section presents the methodological approach.

2.3   Materials and Methods

In order to analyze research directly addressing the SDGs, two multidisciplinary databases were used: Scopus and the Web of Science (WoS) Core Collection. As described above, there are disparities in the amount and type of coverage between these databases, hence we decided to include both databases in our analysis in order to draw a more complete picture. The queries were performed on November 6, 2019 using the search string "Sustainable Development Goals" as a phrase in the fields TOPIC (WoS) respectively TITLE-ABS-KEY (Scopus). The search was narrowed to documents with publication years between 2015-2019 and the document type

'article'. This time span was used because of the adoption year of the SDGs in 2015. Regarding the Web of Science Core Collection, it is important to note which editions are included, due to institutional differences in subscriptions (W. Liu, 2019). The set used in this analysis consists of the following collections and coverage time spans:

- SCI-EXPANDED: Science Citation Index Expanded (1945-present)
- SSCI: Social Sciences Citation Index (1956-present)
- A&HCI: Arts & Humanities Citation Index (1975-present)
- ESCI: Emerging Sources Citation Index (2015-present)

The queries resulted in 3,943 hits in Scopus as well as 3,241 hits in the WoS Core Collection. In each database, all available metadata, abstract, keyword, funding and authors' affiliation information of these documents were downloaded as a CSV-file and processed with the Python programming language. After cleaning the data, duplicates in the databases were identified and mapped. For some fields, further data had to be edited. For example, synonyms were merged (e.g. 'USA', 'United States' and 'US' in the affiliation field) and a thesaurus file was created for the keywords (e.g. sustainable development goal; un sustainable development goals → sustainable development goals). A second thesaurus file was created for mapping the keywords to the SDGs (e.g. health policy → good health and well-being (SDG 3); poverty alleviation → no poverty (SDG 1)). For this purpose, the United Nations' descriptions, including the particular targets and indicators of each goal were used and mapped to the keywords manually.

Each database has its own classification system regarding the corresponding research areas of the articles. For mapping the research areas of the analyzed documents, this article relies on the suggestions of (Vera-Baceta et al., 2019). Five main categories are distinguished, which are based on the classification of the Web of Science Core Collection (Clarivate Analytics, 2018). These categories are:

- Arts & Humanities
- Life Sciences and Biomedicine
- Physical Sciences
- Social Sciences
- Technology

For articles from Scopus, a mapping to these five categories was conducted according to Vera-Baceta et al. (2019), whereas the category "Multidisciplinary" remained unaffected. Each article can be dedicated to several research areas and the assignment is hence not unique. For analyzing international collaboration, we evaluated the affiliation fields in our dataset. Following Glänzel (2001), a research piece can be considered as international, when at least two different countries are represented among the authors' affiliations, while papers with only one affiliation country can be considered as domestic. For assessing existing funding, we used a dichotomous approach, simply marking those articles with existing funding information in Scopus or WoS.

The evaluation of the documents was then performed with Python and its modules *pandas* and *matplotlib*. In some cases, some information was missing for the articles (e.g. no keywords or abstract), so that some analyzes only considered those documents where the corresponding information was given. Network maps were created with VosViewer 1.16.11, which is a freely available tool for visualizing networks from bibliometric data, such as authors, journals, co-citations or keywords (van Eck & Waltman, 2010).

2.4   Results

After mapping duplicates within the hits, 3,934 documents remained for the analysis from the Scopus database, whereas 3,237 documents could be analyzed from WoS. From these, 2,578 could be identified in both databases (Figure 2.1). As a result, 1,356 documents were solely dedicated to Scopus, while 659 articles were only found in WoS. In total, 4,593 documents could be used for the overall analysis.
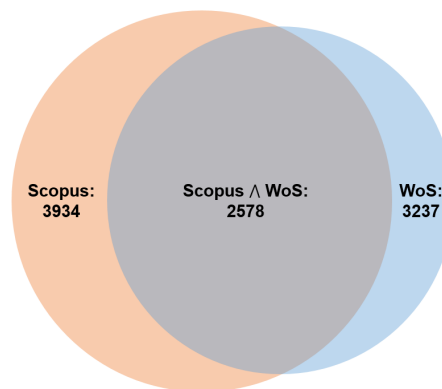
Figure 2.1: Number of articles from 2015-2019 with TOPIC=TITLE-ABS-KEY="Sustainable Development Goals" in the databases Scopus and WoS Core Collection

2.4.1 Sources and Research Areas

In general, research directly addressing the SDGs in the abstract, title or keywords is constantly growing since 2015. This is also true with regard to the different research areas (Figure 2.2). However, differences can be observed in the absolute numbers of research items per discipline. Overall, the most prevalent research area is Life Sciences & Biomedicine (2,261 articles), followed by Social Sciences (1,960 articles) and Technology (850 articles). In comparison, the categories Physical Sciences as well as Arts & Humanities are underrepresented with 121 and 110 articles respectively. Furthermore, 49 articles were classified as Multidisciplinary. Note again, that one article can be dedicated to more than one research are, which is why the sum of the articles in each research area exceeds the number of all documents ($N = 4,593$).

From the 4,593 analyzed documents, 1,330 articles (29%) acknowledge some kind of funding for the research, whereby variations could be detected across the research areas: Life Sciences & Biomedicine report about funding in 38.9% of the articles, Social Sciences in 30.4%, Technology in 34.3%, Arts & Humanities in 19.1% and Physical Sciences in 53.7% of the research items.

The 4,593 analyzed articles were published in 1,667 different sources, whereby *Sustainability* is by far the most occurring journal with 273 published documents. Noticeably, several open access journals such as *Sustainability*, *PLOS ONE* or *BMJ Global Health* are among the sources. In total, nearly 45% of all articles are published under an open access licence.
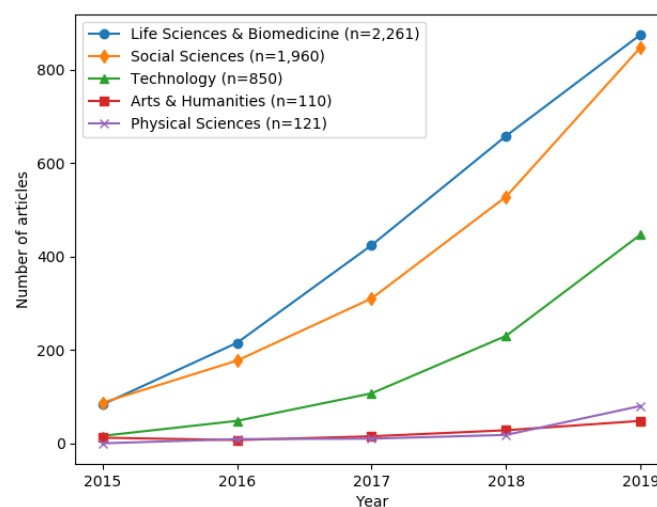
Figure 2.2: Number of articles per research area and year

Figure 2.3 shows the top 15 sources according to the number of articles in descending order. With 863 publications, these 15 journals make up only 0.9% of all sources but account for 18.8% of all articles in our initial set. The degree of inequality becomes apparent when looking at the corresponding Lorenz curve and Gini coefficient ($G = 0.55$) for the sources of the analyzed articles (Figure 2.4). In the Lorenz curve, the cumulative proportion of journals is plotted against the cumulative proportion of the total number of articles and thus the degree of inequality is visualized (Bornmann, Mutz, Neuhaus, & Daniel, 2008). The more the blue curve deviates from the perfect equality line, the less journals do contribute equally to the number of articles published. The Gini coefficient (ranging from 0=perfect equality to 1=complete inequality) summarizes the degree of concentration in one number.
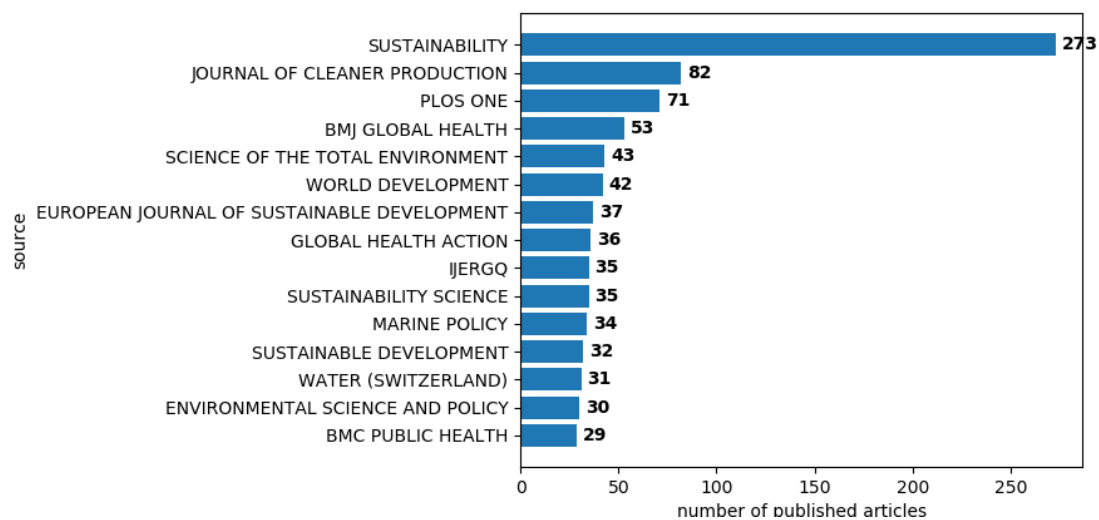
Figure 2.3: Top 15 sources that published articles addressing the SDGs
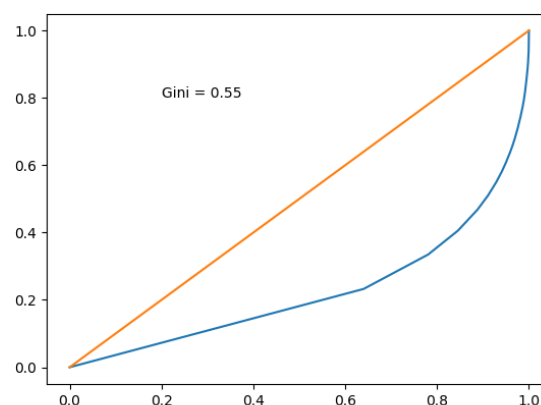
Figure 2.4: Lorenz curve with Gini coefficient for the sources of articles

2.4.2 Affiliation Countries and International Collaborations

Taking a look at the countries that belong to the authors' affiliations, a total of 184 countries are represented in our study. From the 4,593 articles, 1,005 were published with at least one author affiliated with an institution in the United States. This is followed by 822 articles with involvement from the United Kingdom. The 15 most occurring countries are depicted in Figure 2.5. Aggregating the number of publications per continent, however, European countries are involved in 2,071 publications, North America in 1,229 and Asia in 1,138 publications. Nearly half (2,270) of all publications are domestic articles (only one country among the authors' affiliations), whereas for 634 documents no affiliation information was given. The remaining 1,689 publications are considered as international publications (at least two countries among the authors' affiliations). Most of these (985) were published by authors from two countries, followed by 341 documents from three countries and 363 articles from four or more countries.
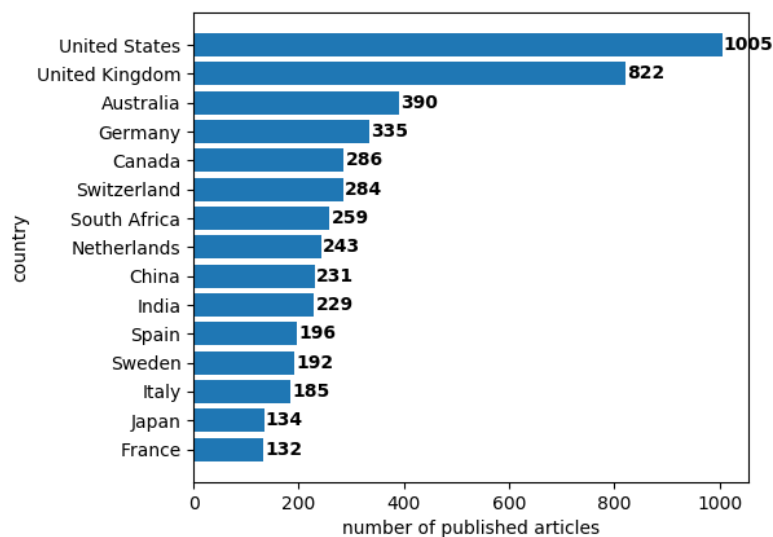
Figure 2.5: Top 15 countries that are involved in articles addressing the SDGs

Figure 2.6 shows the amount of domestic and international articles by research area. Documents without affiliation information are excluded. With 69% the highest relative share of domestic articles was detected in Arts & Humanities, while the lowest share of domestic articles comes from Physical Sciences (51%). Because of the different amount of publications per research areas, these variations are not significant.

International articles tend to have more funding available than domestic articles. From the 2,269 domestic articles, 610 (27%) acknowledge some funding, whereas from the 1,690 international
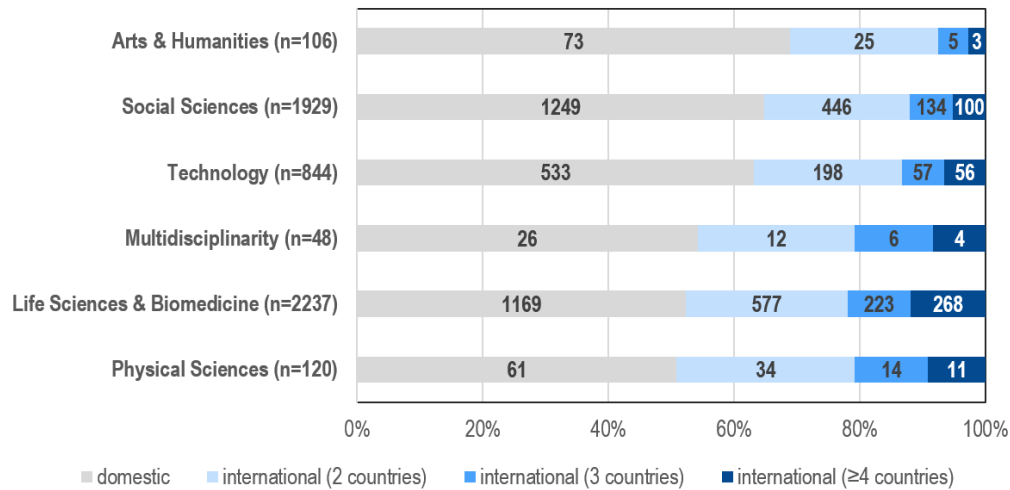
Figure 2.6: Share of domestic and international publications by research area

articles, 714 (42%) report about funding. Calculating Spearman's ρ between the number of countries involved in an article and the relative share of funded articles, a significant positive correlation can be detected ($\rho = 0.86$, $p < 0.01$), indicating that the more countries are involved in an article, the more it is likely to get funding.

Concentrating on the countries that are involved in at least 50 publications (35 countries) and calculating the share of international publications per country for these, the highest share of international articles is published by Belgium (93%), Kenya (87%), France (86%), Denmark and Switzerland (both 85%) as well as Bangladesh (83%). In contrast, low shares of international publications were calculated for the Russian Federation (42%), India (46%) and Nigeria (47%).

Figure 2.7 visualizes four clusters based on the co-occurrence of countries according to the authors' affiliations. Included are all countries that are involved in at least 50 publications. This condition is true for 35 countries. The size of a country's frame reflects the number of publications in our set that are associated to the country. The first cluster consists of eleven European countries and in addition Ethiopia, Ghana, Iran and the Russian Federation. The second cluster consists of nine Asian countries, Australia and New Zealand. Cluster 3 and 4 entail the United States and the United Kingdom, respectively, the two most occurring countries. Whereas the United Kingdom can be linked especially to the African countries Kenya, Nigeria and South Africa, strong links were found with the United States and Brazil, Canada, India, Mexico as well as Switzerland.
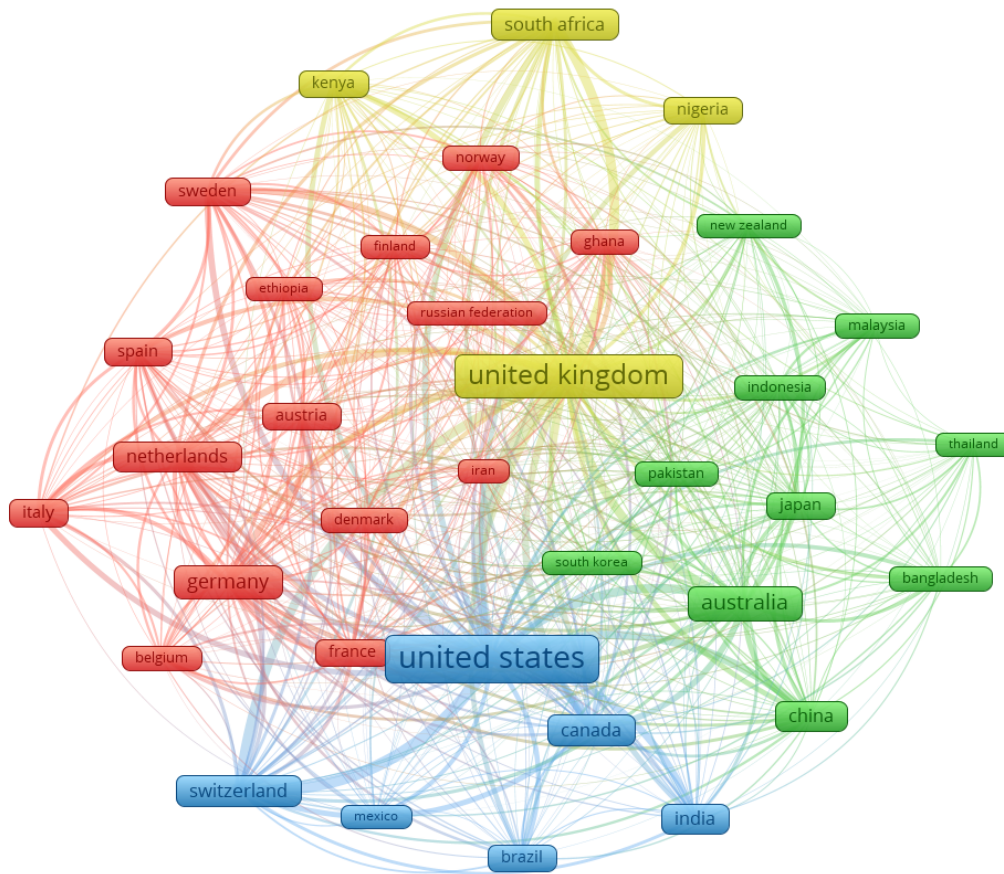
Figure 2.7: Clusters of 35 countries with at least 50 associated publications based on co-occurrence of authors' affiliation countries, map created with VosViewer 1.16.11

2.4.3   Thematic foci

Depending on our query, documents in this study contain the phrase "Sustainable Development Goals" in its title, abstract or the assigned keywords. From the documents in the initial set, 1,169 articles contained the phrase among their keywords, 3,471 in the abstract and 738 in its title. Analysing the corresponding keywords of all documents in more detail, we can discover five main keyword clusters (Figure 2.8). Our search phrase *Sustainable Development Goals* is naturally at the center of the keyword map and forms a cluster with the keywords *Agenda 2030* and *United Nations* which together describe the agenda in general. Furthermore, these keywords are associated with the thematic foci *human rights*, *inequalities*, *migration*, and *poverty*.

The biggest cluster around the general keyword *sustainable development* shows a focus on health-related topics, e.g., *hygiene*, *maternal health*, and *mortality*, thus representing SDG 3. Further keywords in this cluster are linked to *water* and *sanitation* (SDG 6) as well as keywords showing
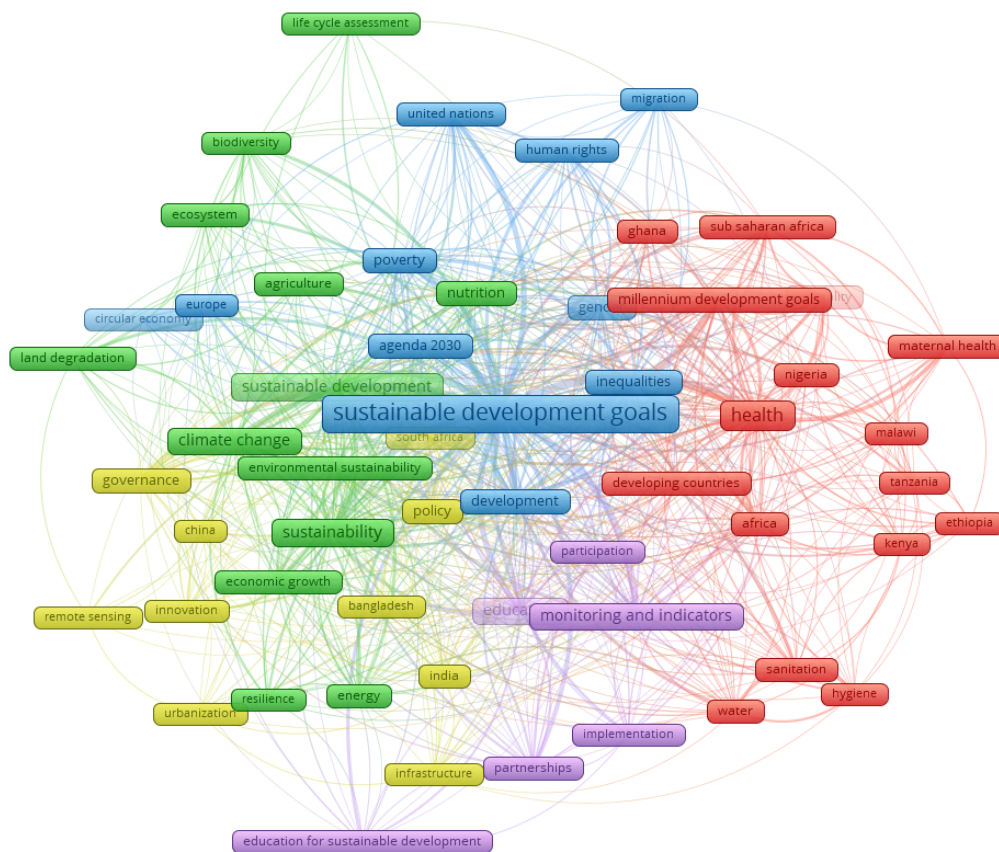
Figure 2.8: Clusters of author keywords based on co-occurrence of the keywords with at least 20 occurrences (71 keywords), map created with VosViewer 1.16.11

a focus on African countries according to keyword co-occurrences. These keywords are further linked to the *Millennium Development Goals* - the predecessor of the SDGs.

Another cluster around the general keyword *sustainable development* shows a focus on *environmental sustainability*, represented by keywords such as *energy* (SDG 7), *climate change* (SDG 13), *land degradation* (SDG 15) and *biodiversity* (SDGs 14 and 15), but also *economic growth* (SDG 8), as well as *agriculture* and *nutrition* (SDG 2).

The other two clusters have their focus on *governance*, *policy*, *innovation* and *infrastructure* in relation to *urbanization* and the countries *Bangladesh*, *South Africa* and *China*, respective the keywords *education* (SDG 4), *Education for Sustainable Development*, as well as *implementation*, *monitoring and indicators*, *partnerships* (SDG 17) and *participation*.

Considering the mapped SDGs on the keywords for each country, thematic foci for the countries in terms of keyword occurrences can be discovered. Research from the 15 countries with the highest research output directly addressing the SDGs in particular concentrates on SDG 3, good

health and well-being which has already been detected as a main keyword in Figure 2.8. Except for Italy, keywords reflecting this SDG are among the two most widely addressed SDGs (Table 2.2).

Table 2.2: Focal SDGs per country

Country	Focus on SDGs
United States	3 (health), 6 (water)
United Kingdom	3 (health), 10 (inequalities)
Australia	3 (health), 6 (water)
Germany	13 (climate), 3 (health)
Canada	3 (health), 6 (water)
Switzerland	3 (health), 10 (inequalities)
South Africa	3 (health), 10 (inequalities)
Netherlands	3 (health), 6 (water)
China	13 (climate), 3 (health)
India	3 (health), 10 (inequalities)
Spain	4 (education), 3 (health)
Sweden	3 (health), 6 (water)
Italy	2 (hunger), 13 (climate)
Japan	13 (climate), 3 (health)
France	3 (health), 13 (climate)

Aggregating the countries to the corresponding continents (and Oceania), again SDG 3 is the most occurring SDG for all continents (Table 2.3). Furthermore, SDG 6 is among the top 5 SDGs for all continents. In contrast, SDG 10 is mainly addressed in all continents except for South America. SDG 4 is a focus in Europe and South America, and partly Africa. SDGs 1, 2, 5, 7, 8, 9, 11, 12, 14, 15 are not among the top 5 occurring themes in all continents according to the used keywords.

Table 2.3: Focal SDGs per continent

Continent	Focus on SDGs
Africa	3 (health), 6 (water), 10 (inequalities), 4 (education), 17 (partnerships)
Asia	3 (health), 13 (climate), 6 (water), 10 (inequalities), 17 (partnerships)
Europe	3 (health), 4 (education), 13 (climate), 6 (water), 10 (inequalities)
North America	3 (health), 6 (water), 10 (inequalities), 13 (climate), 16 (peace)
Oceania	3 (health), 13 (climate), 10 (inequalities), 6 (water), 17 (partnerships)
South America	3 (health), 4 (education), 13 (climate), 17 (partnerships), 6 (water)

2.5   Discussion

With the Sustainable Development Goals, the United Nations adopted an ambitious agenda aiming at ending poverty, protecting the planet and ensuring prosperity for all. Partnerships for the goals (SDG 17) as well as international and interdisciplinary research are regarded as crucial for achieving progress towards the SDGs. In this paper, we assessed the current status of research on the 17 goals by analyzing research articles directly addressing the SDGs. For this purpose we used scientometric means, more precisely, we downloaded metadata and content-related information for more than 4,500 publications from the WoS Core Collection and Scopus published between 2015 and 2019. The resulting dataset was analyzed with regard to the associated sources and research areas, affiliation countries and international collaboration as well as thematic foci.

The comparably small amount of research articles directly addressing the SDGs available in the databases WoS and Scopus shows that many authors do not yet link their research to the goals. For facilitating knowledge sharing on the SDGs, it would be useful to raise awareness by directly referring to them. Of course, it is not necessary to mention the SDGs for achieving progress towards them in general. Still, revealing research articles connected to the goals and making these more visible and more comfortable to find would contribute to establishing collaboration and partnerships, thus directly strengthen progress towards SDG 17. This gap becomes especially evident with the sophisticated search strings other researchers had to apply for mapping SDG related research, e.g., as presented in Körfgen et al. (2018).

In our study, the most prevalent source for articles addressing the SDGs is the journal Sustainability located in Switzerland. According to Olawumi and Chan (2018), most journals publishing research on sustainable development are located in the US, China, UK and Canada when referring to the WoS Core Collection. In general, several studies have shown that publications from English-speaking countries as well as English language journals are over-represented in databases like Scopus or Web of Science (Vera-Baceta et al., 2019). This is also true for research on the SDGs, as confirmed by Hassan et al. (2014). Similarly, research from English-speaking countries is predominant in our study. Nearly half of the publications in our dataset are domestic articles, i.e. articles authored by persons from one country only. Thereby, the share of international articles varies among research area and country. A positive correlation between the number of

involved countries and the availability of funding acknowledgements could be calculated, which supports previous research by Morillo (2019).

In contrast to a general underestimation of the Social Sciences in the databases Scopus and WoS found in previous studies (Mongeon & Paul-Hus, 2016), according to our findings this research area is strong regarding research addressing the SDGs (1,960 articles). However, the most prevalent research area in our dataset is Life Sciences & Biomedicine (2,261 articles), which explains the strong thematic focus on health-related topics detected through the keywords. This research area further seems to benefit most from funding possibilities according to the funding acknowledgements gathered from WoS and Scopus.

In contrast to the survey by Salvia et al. (2019), we identified other predominant SDGs in our dataset. In Asia, Europe and North America, the experts of the study by Salvia et al. (2019) commonly referred to SDG 4 (quality education), 11 (sustainable cities and communities) and 13 (climate action), but also SDG 15 (life on land - Asia and North America) and SDG 12 (responsible consumption and production - Europe). In contrast, research directly referring to the SDGs in particular focuses on SDG 3 (good health and well-being) in all continents. Further predominant SDGs in research of all continents are SDG 6 (clean water and sanitation) and SDG 10 (reduced inequalities). The prevalence of SDG 13 as well as SDG 4 in Europe conforms with the study of Salvia et al. (2019). A strong focus of Austrian universities on SDG 4 was also detected by Körfgen et al. (2018). Compared to the study of Olawumi and Chan (2018) some thematic overlaps could be detected. For example, monitoring sustainable development and according indicators were deemed relevant in both studies. In contrast, our analysis revealed a strong focus on health-related topics, which is not a priority according to Olawumi and Chan (2018).

This study has some limitations. While most bibliometric studies regarding a specific topic focus on documents from one database, we consulted two popular databases to get a more complete picture. Still, Scopus and Web of Science do not cover every research item and especially with regard to the WoS Core Collection, the coverage depends on institutional subscriptions (W. Liu, 2019). The coverage between the databases differs notably, but both show an over-representation of documents from English language journals (Archambault et al., 2006; Mongeon & Paul-Hus, 2016; Vera-Baceta et al., 2019). As we performed our query in November 2019, the records for

2019 are not complete. Using the same query in April 2020, 350 and 450 further articles are available in the databases Scopus respectively WoS, which were not considered in our bibliometric analysis. In addition, analyzing funding acknowledgement has its limitations. While funding acknowledgement is fully covered for documents published since 2015 in the WoS SSCI, the WoS A&HCI subset is not covered (Paul-Hus, Desroches, & Costas, 2016). Furthermore, there are differences regarding the availability of funding information between Scopus and WoS (Kokol & Blažun Vošner, 2018). Again, with the use of these two databases we reduced the limitations. The query strategy used in this study is quite simple. Searching with the phrase "Sustainable Development Goals" does not include those documents dealing with subtopics of sustainable development that do not directly refer to the SDGs, but still support progress towards them. We used the approach to reveal those articles that are already including this phrase in their title, abstract, and keywords, thus facilitating to identify SDG-related research. We did not include the abbreviation "SDG" in the query, as it stands for several further scientific concepts, such as "spatial distribution of gradients".

2.6 Conclusion

Despite these limitations, this study reveals some interesting insights into current research addressing the SDGs. The existing thematic foci reveal current research gaps. While SDG 3 is already well represented in research addressing the SDGs in articles by authors from all countries, other SDGs, such as SDG 1 (no poverty), 5 (gender equality), 11 (sustainable cities and communities) or 16 (peace, justice and strong institutions) are barely represented in our dataset. This does not mean, that there is no research supporting these SDGs, but that existing research in these areas does not necessarily refer to the goals by addressing the SDGs in its title, abstract or keywords. If all research supporting the goals was directly linked to the SDGs, knowledge sharing could be facilitated and progress towards the goals would be supported.

In addition, even though transnational cooperation is apparent with nearly 37% of all articles being co-authored by authors from affiliations of multiple countries, collaboration can still be expanded in future research on the SDGs. The relatively high share of articles being published open access and the presence of pure open access journals among the main sources for articles addressing the SDGs further supports the idea of knowledge and infor-

mation sharing which is also among the targets of the SDGs (Target 16.10: "Ensure public access to information and protect fundamental freedoms, in accordance with national legislation and international agreements" (United Nations, 2019)). There are also efforts on identifying the role of open access for the SDGs, e.g. as formulated by the International Federation of Library Associations and Institutions (`https://blogs.ifla.org/lpa/2018/10/24/how-open-access-can-help-achieve-sustainable-development-goals-sdgs/`).

In the future, research could focus on this special role of open access for the SDGs, but also on other solutions for further facilitating knowledge sharing on the SDGs. The comparable low availability of articles directly addressing the SDGs, respective the complex queries used by other authors, reveal that more research is necessary to map SDG-related research adequately, and to facilitate knowledge sharing thereon. Additionally, practical solutions to broaden the network and foster collaboration regarding the goals are crucial.

In addition to the mere availability of funding acknowledgments, it would be interesting to analyze the types of funding bodies, e.g., governmental institutions, commercial enterprises, or non-profit foundations. That would require a mostly qualitative analysis of the funding texts available in the databases. This bibliometric overview can serve as a starting point for identifying current countries, sources and thematic foci in existing research articles addressing the SDGs.

References

Annan-Diab, F., & Molinari, C. (2017). Interdisciplinarity: Practical Approach to Advancing Education for Sustainability and for the Sustainable Development Goals. *International Journal of Management Education*, *15*(2), 73–83. doi: 10.1016/j.ijme.2017.03.006

Archambault, E., Vignola-Gagne, E., Côté, G., Larivière, V., & Gingras, Y. (2006). Benchmarking Scientific Output in the Social Sciences and Humanities: The Limits of Existing Databases. *Scientometrics*, *68*, 329–342. doi: 10.1007/s11192-006-0115-z

Bornmann, L., Mutz, R., Neuhaus, C., & Daniel, H. D. (2008). Citation counts for research evaluation: Standards of good practice for analyzing bibliometric data and presenting and interpreting results. *Ethics in Science and Environmental Politics*, *8*, 93–102. doi: 10.3354/esep00084

Clarivate Analytics. (2018). *Research Areas (Categories / Classification).* Retrieved November 11, 2019, from `https://images.webofknowledge.com/images/help/WOS/hp_research_areas_easca.html`

Gavel, Y., & Iselid, L. (2008). Web of Science and Scopus: A Journal Title Overlap Study. *Online Information Review*, *32*(1), 8–21. doi: 10.1108/14684520810865958

Glänzel, W. (2001). National Characteristics in International Scientific Co-authorship Relations. *Scientometrics*, *51*, 69–115. doi: 10.1023/A:1010512628145

Halvorsen, T. (2017). The Sustainable Development Goals, Knowledge Production and the Global Struggle Over Values. In T. Halvorsen, H. Ibsen, H.-C. Evans, & S. Penderis (Eds.), *Knowledge for Justice. Critical Perspectives From Southern African-Nordic Research Partnerships* (pp. 13–36). Cape Town, Belville; South Africa: African Minds, SANORD.

Halvorsen, T., Ibsen, H., Evans, H.-C., & Penderis, S. (2017). Introduction. In T. Halvorsen, H. Ibsen, H.-C. Evans, & S. Penderis (Eds.), *Knowledge for Justice. Critical Perspectives From Southern African-Nordic Research Partnerships* (pp. 1–9). Cape Town, Belville; South Africa: African Minds, SANORD.

Hassan, S. U., Haddawy, P., & Zhu, J. (2014). A Bibliometric Study of the World's Research Activity in Sustainable Development and Its Sub-areas Using Scientific Literature. *Scientometrics*, *99*, 549–579. doi: 10.1007/s11192-013-1193-3

Kokol, P., & Blažun Vošner, H. (2018). Discrepancies Among Scopus, Web of Science, and Pubmed Coverage of Funding Information in Medical Journal Articles. *Journal of the Medical Library Association*, *106*(1), 81–86. doi: 10.5195/jmla.2018.181

Körfgen, A., Förster, K., Glatz, I., Maier, S., Becsi, B., Meyer, A., . . . Stötter, J. (2018). It's a Hit! Mapping Austrian Research Contributions to the Sustainable Development Goals. *Sustainability*, *10*(9), 1–13. doi: 10.3390/su10093295

Leal Filho, W., Azeiteiro, U., Alves, F., Pace, P., Mifsud, M., Brandli, L., . . . Disterheft, A. (2018). Reinvigorating the Sustainable Development Research Agenda: the Role of the Sustainable Development Goals (SDG). *International Journal of Sustainable Development and World Ecology*, *25*(2), 131–142. doi: 10.1080/13504509.2017.1342103

Leydesdorff, L., Bornmann, L., & Wagner, C. S. (2019). The Relative Influences of Government Funding and International Collaboration on Citation Impact. *Journal of the Association for Information Science and Technology*, *70*(2), 198–201. doi: 10.1002/asi.24109

Liu, W. (2019). The Data Source of This Study is Web of Science Core Collection? Not Enough. *Scientometrics*, *121*, 1815–1824. doi: 10.1007/s11192-019-03238-1

Mago, S. (2017). North–South Research Collaboration and the Sustainable Development Goals: Challenges and Opportunities for Academics. In T. Halvorsen, H. Ibsen, H.-C. Evans, & S. Penderis (Eds.), *Knowledge for Justice. Critical Perspectives From Southern African-Nordic Research Partnerships* (pp. 163–174). Cape Town/Belville, South Africa: African Minds, SANORD.

Mongeon, P., & Paul-Hus, A. (2016). The Journal Coverage of Web of Science and Scopus: A Comparative Analysis. *Scientometrics*, *106*, 213–228. doi: 10.1007/s11192-015-1765-5

Morillo, F. (2019). Collaboration and Impact of Research in Different Disciplines with International Funding (From the EU and Other Foreign Sources). *Scientometrics*, *120*, 807–823. doi: 10.1007/s11192-019-03150-8

Olawumi, T. O., & Chan, D. W. (2018). A Scientometric Review of Global Research on Sustainability and Sustainable Development. *Journal of Cleaner Production*, *183*, 231–250. doi: 10.1016/j.jclepro.2018.02.162

Paul-Hus, A., Desroches, N., & Costas, R. (2016). Characterization, Description, and Considerations for the Use of Funding Acknowledgement Data in Web of Science. *Scientometrics*, *108*, 167–182. doi: 10.1007/s11192-016-1953-y

Ribeiro, L. C., Rapini, M. S., Silva, L. A., & Albuquerque, E. M. (2018). Growth Patterns of the Network of International Collaboration in Science. *Scientometrics*, *114*, 159–179. doi: 10.1007/s11192-017-2573-x

Salvia, A. L., Leal Filho, W., Brandli, L. L., & Griebeler, J. S. (2019). Assessing Research Trends Related to Sustainable Development Goals: Local and Global Issues. *Journal of Cleaner Production*, *208*, 841–849. doi: 10.1016/j.jclepro.2018.09.242

United Nations. (2015). *Sustainable Development Goals.* Retrieved January 5, 2018, from `http://www.un.org/sustainabledevelopment/sustainable-development-goals/`

United Nations. (2019). *World Urbanization Prospects: The 2018 Revision.* New York, NY: United Nations. Retrieved August 1, 2018, from `https://population.un.org/wup/Publications/Files/WUP2018-Report.pdf`

van Eck, N. J., & Waltman, L. (2010). Software Survey: VOSviewer, a Computer Program for Bibliometric Mapping. *Scientometrics*, *84*, 523–538. doi: 10.1007/s11192-009-0146-3

Vera-Baceta, M. A., Thelwall, M., & Kousha, K. (2019). Web of Science and Scopus Language Coverage. *Scientometrics*, *121*, 1803–1813. doi: 10.1007/s11192-019-03264-z

Wagner, C. S., Whetsell, T. A., & Leydesdorff, L. (2017). Growth of International Collaboration in Science: Revisiting Six Specialties. *Scientometrics*, *110*, 1633–1652. doi: 10.1007/s11192-016-2230-9

WCED. (1987). *Report on the World Commission on Environment and Development. Our Common Future.* Oxford, UK: Oxford University Press. Retrieved August 5, 2018, from `http://www.un-documents.net/our-common-future.pdf`

Zhu, J., & Hua, W. (2017). Visualizing the Knowledge Domain of Sustainable Development Research Between 1987 and 2015: A Bibliometric Analysis. *Scientometrics*, *110*, 893–914. doi: 10.1007/s11192-016-2187-8

3 Sustainability and Sustainable Development in the Context of Library and Information Science Publications

3.1 Introduction

On January 1st, 2016, the Sustainable Development Goals (SDGs) went into effect. These 17 goals are intended to "end poverty, protect the planet and ensure prosperity for all" (United Nations, 2015c, 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, 2016b). 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, & 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, 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 (`https://2030-watch.de`). 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). It seems, however, that while the scientific interest in sustainability and sustainable development has been growing rapidly during the recent years (see Figure 3.2), 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 & Janowski, 2013), knowledge management (Evangelista & Durst, 2015) or information systems and sustainable supply chain management (de Camargo Fiorini & Jabbour, 2017). Quental and 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.

This article attempts a complete 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 (LIS). 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.

3.2   Methods

The items included in the analysis were obtained from the Scopus database. Figure 3.1 describes the procedure 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 and Rafols (2009) the SJR can be used as an alternative to the Journal Impact Factor. Beside
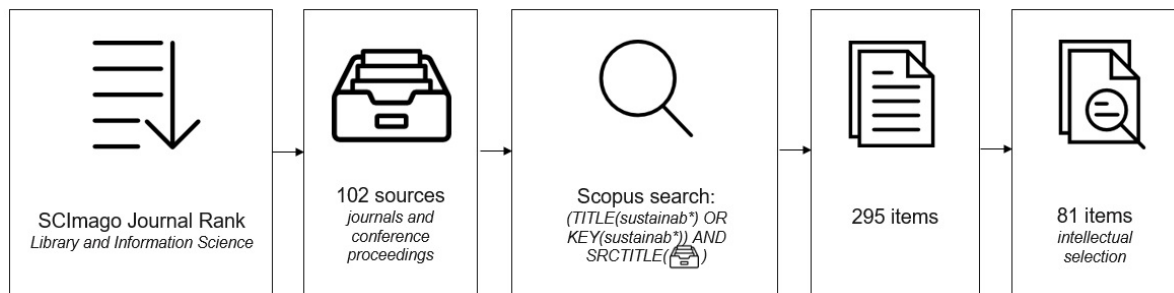
Figure 3.1: Obtaining a set of articles for the analysis

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 contains the string *sustainab**. With this, it was made sure to only include 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 & Lourenço, 2012, p. 364). Further, only research articles were considered (not e.g. editorials) and the renaming of journals was taken into account (thus the *Journal of the American Society for Information Science and Technology* was included). Other keywords were not included in order to prevent bias towards one of the sub-dimensions of sustainability. With this approach 295 publications could be identified.

All documents' titles and abstracts were sighted manually and 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 be-fore were deemed irrelevant for this review. Then again, some further relevant publications were identified through the references of the core set. In four cases no full text could be provided, so that in the end 81 publications remained for the analysis. This set has been examined by both, methods of bibliometrics and a structured literature review. Considering bibliometric indicators, metadata, keywords and citation information have been used as provided by Scopus. Keyword networks were visualized with the help of VOSviewer (van Eck & Waltman, 2010). For the literature review, all publications were read. In each case it has been noted what dimension of sustainability (environmental, economic, social) was addressed. Furthermore, the main topic, applied methods and addressed countries were listed. Examples for the coding process can be found in Table 3.1.

Table 3.1: 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, & 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, Rodero-Cosano, Ruiz-Lozano, & Rios-Berjillos, 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, & 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 et al., 2016, p. 2053).	responses obtained from 168 registered users,7-point Likert scale	Structured survey

3.3 Results

In total, 81 publications were analyzed, 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 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.

3.3.1 Citations

Overall, publications received a mean value of 23.3 citations (Scopus) up until February 28, 2018 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 3.2). 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, & 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 envi-

Table 3.2: 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

ronmentally friendly. In contrast, Jenkin et al. (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 (Li & Yeh, 2000; Yeh & Li, 1998). In these articles, they propose models for sustainable land development and sustainable urban development with the help of geographical information systems (GIS). The most recent article among the top five cited articles addresses a different topic: the sharing economy and collaborative consumption (Hamari et al., 2016). The authors investigate consumers' motivations to take part in collaborative consump-

tion. 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.

3.3.2   Publication Year

Going back in time, there are only a few early publications on sustainability in the LIS field (Figure 3.2). The first article was published in 1990 and addresses the role of geographic information systems (GIS) for sustainable development exemplified by the situation in Canada (Manning, 1990). The author claims that GIS 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 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 3.2). 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 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
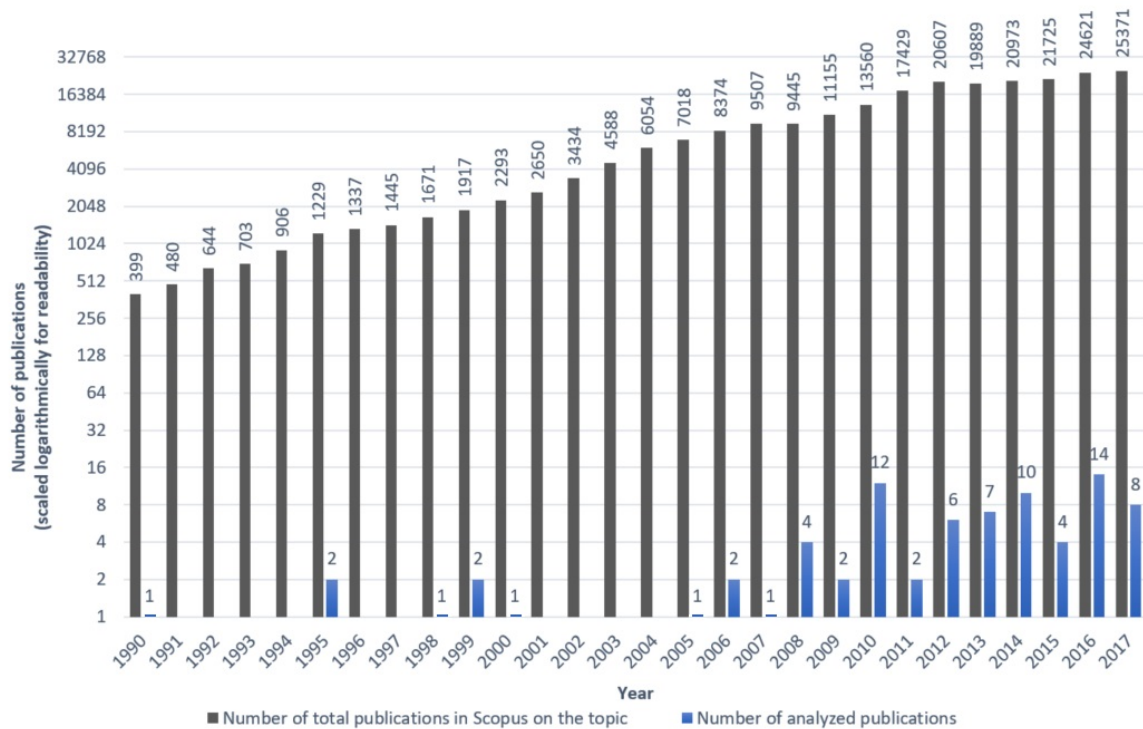
Figure 3.2: Number of total publications on sustainability in Scopus and number of analyzed articles per year

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 3.2, 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.

3.3.3   Main Topics

Figure 3.3 shows the co-occurrences of the assigned keywords as provided by Scopus with clustering (clusters displayed in color). 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 occurrence. 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 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*).
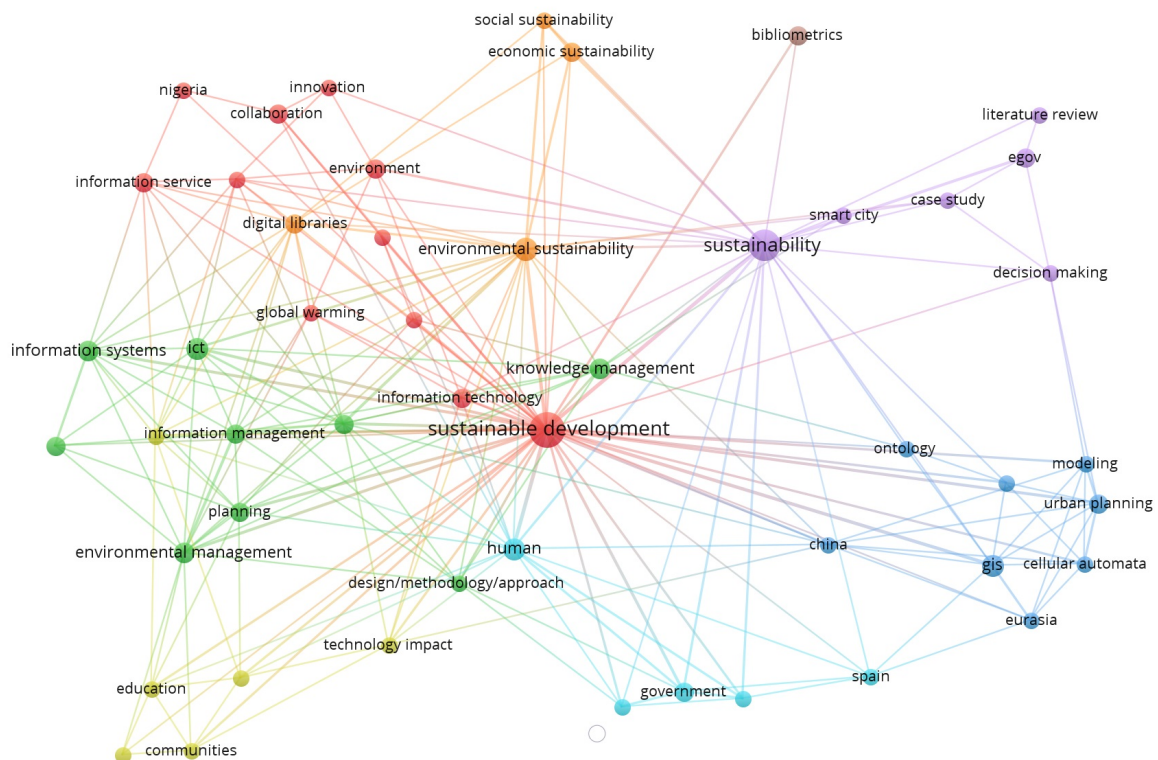
Figure 3.3: Keyword co-occurrence map in N=81 LIS articles on sustainability
(The terms are based on the keywords provided by Scopus, the map was created using VOSviewer)

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 3.3). 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 (Afacan, 2017; Barnes, 2012; Noon, 2008), topics like information dissemination for enhancing user awareness on environmental sustainability (Townsend, 2014) or education for sustainability (Jankowska, Smith, & Buehler, 2014) are addressed. In another publication it is investigated how libraries can support in achieving the SDGs (Granda & Machin-Mastromatteo, 2016).

Table 3.3: Main topics of LIS articles on sustainability (N = 81)

Number of publications	Topic	Subtopics
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

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 & Cuthbertson, 2009), and monitoring gas and water consumption through ICT in order to improve user awareness (Lanzarone & Zanzi, 2010).

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, e.g. in relation to media pressure (Cuadrado-Ballesteros et al., 2014) and open data (Zhang, Liu, Sayogo, Picazo-Vela, & Luna-Reyes, 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 urban development 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. 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.

3.3.4 Discussed Countries

Some articles concentrate the 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 dedicated publications:

- United States (6)
- Spain (4)
- Austria (1)
- Mexico (1)
- Nigeria (5)
- Canada (2)
- England (1)
- Puerto Rico (1)
- Australia (4)
- Italy (2)
- Indonesia (1)
- Sweden (1)
- China (4)
- Iran (2)
- Japan (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 precise the dissemination of information on HIV/AIDS (Uhegbu & 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 et al. (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.

3.4 Discussion and Conclusion

Awareness for 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 and ranked 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, a special issue in a LIS related journal. Indeed, while 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" (`https://www.ifla.org/environmental-sustainability-and-libraries/conferences`), the European Conference on Information Literacy (ECIL) with the theme "Information Literacy in the Green Society" in 2015 (`http://ecil2015.ilconf.org/`) which was planned to be a "green conference" itself, or the 2018 Annual Meeting of the Association for Information Science and Technology (ASIS&T) focusing on "building an ethical and sustainable information future with emerging technology" (`https://www.asist.org/am18/call-for-proposals/`).

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, p. 181), 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. 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 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 & 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 3.3) 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 informa-

tion 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 et al., 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 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.

References

Afacan, Y. (2017). Sustainable Library Buildings: Green Design Needs and Interior Architecture Students' Ideas for Special Collection Rooms. *Journal of Academic Librarianship*, *43*(5), 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), 84–87. doi: ajit.2009.84.87

Barnes, L. L. (2012). Green Buildings as Sustainability Education Tools. *Library Hi Tech*, *30*(3), 397–407. doi: 10.1108/07378831211266546

Brusca, I., Manes Rossi, F., & Aversano, N. (2016). Online Sustainability Information in Local Governments in an Austerity Context. *Online Information Review*, *40*(4), 497–514. doi: 10.1108/OIR-05-2015-0161

Chowdhury, G. (2010). Carbon Footprint of the Knowledge Sector: What's the Future? *Journal of Documentation*, *66*(6), 934–946. doi: 10.1108/00220411011087878

Chowdhury, G. (2012). An Agenda for Green Information Retrieval Research. *Information Processing and Management*, *48*(6), 1067–1077. doi: 10.1016/j.ipm.2012.02.003

Chowdhury, G. (2013). Sustainability of Digital Information Services. *Journal of Documentation*, *69*(5), 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), 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), 2379–2391. doi: 10.1002/asi.23599

Chowdhury, G., & 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), 2128–2138. doi: 10.1002/asi.23825

Cuadrado-Ballesteros, B., Frías-Aceituno, J., & Martínez-Ferrero, J. (2014). The Role of Media Pressure on the Disclosure of Sustainability Information by Local Governments. *Online Information Review*, *38*(1), 114–135. doi: 10.1108/OIR-12-2012-0232

de Camargo Fiorini, P., & 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*, *37*(4), 241–249. doi: 10.1016/j.ijinfomgt.2016.12.004

Dudziak, E. A. (2007). Information Literacy and Lifelong Learning in Latin America: The

Challenge to Build Social Sustainability. *Information Development*, *23*(1), 43–47. doi: 10.1177/0266666907075630

Elkington, J. (1997). *Cannibals with Forks: The Triple Bottom Line of 21st Century Business.* North Mankota, MN: Capstone.

Engida, G. (2015). Foreword. In J. Singh, A. Grizzle, S. J. Yee, & S. H. Culver (Eds.), *Media and Information Literacy for the Sustainable Development Goals* (pp. 9–11). Göteburg, Sweden: Nordicom.

Estevez, E., & Janowski, T. (2013). Electronic Governance for Sustainable Development - Conceptual Framework and State of Research. *Government Information Quarterly*, *30*(Supplement 1), S94-S109. doi: 10.1016/j.giq.2012.11.001

Evangelista, P., & Durst, S. (2015). Knowledge Management in Environmental Sustainability Practices of Third-Party Logistics Service Providers. *Vine*, *45*(4), 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 and Society*, *13*(1), 23–47. doi: 10.1080/13691180902801585

Granda, R., & Machin-Mastromatteo, J. D. (2016). From Caracas to Lyon: A Road Toward Sustainable Development? *Information Development*, *32*(2), 216–218. doi: 10.1177/0266666915626830

Hamari, J., Sjöklint, M., & Ukkonen, A. (2016). The Sharing Economy: Why People Participate in Collaborative Consumption. *Journal of the Association for Information Science and Technology*, *67*(9), 2047–2059. doi: 10.1002/asi.23552

Hassan, S. U., Haddawy, P., & Zhu, J. (2014). A Bibliometric Study of the World's Research Activity in Sustainable Development and Its Sub-areas Using Scientific Literature. *Scientometrics*, *99*, 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), 251–265. doi: 10.1108/LR-09-2016-0078

Jankowska, M. A., Smith, B. J., & Buehler, M. A. (2014). Engagement of Academic Libraries and Information Science Schools in Creating Curriculum for Sustainability: An Exploratory Study. *Journal of Academic Librarianship*, *40*(1), 45–54. doi: 10.1016/j.acalib.2013.10.013

Jenkin, T. A., Webster, J., & McShane, L. (2011). An Agenda for 'Green' Information Technology and Systems Research. *Information and Organization*, *21*(1), 17–40. doi: 10.1016/j.infoandorg.2010.09.003

Lanzarone, G. A., & Zanzi, A. (2010). Monitoring Gas and Water Consumption Through ICTs for Improved User Awareness. *Information, Communication & Society*, *13*(1), 121–135.

Leydesdorff, L., & Rafols, I. (2009). A Global Map of Science Based on the ISI Subject Categories. *Journal of the American Society for Information Science and Technology*, *60*(2), 348–362. doi: 10.1002/asi.20967

Li, X., & 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), 131–152. doi: 10.1080/136588100240886

Manning, E. W. (1990). Geographic Information Systems and Sustainable Development. *Government Information Quarterly*, *7*(3), 329–342. doi: 10.1016/0740-624X(90)90028-M

Mitrea, O., Werner, M., & Greif, H. (2010). Sustainability ICT Visions and Their Embedding in Technology Construction. *Information, Communication & Society*, *13*(1), 48–67. doi: 10.1080/13691180903026372

Nathan, L. P. (2012). Sustainable Information Practice: An Ethnographic Investigation. *Journal of the Association for Information Science and Technology*, *63*(11), 2254–2268. doi: 10.1002/asi.22726

Navarro-Galera, A., Alcaraz-Quiles, F. J., & Ortiz-Rodríguez, D. (2016). Online Dissemination of Information on Sustainability in Regional Governments. Effects of Technological Factors. *Government Information Quarterly*, *33*(1), 53–66. doi: 10.1016/j.giq.2015.12.003

Nolin, J. (2010). Sustainable Information and Information Science. *Information Research - An International Electronic Journal*, *15*(2), paper 431. Retrieved from `http://informationr.net/ir/15-2/paper431.html`

Noon, P. (2008). The Lanchester Library - Building a Sustainable Library. *LIBER Quarterly*, *18*(2), 129–136. doi: 10.18352/lq.7916

Nugroho, Y. (2010). NGOs, the Internet and Sustainable Rural Development: The Case of Indonesia. *Information, Communication & Society*, *13*(1), 88–120. doi: 10.1080/13691180902992939

Piotrowicz, W., & Cuthbertson, R. (2009). Sustainability – A New Dimension in Information

Systems Evaluation. *Journal of Enterprise Information Management*, *22*(5), 492–503. doi: 10.1108/17410390910993509

Quental, N., & Lourenço, J. M. (2012). References, Authors, Journals and Scientific Disciplines Underlying the Sustainable Development Literature: A Citation Analysis. *Scientometrics*, *90*, 361–381. doi: 10.1007/s11192-011-0533-4

SCImago. (2007). *SCImago, SJR — SCImago Journal & Country Rank.* Retrieved February 1, 2018, from `http://www.scimagojr.com`

Spink, A. (1995a). Digital Libraries and Sustainable Development? In *Proceedings of Digital Libraries, DL '95, Austin, TX, June 11-13, 1995* (pp. 1–7). College Station, TX: Tamu.

Spink, A. (1995b). Information and a Sustainable Future. *Libri*, *45*(3-4), 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), 1–9. Retrieved from `http://informationr.net/ir/5-1/paper65.html`

Thongmak, M. (2013). A Systematic Framework for Sustainable ICTs in Developing Countries. *International Journal of Information Technologies and Systems Approach*, *6*(1), 1–19. doi: 10.4018/jitsa.2013010101

Tirado-Valencia, P., Rodero-Cosano, M. L., Ruiz-Lozano, M., & Rios-Berjillos, A. (2016). Online Sustainability Information in European Local Governments. *Online Information Review*, *40*(3), 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), 21–23. doi: 10.1108/LHTN-07-2014-0059

Uhegbu, A. N., & 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), 35–44. doi: 10.1108/00242530610641772

United Nations. (2015). *Sustainable Development Goals.* Retrieved January 5, 2018, from `http://www.un.org/sustainabledevelopment/sustainable-development-goals/`

United Nations. (2016). *The Sustainable Development Agenda.* Retrieved October 13, 2019, from `http://www.un.org/sustainabledevelopment/development-agenda/`

van Eck, N. J., & Waltman, L. (2010). Software Survey: VOSviewer, a Computer Program for Bibliometric Mapping. *Scientometrics*, *84*, 523–538. doi: 10.1007/s11192-009-0146-3

Watson, R. T., Boudreau, M.-C., & Chen, A. J. (2010). Information Systems and Environmentally Sustainable Development: Energy Informatics and New Directions for the IS Community. *MIS Quarterly*, *34*(1), 23–38. doi: 10.2307/20721413

WCED. (1987). *Report on the World Commission on Environment and Development. Our Common Future.* Oxford, UK: Oxford University Press. Retrieved August 5, 2018, from `http://www.un-documents.net/our-common-future.pdf`

Yeh, A. G.-O., & Li, X. (1998). Sustainable Land Development Model for Rapid Growth Areas Using GIS. *International Journal of Geographical Information Science*, *12*(2), 169–189. doi: 10.1080/136588198241941

Zhang, J., Liu, H., Sayogo, D. S., Picazo-Vela, S., & Luna-Reyes, L. (2016). Strengthening Institutional-based Trust for Sustainable Consumption: Lessons for Smart Disclosure. *Government Information Quarterly*, *33*(3), 552–561. doi: 10.1016/j.giq.2016.01.009

4 Information Dissemination Related to the Sustainable Development Goals on German Local Governmental Websites

4.1 Introduction

In 2015, the Sustainable Development Goals (SDGs) were adopted by the United Nations within the Agenda 2030. The SDGs are 17 goals "to end poverty, protect the planet and ensure prosperity for all" (United Nations, 2015c, para. 1). The most common definition describes sustainable development 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). The goals, listed in Table 4.1, address sustainable development regarding several dimensions, including social, environmental and economic aspects. Each goal consists of further, more concrete targets, adding up to a total amount of 169 objectives. In contrast to former similar strategic plans like the Millennium Development Goals (MDGs), the agenda does not only focus on sustainable development in developing countries, but demands action of all countries. This is an ambitious task, as different objectives shape different societies regarding social, economic and environmental goals (Sachs, 2012). A crucial point for contributing to a sustainable development and measuring progress on the SDGs is the availability of information and data. Hence, information science research can play a key role for sustainable development. Spink (1995b, p. 207) argued 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." Furthermore, "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).

The role of information is also integrated in the Agenda 2030 for Sustainable Development and similar strategic plans. Chowdhury and Koya (2017) conducted an analysis on four UN policy documents and the importance of information-related concepts embedded in these documents. Considering the SDGs, information access and information sharing seem to be of particular im-

Table 4.1: The Sustainable Development Goals (United Nations, 2015c)

No.	Goal
1	No poverty
2	Zero hunger
3	Good health and well-being
4	Quality education
5	Gender equality
6	Clean water and sanitation
7	Affordable clean energy
8	Decent work and economic growth
9	Industry, innovation and infrastructure
10	Reduced inequalities
11	Sustainable cities and communities
12	Responsible consumption and production
13	Climate action
14	Life below water
15	Life on land
16	Peace, justice and strong institutions
17	Partnerships for the goals

portance. Already in the Agenda 21, the predecessor of the Agenda 2030, information, integration and participation played a major role for sustainable development (Nolin, 2010).

Furthermore, for the first time a goal on sustainable cities is embedded in the agenda. Klopp and Petretta (2017) referred to SDG 11 as the "Urban Sustainable Development Goal (USDG)" and argued that it needs to be realized at the city scale. With more than half of the world's population living in cities, sustainable development in general cannot be achieved without cities. The United Nations estimated that by 2050 the number of urban residents will grow even more up to 68 percent. With 74 percent, Europe currently already counts to the most urbanized regions of the world (United Nations, 2019). Today, many cities transform to smart cities, i.e. prototypical cities of the knowledge society. A smart city can be conceptualized "as an icon of a sustainable and livable city" (Chourabi et al., 2012, p. 2289). According to Corbett and Mellouli (2017), smart sustainable cities can contribute to the SDGs by an integrated information ecosystem. Thereby, an improvement of aspects like participation, equity and mobility can be achieved (Bibri & Krogstie, 2017). Politics and administration in the form of e-governance and e-government are building blocks in this process (Barth et al., 2017). Through governmental websites, a city can disseminate information and encourage transparency, which are important factors for sustainable development.

There are some studies dealing with governmental websites, e.g. regarding the assessment of factors like maturity and usability (Fietkiewicz, Mainka, & Stock, 2017; Mainka, Fietkiewicz, Kosior, Pyka, & Stock, 2013) or maturity and credibility (Huang & Benyoucef, 2014). Some studies further explored sustainability information on governmental websites. Navarro-Galera, Alcaraz-Quiles, and Ortiz-Rodríguez (2016) analyzed 17 Spanish regional governments and their online dissemination behavior of sustainability information. Overall, they found numerous information about sustainability, but could not identify regional governments who publish sustainability reports. They state that the level of online transparency with regard to sustainability information has to be further expanded. Brusca, Manes Rossi, and Aversano (2016) investigated how austerity has influenced online sustainability information in Italy and Spain. Therefore, the authors analyzed websites of Italian and Spanish local governments with more than 100,000 inhabitants and the dissemination of financial, social and environmental information. They concluded that in both countries the disclosure of these topics is low and could be enhanced in order to improve transparency. Tirado-Valencia, Rodero-Cosano, Ruiz-Lozano, and Rios-Berjillos (2016) expanded the analysis of sustainability information on 142 European cities. In their study, the economic dimension is the most represented aspect on governmental websites, whereas environmental and social information are rare. The authors emphasized that a sustainability strategy is not possible without a balance between all three dimensions. Janowski (2016) emphasized the importance of digital government for the SDGs and called for more research in this area.

This article aims at contributing to research on the dissemination of sustainability information by local governments. With the adoption of the SDGs, a new relevance for sharing information on sustainable development arose. Also the German Federal Government adopted a sustainability strategy based on the SDGs (Bundesregierung, 2017). With an urban population of 77 percent and the USDG, the role of cities for sustainable development in Germany comes to the fore. The Association of German Cities (Deutscher Städtetag, 2015) recognized the importance of urban areas for sustainable development and recommended German cities to commit themselves to the SDGs by signing a resolution template prepared by the association. Hence, our first research question aims at investigating which cities report on their commitment to the SDGs on their websites:

RQ1. Which German cities announce their commitment to implement the SDGs on their official governmental websites?

Although the SDGs demand action of every nation, be it a developing country or a high-income economy, societies are shaped by divergent priorities, capabilities and intentions. "Almost all the world's societies acknowledge that they aim for a combination of economic development, environmental sustainability, and social inclusion, but the specific objectives differ globally, between and within societies" (Sachs, 2012, p. 2206). Due to these differences, Lior, Radovanović, and Filipović (2018) recommended to develop separate indicators for measuring the state of sustainable development for developed, medium-developed and poor countries. Although sustainability indicators for Germany were positive for the most part (Blum, Mclaughlin, & Hanley, 2019), Open Data Watch (2017a) recommended Germany to publish more data regarding environmental statistics. With our second research question, we aim to identify topics that local governments link to the SDGs on their websites, in order to investigate thematic priorities of German cities:

RQ2. Which topics linked to the SDGs do German municipalities inform about on their websites?

Sustainable development cannot be managed by one contributor alone. With SDG 17, the role of partnerships for achieving the SDGs is thus highlighted. In particular, five main fields are addressed in this goal (United Nations, 2018): finance (e.g. additional financial resources for developing countries), information and communication technology (e.g. the expansion of broadband access), capacity building (e.g. international support for developing countries), trade (e.g. a growing share of international trade for developing countries) and systematic issues (e.g. official commitment to the SDGs as well as data, monitoring and accountability). At the urban level, "[t]he USDG thus raises the question of the relationship – and coordination – between cities and other subnational as well as national governments in relation to implementation of the goals and monitoring" (Klopp & Petretta, 2017, p. 95). Thereby, citizens can also become partners for contributing to sustainable development. Sriskandarajah (2018, p. 302) even argued that "[t]he Sustainable Development Goals (SDGs) will not be achieved without significant public awareness and engagement". Hence, with our third research question, we address the role of citizen participation and partnerships in the cities:

RQ3. What roles do citizen participation and partnerships play in achieving the SDGs according to the governmental websites?

In the following section, the methodological approach for answering *RQ1–RQ3* is described. The corresponding results are presented subsequently.

4.2   Methodology of Research

According to the OECD (2018), urban areas with a population size of at least 500,000 are classified as (large) metropolitan areas. To analyze German local governmental websites and the information about the SDGs shared on these websites, the 15 largest cities in Germany provided our starting point (German Federal Statistical Office, 2018) and were chosen as our sample. With a total of over 13.8m inhabitants, these cities make up 17 percent of the whole German population. 4.2 lists the cities with the corresponding official governmental websites.

These websites were sighted manually during July 9-17, 2018, and analyzed by the means of a content analysis (Krippendorff, 2018; Mayring, 2015). Content analysis allows the evaluation of any kind of communication and is also accepted as an appropriate method for web content (McMillan, 2000). Figure 4.1 summarizes the methodological approach for this study based on the three research questions (Step 1). As a starting point, German and English search terms related to the SDGs (SDG, Sustainable Development Goal(s), Agenda 2030, Nachhaltigkeitsziele, UN, United Nations, Vereinte Nationen) were entered into the websites' search interface to investigate the information given. Thereby, different spellings of the above-mentioned terms were considered. The resulting pages were sighted manually in order to detect further relevant search terms. This recursive approach was used until no additional relevant content could be

Table 4.2: Largest German cities with number of inhabitants (German Federal Statistical Office, 2018) and link to governmental website

City	Inhabitants	Governmental website
Berlin	3,574,830	`www.berlin.de/`
Hamburg	1,810,438	`www.hamburg.de/`
Munich	1,464,301	`www.muenchen.de/`
Cologne	1,075,935	`www.stadt-koeln.de/`
Frankfurt	736,414	`www.frankfurt.de/`
Stuttgart	628,032	`www.stuttgart.de/`
Düsseldorf	613,230	`www.duesseldorf.de/`
Dortmund	585,813	`www.dortmund.de/`
Essen	583,084	`www.essen.de/`
Leipzig	571,088	`www.leipzig.de/`
Bremen	565,719	`www.bremen.de/`
Dresden	547,172	`www.dresden.de/`
Hannover	532,864	`www.hannover.de/`
Nuremberg	511,628	`www.nuernberg.de/`
Duisburg	499,845	`www.duisburg.de/`
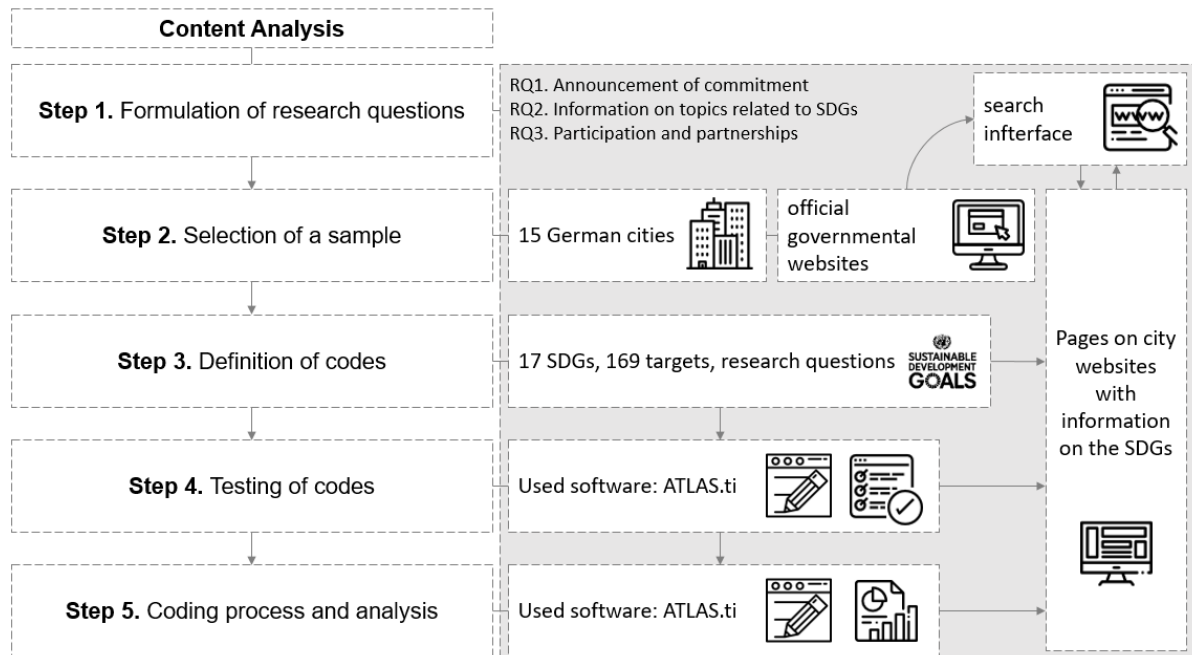
Figure 4.1: Methodology of research

found (Step 2). As each website provides different search functionalities, the combination of the terms differed in each case. Some websites allow a search for phrases or the use of Boolean operators, others do not. We checked all hits for relevance and duplicates. A page was only deemed relevant, if a direct connection to the SDGs was apparent. Further, we only analyzed information that is directly embedded on the governmental websites; information on websites of third parties was not included in the analysis. The final set of webpages was stored and imported into the software ATLAS.ti (`https://atlasti.com/`).

For the actual coding process, we used a list of terms and phrases generated from the descriptions of the SDGs and their targets (United Nations, 2015b). Regarding RQ1 and RQ3, special attention was given to the availability of information regarding the resolution template and indications on participation and partnerships (Step 3). To ensure reliability, two coders analyzed 20 percent of the webpages for each city and tested the application of the codes (Step 4). Then, each webpage was read and coded with the coding tool of ATLAS. ti and the provided list of terms. Each passage that contained a link to one of the categories was marked (Step 5).

4.3   Results

On 14 of the analyzed websites, information regarding the SDGs was found. Only the search on the website of Bremen did not reveal any information. The amount of hits differed notably, ranging from only a couple of relevant hits in the cities Frankfurt, Stuttgart, Dresden and Duisburg to approximately 50 in Berlin and Hannover. In five cities, informing on the SDGs expands on the local Agenda 21 and its MDGs. All examples found on the governmental websites that are included below are listed in Table 4.3.

4.3.1   Announcement of Official Commitment to the Sustainable Development Goals

According to the non-profit organization Engagement Global (2018), 78 German municipalities signed the Agenda 2030 resolution until the end of July 2018. Among the 15 analyzed cities, ten appeared on this list and officially committed themselves to implement the SDGs on the local level (Table 4.3). From these, four cities (Munich, Cologne, Leipzig and Hannover) informed their citizens about the resolution on their official website by publishing the official council decision and the corresponding resolution template. For three further cities (Hamburg, Düsseldorf and Nuremberg), information on the signature of the resolution could be found embedded as a side information, e.g. in news articles or presentation slides for workshops. Six cities gave a general overview on the SDGs and included explanatory text as well as related links. For example, Düsseldorf provided an overview page where the city categorized information regarding the SDGs into various topics. There, general documents related to the Agenda 2030 can be found as well as information of third parties, e.g. explanations of the SDGs in a simple language or enriched with pictures in order to also inform children.

Hamburg did not officially sign the resolution by the Association of German Cities, but the city still committed itself to implement the SDGs and announced this on the local website. In Frankfurt, the resolution has not been signed yet, but the network "Learning Sustainability in Frankfurt" has formally requested the city to commit to the SDGs and sign the template provided by the Association of German Cities. In other cities, similar requests or proposals to follow the call of the Association of German Cities were published. The initiator often differs in

Table 4.3: Cities and their commitment to the SDGs on the local level

City	Signed Resolution (Engagement Global, 2018)	Official commitment on website	Council decision to sign resolution	Note
Berlin	(X)	(X)		Resolution signed by the district Treptow-Köpenick
Hamburg		X		Commitment not through official resolution
Munich	X	X	June 2016	
Cologne	X	X	September 2017	
Frankfurt				Request available to sign resolution
Stuttgart	X			
Düsseldorf	X	X	June 2016	
Dortmund				
Essen				
Leipzig	X	X	January 2017	
Bremen	X			
Dresden	X			
Hannover	X	X	March 2016	
Nuremberg	X	X	October 2017	
Duisburg				

the cities. In Hannover, the Agenda 21 and sustainability office proposed a council order to sign the resolution in January 2016. Therein, the importance of increasing public information and awareness was emphasized. A similar resolution proposal was composed one year later in Leipzig by the department of environment, public order and sports as well as the department for urban development and construction.

Although Bremen was listed among the cities that signed the resolution, not a single information regarding the SDGs can be found on the city's official website. In Berlin, the district Treptow-Köpenick signed the resolution, but not the whole city. The commitment of this district was also announced on the official governmental website of Berlin. Furthermore, the advisory board for development cooperation of Berlin recommended to implement guidelines for a development policy in line with the SDGs. Three cities (Dortmund, Essen and Duisburg) neither signed the resolution template nor officially committed to the SDGs on their websites.

4.3.2   Thematic Priorities Related to the Sustainable Development Goals

In the analysis, the most prevalent topics associated with the SDGs are education, climate protection, fair trade, energy and mobility. Table 4.4 lists these topics and their embedment in the SDGs and the corresponding more concrete targets.

Education

The most often occurring topic linked to the SDGs among all cities is education, which was found on the governmental websites of nine cities. Education is embedded in the Agenda 2030 with its own goal (SDG 4: quality education). This goal addresses several targets including the provision of free primary and secondary education for all girls and boys (target 4.1), an increase of qualified teachers (target 4.c) and the elimination of gender disparities (4.5). The information published on the analyzed websites focus especially on target 4.7, which aims at ensuring education for and promotion of sustainable development. In some cities, a corresponding department or position for Education for Sustainable Development (ESD) has been established, which often organizes activities and events connected to the SDGs. In 2017, the responsible center for ESD of the Berlin district of Charlottenburg-Wilmersdorf initiated a film series named "#2030" together with the regional center for political education and a local cinema. The aim of this event series is to raise awareness for the SDGs by showing a relevant film (e.g. "No" by Pablo Larraín) and discussing related aspects like democracy or citizen participation afterwards. In 2017, the initiative "Hamburg Learns Sustainability" of Hamburg's authority for environment and energy was honored by the Federal Ministry of Education and Research and the German UNESCO Commission for its contribution to ESD. The initiative is involved in the World Action Program ESD in Germany and organizes events for the realization of the SDGs in the city.

Climate Protection

Another prevalent topic on the cities' websites is climate change and protection, which is included on the website of eight cities. In the Agenda 2030, the corresponding goal is SDG 13 on climate action. Goal 13 consists of five targets, from which two are addressed in particular on the analyzed websites: the integration of climate change measures into national policies, strategies

and planning (target 13.2), as well as the improvement of education and awareness-raising on climate change mitigation (target 13.3). For example, the city of Essen published a report on their integrated energy and climate concept in which it is stated that the SDGs have to be addressed in further local climate protection concepts. In Hamburg, the initiative "My tree – my city" aims at planting trees dispersed throughout the city. On the local website, the city informs about this initiative and refers to the importance of the SDGs in this context. The environmental agency of Dortmund supports social engagement for sustainable development and climate protection. Individuals as well as legal entities can apply for a climate protection fund. Eligible applications have to be relevant for sustainable development, the SDGs or climate protection. On the governmental website of Dortmund, an application form for the fund is available.

Fair Trade

Fair trade, which is not dedicated to one particular SDG, but can be related to several sub targets, is a further subject of seven cities. Trade-related aspects are linked to (United Nations, 2015d):

- the reduction of hunger by preventing trade restrictions (target 2.b);

- economic growth by increasing Aid for Trade support in developing countries (target 8.a);

- the reduction of inequalities by implementing special and differential treatment and aid for developing countries in accordance with the provisions of the World Trade Organization (target 10.a); and

- the support of partnerships by promoting a universal, non-discriminatory trading system (target 17.10), by increasing exports of developing countries (target 17.11) and by realizing an implementation of duty-free and quota-free market access for all least developed countries (target 17.12).

In the analyzed cities, the main focus with regard to fair trade lies on SDG 17, the strengthening of partnerships. The cities contribute to fair trade by taking part in the network "Fair Trade Town," which aims at bringing together civil society, politics and economy.

Table 4.4: Most prevalent topics on governmental websites and their embedment in the SDGs

Topic	Cities	Focus	SDG	Target description (United Nations, 2015d)
Education	9	Education for Sustainable Development (ESD)	4.7	"By 2030, ensure that all learners acquire the knowledge and skills needed to promote sustainable development, including, among others, through education for sustainable development and sustainable lifestyles, human rights, gender equality, promotion of a culture of peace and non-violence, global citizenship and appreciation of cultural diversity and of culture's contribution to sustainable development" (p. 19)
Climate protection	8	Measurement & Awareness	13.2	"Integrate climate change measures into national policies, strategies and planning" (p. 25)
			13.3	"Improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning" (p. 25)
Trade	7	Fair Trade Towns	17.10	"Promote a universal, rules-based, open, non-discriminatory and equitable multilateral trading system under the World Trade Organization, including through the conclusion of negotiations under its Doha Development Agenda" (p. 29)
			17.11	"Significantly increase the exports of developing countries, in particular with a view to doubling the least developed countries' share of global exports by 2020" (p. 29)
			17.12	"Realize timely implementation of duty-free and quota-free market access on a lasting basis for all least developed countries, consistent with World Trade Organization decisions, including by ensuring that preferential rules of origin applicable to imports from least developed countries are transparent and simple, and contribute to facilitating market access" (p. 29)
Energy	6	Renewable Energy	7.2	"By 2030, increase substantially the share of renewable energy in the global energy mix" (p. 21)
			7.a	"By 2030, enhance international cooperation to facilitate access to clean energy research and technology, including renewable energy, energy efficiency and advanced and cleaner fossil-fuel technology, and promote investment in energy infrastructure and clean energy technology" (p. 21)
Mobility	5	Public Transport and Traffic	11.2	"By 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons" (p. 24)

In order to qualify for the title Fair Trade Town, cities have to fulfill certain criteria, including media campaigns for promoting their application. All 15 cities in this analysis are currently Fair Trade Towns, though with differing entry dates (Fairtrade Deutschland, 2018). For example, Dortmund was the third city in Germany qualifying for the title and thus, the first among the analyzed cities. Hannover, which was the 13th city in Germany, further reports on its award as a Fair Trade Town in relation to the SDGs. With its fair trade campaign and related activities like a "fair brunch" or a "fair week," the city aims at contributing to the SDGs. With its brochure entitled "Engaged Berlin – how Berlin becomes a sustainable city with responsibility in the One World," the city provides comprehensive information on projects of engaged actors who contribute to the SDGs on the local level. Besides the emphasis of the importance of cities and education for the SDGs, fair trade is a central topic in the brochure, by informing, inter alia, about the city's application as a fair trade town, which was granted in November 2018 as the 574th city in Germany (Fairtrade Deutschland, 2018).

Energy and Mobility

The topics energy and mobility occur in relation to the SDGs on the local websites of six and five cities, respectively, often in one context. While there is a concrete SDG on affordable clean energy (SDG 7), mobility is not embedded in the Agenda 2030 with its own goal, but as a subtopic of SDG 11, sustainable cities and communities (target 11.2 mobility). Thereby, mobility and energy are deeply related, as the improvement of mobility in terms of public transport, less cars and more bikes in a city have a direct impact on energy consumption. Four cities emphasize these two topics in relation to each other. For example, the aforementioned brochure "Engaged Berlin" reports on the European Energy Forum situated in Berlin as a reference site for a smart city strategy which tests interconnected mobility and energy concepts. Further, Hannover reports on its master plan "Mobility 2025." Several initiatives are included in this plan to create a well-developed, accessible, resource-saving, safe and preferably barrier-free mobility offer. Among the projects are campaigns for electro mobility, car sharing and car free Sundays. In addition, Nuremberg reports about concrete measurements of these two topics. In a meeting on the topic "Agenda 2030 – What is the relation to my work," Nuremberg's department of environment and health reported on the city's state on the way to sustainable urban development. Therein, the topics mobility and energy are emphasized. The targets of SDG 7 and 11.2 are listed. Further, the

concrete indicators for measuring the progress on these SDGs (energy and power consumption, CO_2 emmissions, means of transportation) are provided. Statistics for Nuremberg are presented and the importance of a digital data acquisition and evaluation is emphasized.

Other Topics

Besides the common topics education, climate protection, fair trade, energy and mobility, other topics related to the SDGs only occur rarely on the cities' websites. For example, in the context of the SDGs the subjects gender equality, poverty, health and peace are only mentioned on the websites of each two cities. In contrast, Hannover aspires to convey comprehensive information on each individual SDG and its various topics in a creative format. With the project "Nachhaltige Ge(o)heimnisse" ("sustainable secrets"), the city expands its service for citizens to explore the region by geocaching. Since January 2018, this program includes geocaches that are dedicated to specific SDGs. For example, the first geocache addresses SDG 10 which deals with reduced inequalities. To log this cache, the geocacher has to identify several inequalities. Other topics that are embedded in the program are sustainable cities and communities (SDG 11), zero hunger (SDG 2), quality education (SDG 4), life on land (SDG 15), sustainable consumption and production (SDG 12), affordable clean energy (SDG 7) and clean water and sanitation (SDG 6). The city aims at creating a geocache for each SDG by the end of 2018. On the website, for each "sustainable secret" information is given on the particular SDG and its relevance for everyone together with advice on how to contribute to this goal. General information on the SDGs with additional links further enables citizen to engage with the topic. In line with sustainability, the city asks geocachers to use bicycles to log caches instead of cars.

4.3.3   The Role of Citizen Participation and Partnerships for the Sustainable Development Goals

For the implementation of the SDGs on a local scale, seven cities count on citizen participation and communicate this on their website. For the cities Berlin, Hamburg, Munich, Cologne, Leipzig, Dresden and Hannover the importance of participation in relation to sustainable development was recognized and promoted on the governmental websites. For example, the authority for environment and energy of the city of Hamburg organized a workshop series with the title

"SDGs for Hamburg" which aims at bringing together government agencies and civil society to discuss the SDGs and their relevance for the city. Among the topics is a workshop on "process and participation," in which speakers emphasize the importance of inter-agency cooperation for contributing to sustainable development. Besides, it is stated that there are some issues which the city cannot cope with alone. As a result, an active participation of the citizens is desired. Likewise, Dresden invites its citizens to work on visions for the future of the city by taking part in several workshops. The realization of these visions resulted in 96 projects to which each citizen can contribute. The city thereby states that it tries to act in line with the SDGs. Sample projects are restaurants for the reduction of food waste and an information portal on the use of solar power. In Berlin, citizen participation and the SDGs could be linked to each other in a different way. The city hosts its own participation platform "My Berlin" in which several participation projects are presented. Among them is the collection of ideas for the future of the former airport Tempelhof. Two proposals focus on the SDGs and imagine the airport as a place for education and research oriented toward common good.

Similar to citizen participation, partnerships are emphasized on several governmental websites. In ten of the analyzed cities, partnerships play a role in connection to the SDGs. In Cologne, a network named "one-world city Cologne" is established which aims at motivating citizens to engage with sustainable development and provides a platform for exchanging ideas and making new contacts. Other cities count on town twinning and promote the SDGs in this context. For example, in Essen a workshop on "green twinning" took place with the partner cities Grenoble, Nischni Nowgorod, Zabrze and Essen. According to the website information, projects of the cities with an orientation toward the Agenda 2030 were discussed in an innovative and participative format. In 2018, Stuttgart celebrated the year of its town twinning and emphasizes the importance of partnerships also with regard to the Agenda 2030. In Munich, Green members of the city council requested the expansion of international project partnerships for supporting the SDGs. It is reported on long-term project partnerships with Subotica, Serbia to strengthened democracy and self-government as well as with Cape Town, South Africa, oriented toward climate protection. Reference is made to SDG 17, partnerships for the goals, and the necessity of municipalities to contribute to this goal is stated. In Munich, proposals like this are available on the city's website through a newsletter of the city hall, which further includes current news and events and responses to city council requests.

4.4   Practical Implications and Recommendations

This study revealed insights into information dissemination related to the SDGs of the 15 biggest German cities. Prime examples to raise awareness on the goals can be found in cities like Berlin or Hannover. Through events like film series and geocaching, these cities convey information regarding sustainable development in a creative format that might attract also those citizens who were not familiar with the SDGs before. The analysis could help cities to scrutinize their own information dissemination with regard to the SDGs on their governmental websites. Examples of other cities can thereby help in identifying possible chances to deal with the SDGs (A list of all mentioned examples can be found in Appendix A.1). Thereby, the cities can learn from each other and further build upon citizen participation and partnerships in order to contribute to sustainable development. Berlin, Hamburg, Hannover and Nuremberg publish a great amount of information regarding the SDGs. In other cities, there is still room for improvement for disseminating related information. Especially in Bremen, where not a single link to the SDGs was found, improvements can be made. Following Sriskandarajah (2018, p.302), who states that the SDGs "will not be achieved without significant public awareness and engagement," we recommend all cities to raise (further) awareness on the SDGs and all its embedded topics.

As a first step, we recommend cities to commit to the SDGs by officially signing the resolution template by the Association of German Cities and benefit from the corresponding network. Publishing an official resolution or council decision, emphasizes the commitment of the city and ensures transparency. In addition, a general overview page about the SDGs embedded on the governmental websites can help citizens to inform themselves about the purpose of the goals and the relevance for the city. Providing comprehensive information and links to further websites gives citizens the possibility to expand their knowledge.

In order to evolve into a smart city, or "an icon of a sustainable and livable city" (Chourabi et al., 2012, p. 2289), cities have to identify aspects that concern the citizens. Therein, the SDGs can provide a framework. With suitable forms of citizen participation, a city may identify topics related to the SDGs that are deemed relevant. The provision of information is a necessary step in this regard. Governmental websites give one possibility in doing so. Besides the availability of general information on the SDGs, a way to improve transparency is the publication of data and

indicators regarding sustainable development for a certain city. In the analysis, the availability of corresponding data on the governmental websites was not prevalent. Possible reasons for this can be separate (open) data portals hosted by the city where such information is embedded. Nonetheless, linking to these kinds of portals on the official website and preparing the data for greater clarity would further enhance transparency.

4.5   Discussion and Conclusion

The analysis of 15 local governmental websites in Germany revealed some interesting aspects on the information dissemination of these cities in relation to the SDGs:

- Not even half of the analyzed cities promote an official commitment to the SDGs on their governmental websites.

- In relation to the SDGs, topics that were mentioned most frequently on the websites of the analyzed cities are education, climate protection, fair trade, energy and mobility.

- The mentioned topics are deeply embedded in the SDGs with its own goal or through several targets, in particular the SDGs 4, 7, 11, 13 and 17 are addressed.

- Topics that are less represented on the governmental webpages about the SDGs are gender equality, poverty, health and peace.

- The way in which information is published differs notably. While some cities create a subpage to broadly inform on the SDGs and its implications for the city, others merely mention the goals in reports on related topics.

- Half of the cities emphasize citizen participation for implementing the SDGs on a local scale, whereas two-thirds highlight the role of partnerships.

In line with the USDG and the recommendations of the Association of German Cities, many German cities have already recognized the relevance of the SDGs on the urban level and agreed to implement the Agenda 2030 at the local scale. This supports the argumentation of Klopp and Petretta (2017) to realize sustainable development at the city scale.

Coming back to the assumption that most societies "aim for a combination of economic development, environmental sustainability, and social inclusion, but the specific objectives differ globally, between and within societies" (Sachs, 2012, p. 2206), the thematic emphasis on education, climate protection, fair trade, energy and mobility reflects the development status of Germany as a prosperous industrial state. A comparison with the information dissemination in a developing country, but also other developed or transitional countries would reveal further insights into thematic differences. Although the Agenda 2030 demands action of all countries, the concrete realization is dependent on cultural and economic factors.

Education seems to be the most important aspect in relation to the SDGs in the analyzed German cities. UNESCO (2017, p. 7) saw ESD as "a key instrument to achieve the SDGs." Many German cities support this idea by offering several learning opportunities that are oriented toward sustainable development. Besides students, the target group can consist of every interested citizens, by offering workshops, film series and similar activities with relevance to the SDGs for everyone. Besides the emphasized topics, there are several issues the governmental websites do merely inform about in relation to the SDGs. This supports previous works on information dissemination about sustainability on European governmental websites (Brusca et al., 2016; Navarro-Galera et al., 2016; Tirado-Valencia et al., 2016).

This study has some limitations. First, the analysis of websites can only provide a snapshot of reality as the content changes permanently. Second, a limited amount of cities was considered which should be expanded in future research. Future research could further analyze not only information dissemination with regard to governmental websites, but also corresponding social media accounts. Besides, we presented information dissemination with regard to the SDGs, but did not analyze in what sense citizens accept and adopt these, which is an essential aspect when considering sustainable development. Nonetheless, the analysis revealed some prime examples and topics that large German cities deem relevant with regard to sustainable development. This work can act as a starting point for further analyses on information dissemination in relation to the SDGs and the role of cities in this regard, also in other contexts.

References

Barth, J., Fietkiewicz, K. J., Mainka, A., Gremm, J., Meschede, C., Hartmann, S., & Stock, W. G. (2017). Informational Urbanism. A Conceptual Framework of Smart Cities. In *Proceedings of the 50th Hawaii International Conference on System Sciences, HICSS 2017, Waikoloa, HI, January 4-7, 2017* (pp. 2814–2823). Washington, DC: IEEE Computer Society.

Bibri, S. E., & Krogstie, J. (2017). Smart Sustainable Cities of the Future: An Extensive Interdisciplinary Literature Review. *Sustainable Cities and Society*, *31*, 183–212. doi: 10.1016/j.scs.2017.02.016

Blum, M., Mclaughlin, E., & Hanley, N. (2019). Accounting for Sustainable Development over the Long-Run: Lessons from Germany. *German Economic Review*, *20*(4), 1–37. doi: 10.1111/geer.12148

Brusca, I., Manes Rossi, F., & Aversano, N. (2016). Online Sustainability Information in Local Governments in an Austerity Context. *Online Information Review*, *40*(4), 497–514. doi: 10.1108/OIR-05-2015-0161

Bundesregierung. (2017). *Neue Deutsche Nachhaltigkeitsstrategie verabschiedet*. Retrieved August 8, 2018, from `http://www.bundesregierung.de/breg-de/aktuelles/neue-deutsche-nachhaltigkeitsstrategie-verabschiedet-748178`

Chourabi, H., Nam, T., Walker, S., Gil-Garcia, J. R., Mellouli, S., Nahon, K., . . . Scholl, H. J. (2012). Understanding Smart Cities: An Integrative Framework. In *Proceedings of the 45th Hawaii International Conference on System Sciences, HICSS 2012, Wailea, HI, January 7-10, 2012* (pp. 2289–2297). Washington, DC: IEEE Computer Society.

Chowdhury, G. (2013). Sustainability of Digital Information Services. *Journal of Documentation*, *69*(5), 602–622. doi: 10.1108/JD-08-2012-0104

Chowdhury, G., & 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), 2128–2138. doi: 10.1002/asi.23825

Corbett, J., & Mellouli, S. (2017). Winning the SDG Battle in Cities: How an Integrated Information Ecosystem Can Contribute to the Achievement of the 2030 Sustainable Development Goals. *Information Systems Journal*, *27*(4), 427–461. doi: 10.1111/isj.12138

Deutscher Städtetag.   (2015).   *2030-Agenda für Nachhaltige Entwicklung: Nachhaltigkeit auf kommunaler Ebene gestalten.* Retrieved August 1, 2018, from `http://www.staedtetag` `.de/fachinformationen/staedtetag/075357/index.html`

Engagement Global. (2018). *Zeichnungskommunen der Agenda 2030 Resolution.* Retrieved July 30, 2018, from `https://skew.engagement-global.de/zeichnungskommunen-agenda` `-2030.html`

Fairtrade Deutschland. (2018). *Fair Trade Towns.* Retrieved November 16, 2018, from `https://` `www.fairtrade-towns.de/no_cache/startseite/`

Fietkiewicz, K. J., Mainka, A., & Stock, W. G. (2017). Egovernment in Cities of the Knowledge Society. An Empirical Investigation of Smart Cities' Governmental Websites. *Government Information Quarterly*, *34*(1), 75–83. doi: 10.1016/j.giq.2016.08.003

German Federal Statistical Office.   (2018).   *Städte (Alle Gemeinden mit Stadtrecht) nach Fläche, Bevölkerung und Bevölkerungsdichte am 31.12.2016.*   Retrieved June 30, 2018, from `https://www.destatis.de/DE/ZahlenFakten/LaenderRegionen/` `Regionales/Gemeindeverzeichnis/Administrativ/Aktuell/05Staedte.html`

Huang, Z., & Benyoucef, M. (2014). Usability and Credibility of E-Government Websites. *Government Information Quarterly*, *31*(4), 584–595. doi: 10.1016/j.giq.2014.07.002

Janowski, T. (2016). Implementing Sustainable Development Goals with Digital Government - Aspiration-Capacity Gap. *Government Information Quarterly*, *33*(4), 603–613. doi: 10.1016/j.giq.2016.12.001

Klopp, J. M., & Petretta, D. L. (2017). The Urban Sustainable Development Goal: Indicators, Complexity and the Politics of Measuring Cities. *Cities*, *63*, 92–97. doi: 10.1016/j.cities .2016.12.019

Krippendorff, K. (2018). *Content Analysis. An Introduction to Its Methodology* (4th ed.). Thousand Oaks, CA: SAGE.

Lior, N., Radovanović, M., & Filipović, S. (2018). Comparing Sustainable Development Measurement Based on Different Priorities: Sustainable Development Goals, Economics, and Human Well-being - Southeast Europe Case. *Sustainability Science*, *13*(4), 973–1000. doi: 10.1007/s11625-018-0557-2

Mainka, A., Fietkiewicz, K., Kosior, A., Pyka, S., & Stock, W. (2013). Maturity and Usability of E-Government in Informational World Cities. In E. Ferrari & W. Castelnovo (Eds.),

Proceedings of the 13th European Conference on E-Government, ECEG 2013, Varese, Italy, June 13-14, 2013 (pp. 292–300). Sonning Common, UK: ACPI.

Mayring, P. (2015). *Qualitative Inhaltsanalyse: Grundlagen und Techniken* (12th ed.). Weinheim/Basel, Switzerland: Beltz.

McMillan, S. J. (2000). The Microscope and the Moving Target: The Challenge of Applying Content Analysis to the World Wide Web. *Journalism and Mass Communication Quaterly*, *77*(1), 80–98. doi: 10.1177/107769900007700107

Navarro-Galera, A., Alcaraz-Quiles, F. J., & Ortiz-Rodríguez, D. (2016). Online Dissemination of Information on Sustainability in Regional Governments. Effects of Technological Factors. *Government Information Quarterly*, *33*(1), 53–66. doi: 10.1016/j.giq.2015.12.003

Nolin, J. (2010). Sustainable Information and Information Science. *Information Research - An International Electronic Journal*, *15*(2), paper 431. Retrieved from `http://informationr.net/ir/15-2/paper431.html`

OECD. (2018). *Urban Population by City Size*. Retrieved August 10, 2018, from `https://data.oecd.org/popregion/urban-population-by-city-size.htm`

Open Data Watch. (2017). *Open Data Inventory 2017. Country Profile Germany*. Retrieved October 1, 2018, from `http://odin.opendatawatch.com/ReportCreator/ExportCountryReport/DEU/2017`

Sachs, J. D. (2012). From Millennium Development Goals to Sustainable Development Goals. *The Lancet*, *379*(9832), 2206–2211. doi: 10.1016/S0140-6736(12)60685-0

Spink, A. (1995). Information and a Sustainable Future. *Libri*, *45*(3-4), 203–208. doi: 10.1515/libr.1995.45.3-4.203

Sriskandarajah, D. (2018). A People's Agenda: Citizen Participation and the SDGs. In R. Desai, H. Kato, H. Kharas, & J. McArthur (Eds.), *From Summits to Solutions: Innovations in Implementing the Sustainable Development Goals* (pp. 302–317). Washington, DC: Brookings Institution Press.

Tirado-Valencia, P., Rodero-Cosano, M. L., Ruiz-Lozano, M., & Rios-Berjillos, A. (2016). Online Sustainability Information in European Local Governments. *Online Information Review*, *40*(3), 400–415. doi: 10.1108/OIR-05-2015-0155

UNESCO. (2017). *Education for Sustainable Development Goals: Learning Objectives*. Retrieved August 15, 2018, from `https://unesdoc.unesco.org/ark:/48223/pf0000247444`

United Nations. (2015a). *Sustainable Development Goals.* Retrieved January 5, 2018, from
`http://www.un.org/sustainabledevelopment/sustainable-development-goals/`

United Nations. (2015b). *Transforming Our World: The 2030 Agenda for Sustainable Devel-
opment.* Retrieved January 8, 2019, from `https://sustainabledevelopment.un.org/`
`content/documents/21252030AgendaforSustainableDevelopmentweb.pdf`

United Nations. (2018). *Sustainable Development Goal 17.* Retrieved April 3, 2019, from
`https://sustainabledevelopment.un.org/sdg17`

United Nations. (2019). *World Urbanization Prospects: The 2018 Revision.* New York,
NY: United Nations. Retrieved August 1, 2018, from `https://population.un.org/wup/`
`Publications/Files/WUP2018-Report.pdf`

WCED. (1987). *Report on the World Commission on Environment and Development. Our
Common Future.* Oxford, UK: Oxford University Press. Retrieved August 5, 2018, from
`http://www.un-documents.net/our-common-future.pdf`

5 Mobile Application Services Based Upon Open Urban Government Data

5.1 Introduction

More than half of today's world population lives in urbanized areas. Moreover, in most countries of the world the citizens own and use mobile devices. Especially in so-called "informational cities" (Castells, 1989) or "smart cities" (Hollands, 2008; Shapiro, 2006), which are prototypical communities in the knowledge society (Stock, 2011). In the Apps for Smart Cities Manifesto we read, "To harness the true potential of Smart cities, the city must become a platform, i.e. an enabler for developers, creativity and applications. In doing so, the city becomes like the Internet, i.e. a connector and an enabler for citizens, which aims to empower the citizen. Smart city applications are similar to conventional mobile applications" (Jaokar, 2012, para. 1).

There is a huge amount of open data from official statistics (e.g., data about the age structure of citizens), from sensor-based services (e.g., data about local traffic), and from users (e.g., feedback). Open government data is not only present on the country- and state-level, but also on the level of cities or municipalities. Therefore, we introduce the term open urban government data to refer to the use of open data on the local-level. Many m-apps use this open urban government data for their services and offer new ways of access to governmental documents and records. "The public data is the fuel that makes these applications work" (Millard, 2010, p. 9).

Such urban m-apps are indicators for the evolution of "ubiquitous government" (Belanger, Carter, & Schaupp, 2006) or "smart government". "Smart Government will share resources and information and interoperate with other governments, citizens, NGOs and for-profit businesses much more smoothly than today" (Scholl, 2012, p. 324). The shared resources include "big data" as well as "accurate, comprehensive, and reliable information" (Scholl & Scholl, 2014, p. 167). The aim of such activities of e-government services development and implementation, or of "open government 2.0" is to empower the citizens (Sandoval-Almazán, Gil-Garcia, Luna-Reyes, Luna, & Rojas-Romero, 2012) and to generate new economic and social values (Jetzek, Avital, & Bjørn-Andersen, 2013). Ubiquitous apps can "make it possible to imagine and to do things with a

mobile phone that were previously never associated with the technology" (Goggin, 2011, p. 151). Urban m-apps include location-based participation, "for example helping to re-design the park you're walking in, or the hospital organization which kept you waiting and you think you have a solution" (Millard, 2010, p. 8). Desouza and Bhagwatwar (2012) call such applications, which solve even complex urban problems, citizen apps. But the participation of the citizens goes far beyond the simple commenting on communal problems.

Some municipal governments are looking for successful m-apps, which is reflected in tremendous adaptation of hackathons (hacker marathons). In these hackathons members of government institutions and citizens come together and work on new innovations (Baraniuk, 2013; Briscoe & Mulligan, 2014; DiFranzo et al., 2011), such as the AppVenture Challenge, staged by the Infocomm Development Authority (IDA) of Singapore (Chan, 2013). Nevertheless, the potential of urban m-apps has been highlighted by different researches on open data or mobile applications, however, there is a lack of systematic analyses in this field. In this paper we model a typology of m-apps based on open urban government data and present a unique overview of the variety of types, used operating systems, and developers in order to help governments and m-app developers to identify already existing m-apps. Thus, the study helps to clarify the state of the art of m-apps development. The extension of city-wide exchange between developers and governments could help to improve and adapt successful m-apps.

5.2   Research Background

5.2.1   Open Data - Open Government Data - Open Urban Government Data

In our context, data means quantitative values resulting from measurements and other sources. Open data refers to data which is freely accessible online, while there are no technical or legal restrictions to reuse it (Jetzek et al., 2013). Open government data is open data produced by the government (Open Knowledge International, n.d.-a). Prominent examples of open government data on the national level are `data.gov` (U.S.), `data.gov.uk` (United Kingdom), and the European Union Open Data Portal (`https://open-data.europa.eu/de`). Open urban government data is open government data on the local level like `DataSF.org` (San Francisco, CA) or `Open.Wien.at` (Vienna, Austria).

There are three types of sources for open urban government data: official statistics, sensor-based data, and user-generated content (López-de Ipiña, Vanhecke, Peña, De Nies, & Mannens, 2013). Official statistics include data on population, businesses and economics, jobs, crimes and justice, health, etc. (see as an example: `data.gov`). Additionally, there are city-specific official data collections such as the urban forest map of San Francisco (`http://urbanforestmap.org/`) with detailed data on trees in the city. Sensor networks (Kitchin, 2014) include real-time data from sensors placed in the city, e.g., street lighting, humidity, temperature, gas, electrical resistivity, acoustics, air pressure, movements, speeds, and of transponders monitoring empty spaces in car parks, data from closed circuit television (CCTV), or the progress of trains and buses along a route (Kuhn, 2011), all in all, sensor-based "big data" with relevance for the city (Bettencourt, 2014). Another type of big data is user-generated content, for example, GPS-based data from mobile devices (Boyd & Crawford, 2012). On all these channels data is created and can be analyzed to provide services for citizens. One challenge hereby is to handle the huge amount of big data to make meaningful statistical analyses. Therefore, Boyd and Crawford (2012, p. 663) ask, "Will large-scale [...] data help us to create better tools, services, and public goods?"

5.2.2 M-Government

E-government is a government existing on the web and characterized by functions such as information dissemination (government to users), communication, transaction, interoperability (vertical and horizontal integration) as well as participation (Moon, 2002). M-government implies the use of mobile technologies (e.g., smartphones and tablets) in e-government. Sometimes, especially in Korea, m-government is called ubiquitous government or u-government (Belanger et al., 2006; Cho & Chun, 2010). M-government enables location-based services (Carroll & Ganoe, 2009), which are "personalized services delivered to a mobile device user at a remote location, so citizens can get immediate access to certain government information and services on an anywhere-anytime basis. The government can use the scalable and swift wireless channels to send time-sensitive information such as terror and severe weather alerts to citizens quickly and directly" (Trimi & Sheng, 2008, p. 54). M-government services require another form of (open) data, namely geo-referenced information (data with spatial attributes) (de Reuver, Stein, & Hampe, 2013) and devices which are equipped with a Global Positioning System (GPS).

5.2.3   M-Apps Based Upon Open Urban Government Data

Open urban government data show their assets to advantage when combined among each other or with further open tools such as Google Maps in the sense of mashups (DiFranzo et al., 2011). Such linked data will break "data out of the silos" (Shadbolt & O'Hara, 2013, p. 73) and "facilitates the provision of innovative services" (Shadbolt & O'Hara, 2013, p. 72). Ding, Peristeras, and Hausenblas (2012) identified three stages of the development of applications which are based upon open government data. (1) In the "open stage", governments put their datasets online in reusable formats. (2) In the "link stage", participants combine and link different datasets using declarative links (e.g., a standard vocabulary or concept mapping). (3) Finally, in the "reuse stage", developers build - normally in the form of a mashup - the desired m-apps.

Nowadays, there are different mobile-device operating systems (mainly Google's Android and Apple's iOS, but also less prevalent ones such as Microsoft's Windows Phone, BlackBerry 10) and no single standard for them. Hence, it is possible to create Web Applications optimized for the usage on mobile devices, however, these m-apps need to be designed for each operating system separately. Hitherto, little research has been done on m-apps based on open urban government data and there is lack in empirical scientific evidence upon the quality and quantity of those applications.

5.3   Research Framework

According to OECD/ITU (2011), we are in need of application developers (programming the interfaces between the device and the network) as well as content developers and enablers (compiling content into mobile-ready formats) for the development of m-apps. Citizens become "data pro-sumers (both consumers and providers of data)" (Charalabidis, Loukis, & Alexopoulos, 2014, p. 2114). Designing m-apps by end-users "can require significant technological innovation" (Desouza & Bhagwatwar, 2012, p. 109). Concerning this matter, it will be interesting to see whether it is possible to change the users' behavior "from apathy to adoption" (Schaupp & Carter, 2005) and further to co-development and co- implementation of e-government services. Thus, we will analyze whether citizens or organizations change their role from consumer to a prosumer, and define our first hypothesis as follows:

H1: Not only government agencies, but also citizens develop m-apps based on open urban government data.

At e-government's participation level, "crowd participation" (Garcia, Vivacqua, & Tavares, 2011) leads to real-time m-participation of the citizens resulting in new forms of citizen engagement in the city's development (de Lange & de Waal, 2013). The critical success factor and key driver of mobile government services - including services for emergency and disaster management (Aloudat, Michael, Chen, & Al-Debei, 2014) - is the service's perceived usefulness (Hung, Chang, & Kuo, 2013). One could think that m-apps that cover more topics (e.g., museums, hospitals, news) and features in one are more useful. Thus, we hypothesize:

H2: M-apps with many topics or features are more often downloaded (than those which cover one topic entirely) because they are more useful.

Combining the aspect of becoming a pro-sumer and of service's perceived usefulness, we assume:

H3: M-apps which are developed to improve the city and ask for citizen participation (e.g., reporting broken lights) are more often downloaded than m-apps without this feature.

There co-exist m-app stores which support four operating systems: iOS, Android, Windows Phone, and BlackBerry 10. However, the second and third hypotheses are limited to Android m-apps because this app store is the only one providing download numbers. Some developers create m-apps in order to reach all smartphone users for more than one system. Others develop mobile Web Applications which may be retrieved by any smartphone using a web browser independently of their operating system. Government agencies as service providers have to serve as many citizens as possible. Considering the fact that there is no standard operating system of mobile devices (Tilson, Sorensen, & Lyytinen, 2012), we hypothesize:

H4: Government agencies develop equal m-apps for different operating systems to reach a wide range of smartphone users.

5.4 Data Collection

To find a good starting point for our empirical research, we applied a subset of "Informational World Cities" (Mainka, Hartmann, et al., 2013; Mainka, Hartmann, Stock, & Peters, 2014). Due

to the language barrier, Asian cities were excluded from this investigation except for Singapore and Hong Kong, where the commercial language is English. Online translation tools like "google translate" are not working sufficiently enough to translate Chinese or Japanese sentences. Thus, the m-app descriptions could not be analyzed by the indexers. In total, 24 city governments from the USA, Canada, Australia, Europe, and Asia are included in our corpus (Table 5.1). From prior projects we know that all those metropolitan regions are on their ways to become prototypical cities of the knowledge society, so to speak "top class" Informational World Cities with enhanced infrastructures, e.g., ICT infrastructure.

The corpus is based on m-apps which are listed at government websites and work with government data or government interaction like `data.gov.sg/AppShowcase/AppList.aspx`. This is a special website of the government of Singapore which lists applications and projects resulting from open data use. Considering that some websites are not as easy to find, we wrote emails to the corresponding authorities and asked for further information about m-apps based on government data. To avoid duplicates in our dataset, we restricted our corpus to m-apps which are developed for one city only - this filters popular m-apps like TripAdvisor, which is not based on government data but sometimes also listed on governments' websites. The research was conducted between April 5, 2014 and June 13, 2014 and relies on the data which was available online at that time. To answer our hypotheses, a qualitative content analysis was needed (Krippendorff, 2018; Neuendorf, 2002).

In order to identify the topics and features of an m-app, we established a coding scheme for each topic based on the classification system by Desouza and Bhagwatwar (2012). All detected topics and features will be explained in the results. Three indexers coded the data using the information of app stores and government websites. Every m-app has been analyzed by two

Table 5.1: List of analyzed cities

Amsterdam (The Netherlands)	Hong Kong (China, SAR)	Paris (France)
Barcelona (Spain)	London (United Kingdom)	San Francisco (U.S.A.)
Berlin (Germany)	Los Angeles (U.S.A.)	Singapore
Boston (U.S.A.)	Melbourne (Australia)	Stockholm (Sweden)
Chicago (U.S.A.)	Milan (Italy)	Sydney (Australia)
Dubai (U.A.E.)	Montreal (Canada)	Toronto (Canada)
Frankfurt (Germany)	Munich (Germany)	Vancouver (Canada)
Helsinki (Finland)	New York City (U.S.A.)	Vienna (Austria)

indexers independently from each other. If there was inter-indexer consistency, the selected topics were marked; if there was no joint consensus, the indexers discussed their decisions and reached a compromise. To detect successful and popular m-apps, we used the amount of downloads as an indicator. This is a specialty of the Play Store (`https://play.google.com/`) where Android applications are available. There are no exact figures but data intervals. The other app markets do not show download numbers. Therefore, we were only able to analyze the download numbers of Android m-apps.

5.5 Results

In this section we present the results of our analysis of the exemplary cities as guided by the aforementioned hypotheses. First of all, we have to categorize the variety of m-apps found for the 24 cities and provide an overview of common topics and features. After presenting the state of the art of m-app development based on our analysis we will examine the before mentioned hypotheses.

5.5.1 Typology of M-Apps

Using the classification system by Desouza and Bhagwatwar (2012) we quickly reached its limits and decided to extend their model from classes to "types of applications" because, firstly, one m-app may fulfill the limitations of more than one class, and secondly, we are not able to describe a full classification of m-apps because of the limited corpus. Therefore, we defined six types of applications that represent m- apps of different thematic dimensions, and eight features which can be used independently of contents (Figure 5.1). The definition of all types and features will be described in the following paragraph.

Mobility applications are those providing their users with information and orientation on *Public Transport* (e.g., Metro plans) or *Traffic* (which includes traffic jams and routes). If there is information available about *Accessibility*, e.g., for handicapped persons, the application is also listed there. Applications provide *Points of Interest (POI)* when they refer to events and places for tourists or local people. We distinguish between applications with *Multi Topic* (e.g., parks, museums, and police stations) and *Single Topic* (e.g., just parks) information. M-apps of the
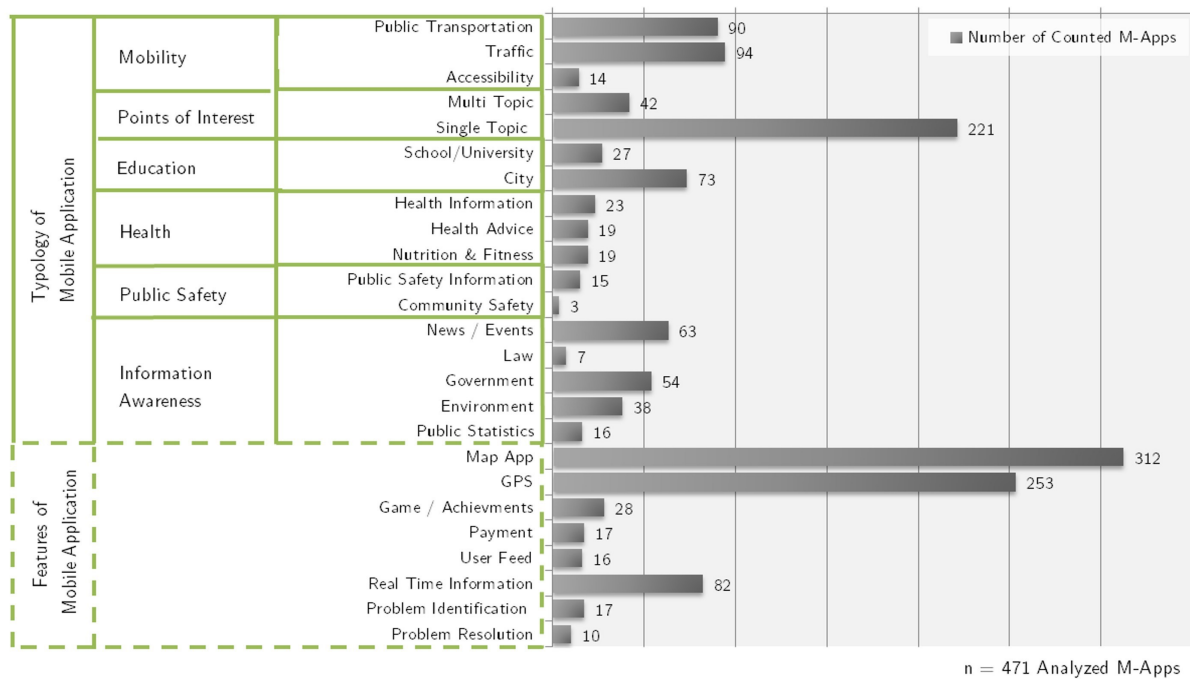
Figure 5.1: Typology and features of m-apps and amount of counted m-apps

type *Education* refer to education about the *City* itself or special *School/University* applications that are developed by schools and universities for their students or parents. *Health* applications provide their users with information about surgeries, hospitals and emergency aid. There are also m-apps that give *Health Advise* or address *Fitness & Nutrition*. Applications in the category *Public Safety* include *Information* on police stations, emergency calls, etc., or work by *Community Safety*, e.g., users inform about the safety in their neighborhood. *Information Awareness* can appear in different ways. There are applications that break *News* and others that inform about *Laws*. Sometimes the *Government* wants to inform its citizens about urban issues. *Environment* and *Public Statistics* are also topics that m-apps deal with. In the further analysis, we will use the term type in reference to the detected topics of this typology.

Many m-apps combine their content with additional features like a *Map* and *GPS*, which includes Google Maps or open city maps; *Game/Achievement*, e.g., a quiz or a puzzle, or on the achievement side points for reaching special goals; *Payment* where users can purchase parking or public transport tickets; *User Feed* options to get in contact with the government or developers; and *Real Time Information* which provides immediate data directly after its collection. Applications with the features *Problem Identification* and *Problem Resolution* are intended to make the city more secure, clean, and livable. Users can, for example, report a problem like a broken street

light. If the goal is solely *Problem Identification*, there will be no feedback on the resolution of the problem. If *Problem Resolution* is intended as well, users will, e.g., be informed by the appropriate department when the problem is solved.

5.5.2 Distribution of Types and Features of Urban M-Apps

In this section we present the available m-apps for each operating system; in section 5.5.4 the popularity of the different topics and features will be limited to Android apps only. All in all, we detected 471 m-apps the cities' governmental websites link to. These m-apps were dedicated to 17 subtypes and eight features (see Figure 5.1). Single Topic as a subtype of the rubric Points of Interest is the category that most m-apps were dedicated to, with more than 200 in number. Since we analyzed m-apps concerning specific cities, this is not surprising. All of those cities are world cities with many POIs, like museums, theatres, bus stops, swimming pools, etc. The m-app "NYC Condoms" (New York), for example, shows its users the nearest venues for FREE NYC Condoms. However, only a few m-apps refer to POIs with different topics (Multi Topics), like cultural facilities, sport facilities, etc., in one application. These applications are often developed by tourism boards or agencies. Similar to the amount of Single Topics m-apps, a high amount of m-apps can be assigned to Public Transportation (90) and Traffic (94). Like POIs, Mobility service is an important need in larger cities, not only for the everyday life of its citizens, but also for tourists.

In contrast to Real Time, Map, and GPS, the features Payment, Game/Achievement, Problem Identification, Problem Resolution, and User Feed are far less often offered, which underlines the importance of navigation in the analyzed cities (see Figure 5.2 and Figure 5.3). Three hundred and twelve m-apps provide a Map, 253 GPS and 82 Real Time Data (Figure 5.1). Likewise, the number of m-apps which combine the features Real Time, GPS, and Map are the highest for the subtypes Single Topic, Traffic, and Public Transportation. In addition to the aforementioned features, Payment is mainly available for m-apps typed as Public Transportation or Traffic and the most m-apps with gaming features are offered for the purpose of Education in regard to the City and POIs with a Single Topic. A mentionable example is the m-app "Anne's Amsterdam" (Amsterdam) which shall give citizens and tourists an understanding of what happened during the World War II and guides through Amsterdam with focus on that period of time. This m-app
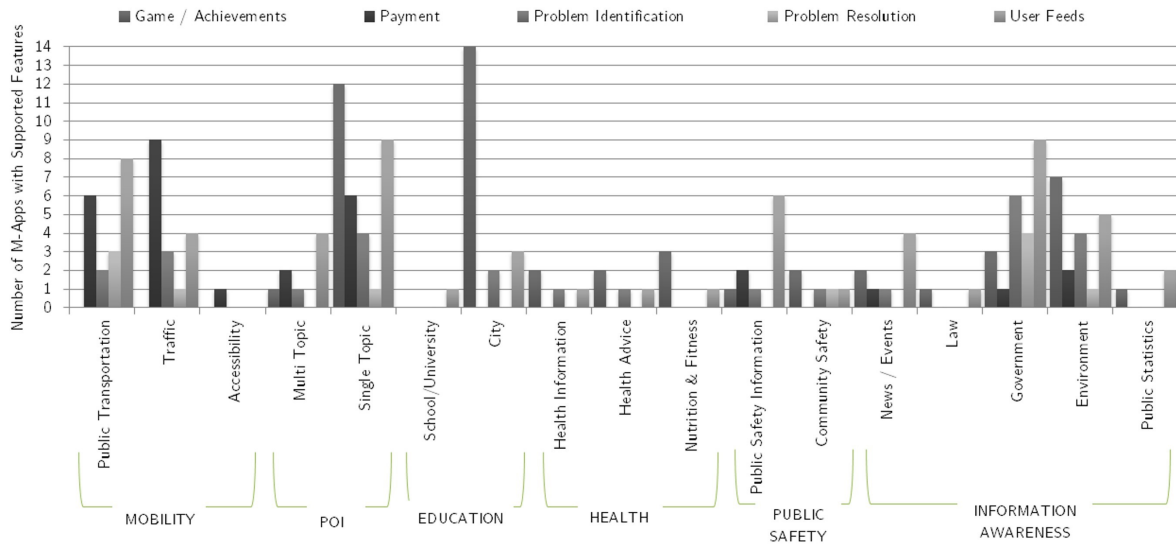
Figure 5.2: M-app types in relation to the features game/achievements, payment, problem identification, problem resolution, and user feeds
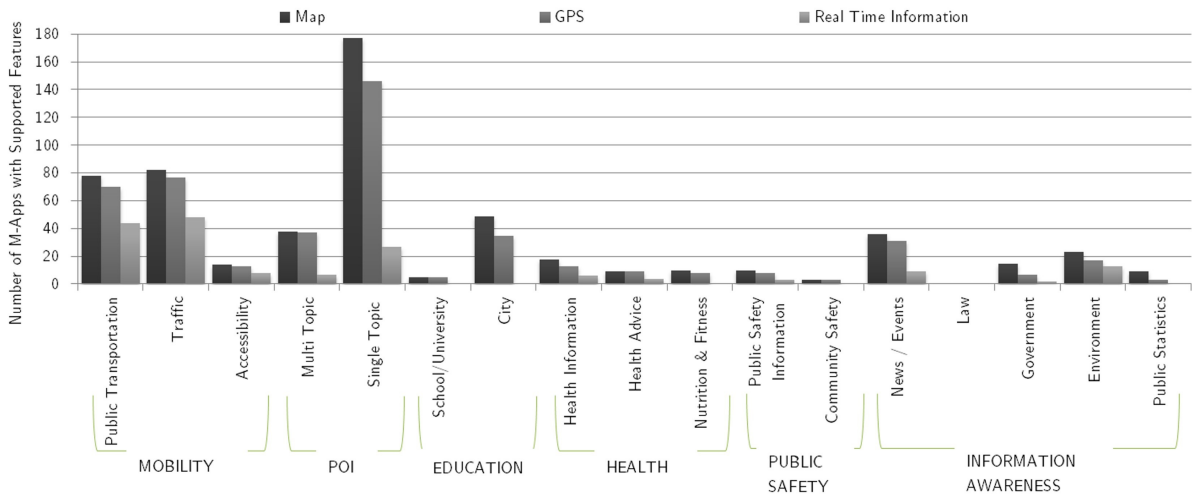
Figure 5.3: M-app types in relation to the features map, GPS, and real time information

provides gaming-elements by challenging its users to collect items which can be used to create an album about Amsterdam.

User Feeds are primarily used for the subtypes Single Topic, Government, and Public Transportation. The features Problem Identification and Resolution are most offered in m-apps of the type government information. Often those m-apps using User Feed for government information awareness additionally provide Problem Identification and/or Resolution. For example, the m-app "Boston Citizens Connect" is offered by the City of Boston, MA to report on social issues, like potholes, graffiti, etc. The specialty of this m-app is that citizens can watch the status of their request.

In general, the subtypes which provide the most features are Public Transportation and Traffic. Examples are "FahrInfo Berlin", a Berlin m-app for timetable information, planning routes, and ticketing and "ComfortDelGro Taxi booking" (Singapore) which allows users to book a taxi depending on their current location (GPS). The subtypes to which the fewest m-apps are dedicated to are Laws, Accessibility, and both subtypes of Public Safety. Since we know more about the variety of citizen m- apps, now we want to investigate whether our hypotheses H1 to H4 meet the results of the data.

5.5.3   Developers of Urban M-Apps

Not only companies can develop applications but also every citizen with programming skills can develop m-apps. For example, Vienna offers many m-apps developed by private persons like Christian Fessl (`http://chrfessl.blogspot.de/`), who used the city's open data for the m-app "Museen Wien". However, not in all cases the developer description is clear enough to distinguish between governmental agencies, companies, and citizens, who may develop applications just because they are interested in. Especially the difference between companies and citizens is difficult to determine, since citizens can start a business with their successful m-apps and name it with their personal names, although they pursue commercial purposes. Therefore, only governmental developers, like the city's government itself, a governmental department or institution, or other developers, who mentioned that they work in corporation or on behalf of the city's government, are considered as "developed by government agencies" in our analysis. For example, the "Ajuntament de Barcelona" which developed most of Barcelona's m-apps is recognized as a government agency as well as the "Environmental Protection Department of HKSARG" (Hong Kong).

Figure 5.4 presents the numbers of m-apps developed by government agencies and non-government persons or institutions. These numbers vary greatly between cities. For example, Hong Kong offers the highest number of m-apps and most of them are provided by government agencies. Barcelona and Dubai offer similar results: Most of all presented m-apps are developed by a government agency. In contrast, none of the m-apps found on Vienna's and Chicago's government websites could be recognized as ones developed by a government agency.
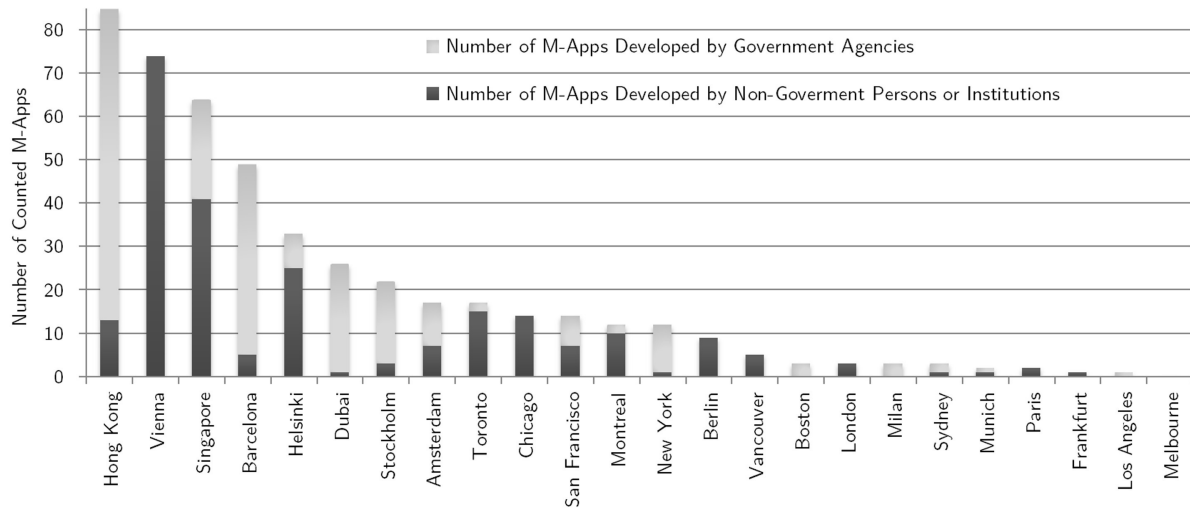
Figure 5.4: Developer of m-apps: government agencies vs. non-government persons or institutions

5.5.4   Popularity of Urban M-Apps

The popularity of m-apps can be measured by the amount of downloads. Since downloads mean that smartphone users have used an app at least once. The Android Play Store is the only app market that offers this information. If one would like to identify the popularity of iPhone apps, the only hint is given by a popularity list. The iPhone app market iTunes offers a popularity list for every category in its store. However, there is no information about the amount of users who may have used an app. Thus, it is possible that the "best" app in one category could just be downloaded 100 times, whereas the "best" app in another category was downloaded more than one million times. Therefore, we decided to refer in this section to Android m-apps only, which means that our second and third hypotheses are analyzed only for this app store as well.

Most of the Android m-apps (24%) have been downloaded between 1,000 to 5,000 and 10,000 to 50,000 times. Figure 5.5 shows the download numbers for the different types of applications. The download numbers of Android m-apps for a specific type have to be viewed in regard to the total number of m-apps of that type. For example, more applications of the type Point of Interest are downloaded than of Mobility since the total number of offered POI m-apps is larger. With the exception of the type Mobility, the highest numbers of m-apps for all types were downloaded between 1.000 and 5.000 times. For the type Mobility we see that there are a lot of very successful m-apps. Sixty percent of these m-apps have been downloaded at least 10,000 times, whereas only 35% of m-apps assigned to the type POI reach that download numbers.
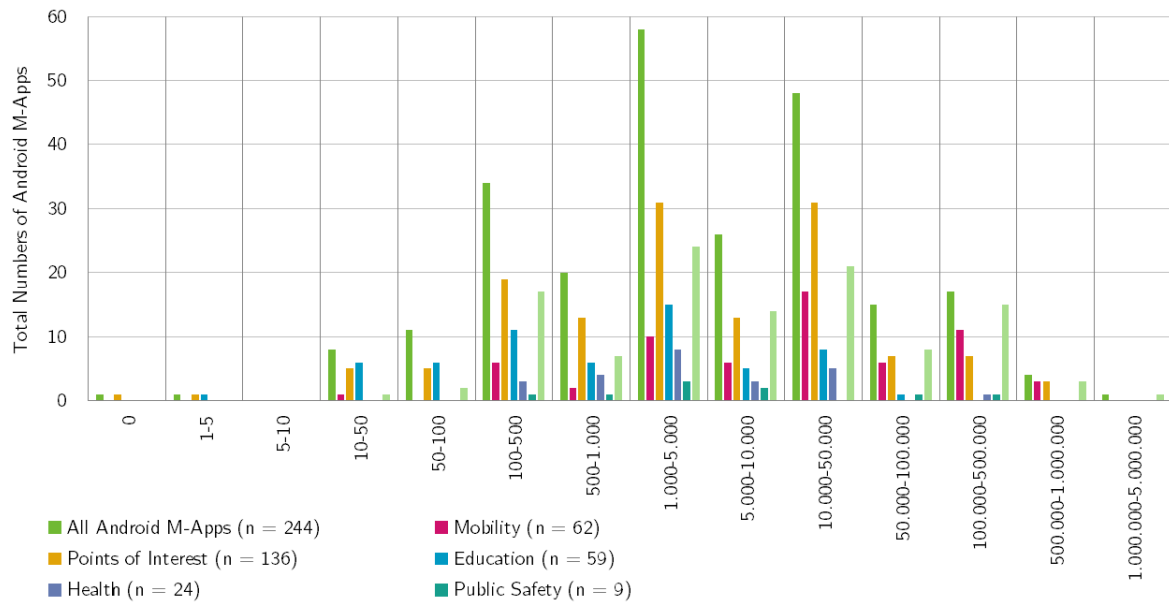
Figure 5.5: Distribution of download numbers in relation to types

Essential city data like traffic information seem to be more important for citizens. For m-apps of the type Education it is more critical to achieve a very high download number, only 15% have 10,000 downloads or more. There is only one m-app that has more than 1,000,000 downloads, namely "MyObservatory" (Hong Kong), which provides meteorological data. It is only dedicated to one type, which is Information Awareness.

Between all considered Android m-apps, there are only two that have been assigned to four different types. The first one, "Barcelona Official Guide" serves the types Mobility, Points of Interest, Education, and Information Awareness. It has been downloaded between 10,000 and 50,000 times. It combines information on events and interesting places with Public Transport connections. The second one, "mDubai", which has been downloaded 5,000 to 10,000 times, is listed in Points of Interest, Health, Public Safety, and Information Awareness. This application offers news and events of the Dubai Government, as well as e-services, information on hospitals, and many other important locations.

In addition to the comparison of the diverse types of the downloaded m-apps, the diverse features of those applications can be compared (Figure 5.6). Among all m-apps that have been downloaded at least 10,000 times (85 m-apps), 60% use GPS. On the other side, only 5% of applications with less than 500 downloads offer GPS. Other features, like Game/Achievement (4%), Problem Identification (4%), or Problem Resolution (1%) are not very common among
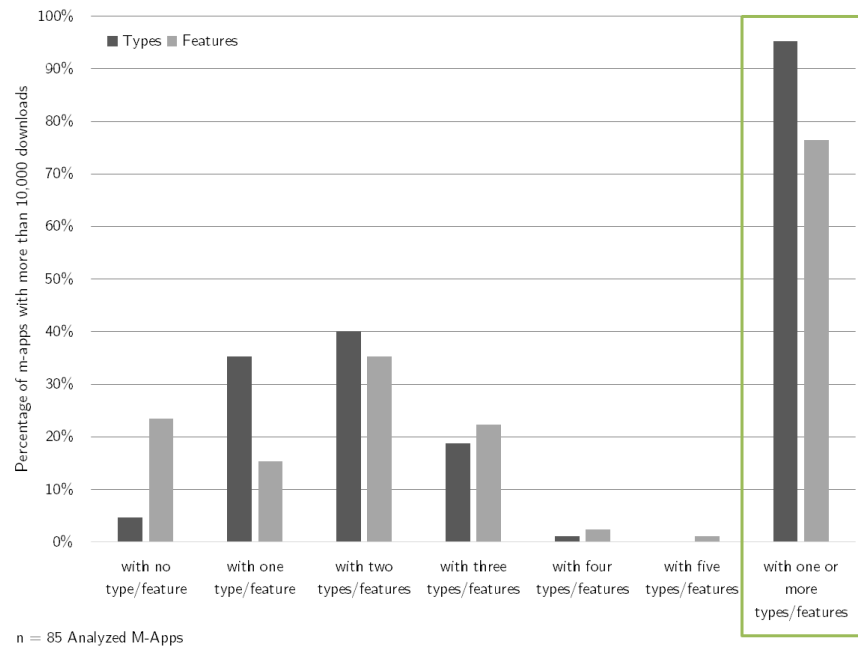
Figure 5.6: Percentage of m-apps with more than 10,000 downloads in relation to their number of types and features

the top downloaded m-apps. Further, 24% of the successful applications do not even have any feature. Only 3.5% of the top Android applications have more than three features. Fifteen percent provide exactly one feature, 35% have two features, and 22% three features. As a result, more features do not imply more downloads. Amongst the analyzed features we assigned to the m-apps, Payment is a rather rare feature. For citizens it is a comfortable possibility to pay via an application. But such applications work with sensitive data which comes with several risks. In total, only 17 out of the analyzed 471 m-apps work with the feature Payment.

5.5.5   Operating Systems of Urban M-Apps

Like in Tilson et al. (2012), our findings clearly show that there are two wide-spread operating systems (Android and iOS) for m-apps. This seems to be noteworthy with regard to the specific characteristics of information markets. The more users an information service is able to attract, the more value the service will have. More valuable services will attract further users. If an information service passes the critical mass of users, network effects will start (Katz & Shapiro, 1994). Our analysis shows that there is still no agreement on one operating system. Figure 5.7 shows the number of all counted m- apps in comparison to the number of m-apps of a specific operating system. Android and iOS m-apps are the predominant ones amongst all operating

systems. Most iOS applications are provided by Hong Kong (81), Barcelona (49), and Singapore (43). Android applications are also particularly found in Hong Kong (74) and Barcelona (30). Some m-apps are available for different operating systems, e.g., 41% of all m-apps are available for both, iOS and Android. The application "bicing" (Barcelona) has even been developed by the government for four different systems: iOS, Android, Windows Phone, and BlackBerry. This app shows available city bikes on a map and its distances to each other. Furthermore, Figure 5.7 shows the number of m-apps developed by government agencies in comparison to the distribution of m-apps with different operating systems.

It is conspicuous that in cities, where government agencies as developers are predominant (like Hong Kong), m-apps for Android and iOS are primarily offered. In total, 168 m-apps have been developed by government agencies and just ten of them were developed for Android only. In contrast, 87% of m-apps from non-governmental developers are designed for one operating system only. That means, e.g., that only iOS or only Android users may benefit from these m-apps. Indeed, Windows Phone, Blackberry, and Mobile Web Applications are less frequently represented in the majority of all investigated cities. However, Helsinki and Vienna, which are dominated by non- governmental developers, offer a plenty of Mobile Web Applications, which can be used independently of the operating system.
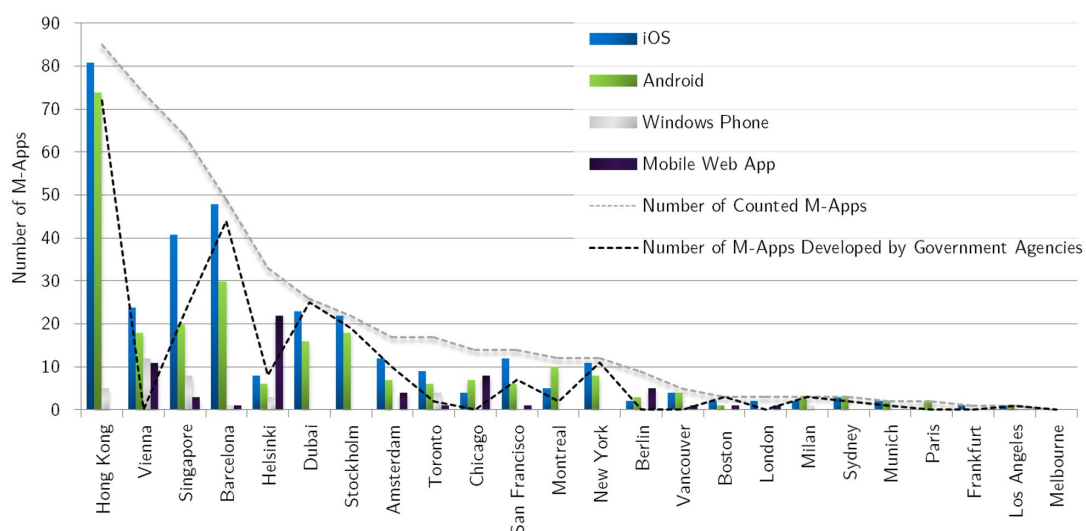
Figure 5.7: Operating systems in relation to the analyzed city and the m-app developer

5.6   Discussion

To classify m-apps like Desouza and Bhagwatwar (2012) did in their classification model was not sufficient for the broad range of m-apps we found. Therefore, we needed to expand and redesign the defined classes used in this investigation as described in the results. As the development of m-apps based upon open urban government data is a fast moving topic, new m-apps emerge frequently. In addition, the m-app descriptions in app stores are in some cases very short, which makes it difficult to recognize all types and features the m-apps could be assigned to. These descriptions are also the information users have to rely on before downloading an application. The app stores do not have a consistent and proved categorization system either.

Our first hypothesis was whether open data provided by the government animates citizens and institutions to develop own m-apps (H1). Our results show that there is no consistent answer for all cities. In some cities all m-apps have been developed by citizens and institutions, e.g., Vienna, in the others the government agencies developed masses of m-apps, e.g., Hong Kong. Both cities offer a high amount of m-apps compared to other cities and both cities open all their digital data on a website (Data website Vienna: `https://open.wien.at/site/datenkatalog/`, Data website Hong Kong: `http://www.gov.hk/en/theme/psi/datasets/`) in a structured way. Citizens and regional companies from Vienna work with that data on their own; in Hong Kong the city invested a lot of money to produce own governmental m-apps. This shows that available open data do not necessarily lead to a high production of m-apps by citizens and non-governmental organizations. Therefore, there is need for more analyses about cultural or regional characteristics which may influence the amount of "private" developers.

The second hypothesis refers to the usefulness of m-apps. We assumed that those applications which serve many features and types are downloaded more often (than those which cover one type entirely) (H2). Our investigation shows that m-apps with one or more types or features are very popular, but it is not necessary to have any feature. Thus, we cannot prove our hypothesis. A lot of m-apps belong to the type Single Topic (POI). Like in the case of Vienna: The government offers a huge amount of data sources which are related to locations like theaters, museums, galleries, toilets, etc. There exist a lot of m-apps for different operating systems, which just locate, for example, all museums in the city, but do not tell you where the next ATM is. If

you like to know this, you have to download another m-app for ATM locations. Most of those m-app services work with Google Maps. Only a few historical maps, like in Helsinki, or open maps created by the city's government, like in Singapore, are used. However, there are no m-apps which cover the whole array of types. Furthermore, m-apps which offer a wide range of topics did not receive more downloads than those which address one topic only. Possibly, citizens prefer to download m-apps that cover their specific needs, whereas m-apps which consolidate several topics may contain unnecessary contents and take too much memory space. Another reason might be that the combination of topics and features is not yet as useful as it could be. Therefore, the reasons for that should be analyzed in future work. However, governments can find out more about citizens needs by hackathons and app competitions. Nevertheless, some m-apps are very successful in gathering high download numbers. Considering the m-apps of the three categories of the highest download numbers, it is conspicuous that most of those applications are from Hong Kong and Singapore which are the first and third placed cities regarding the total number of counted m-apps. To sum up, the limitation on Android download numbers only shows the popularity of Android m-apps. It was not possible to compare the download numbers from different operating systems. Another factor which should not be missed when dealing with this data is that the frequency with which the m-apps in general are used or deleted is not published at app stores.

We also hypothesized that m-apps which are developed to improve the city and ask for citizen participation (e.g., reporting broken lights) are downloaded more often than m-apps without this feature (H3). Our results can not verify a relation between m-participation (de Lange & de Waal, 2013) and the amount of downloads. The amount of downloads for m-apps with the features Problem Identification or Problem Resolution is very small. The reason for this small amount may be the fact that the citizens do not see the usefulness of these applications for their everyday life. In contrast, m-apps of the type Mobility appear to be more useful for them, since their download counts are higher. This may also explain the success of GPS and Map as a feature, which helps citizens and tourists to navigate through the city. Therefore, it can be criticized that creating value-added applications is a waste of effort since citizens are more interested in m-apps they derive personal benefits from, than the ones that further common weal. The provision of open data itself does not necessarily seem to lead to more participation. A lot of marketing efforts are needed in order to change citizens' thinking and behavior, and to transform

the society into a more participatory one. But governments can further these developments by clarifying the benefits of participation. Citizens have to realize that everyone is needed and can make a major difference. Furthermore, it should be obvious to them which specific problems they can solve.

Finally, we investigated whether m-apps developed by government agencies are available for different operating systems (H4). This assumption can be proved. Nearly all m-apps (94%) developed by government agencies support the Android and iOS operating systems in parallel. This is not very surprising since the government should grant the access to services for the whole society. All in all, we were not able to validate all assumptions. This could be due to the fact that a lot of analyzed m-apps are not very professional. As on social media websites, we have a lot of people who may engage and produce content, in this case, m-apps. Thus, we see plenty of m-apps but it is not clear whether they work appropriately or provide qualified content. Apart from Paris, no city has implemented a rating for urban m-apps that could give some information about the quality of the used data or programmed application. However, taking into account that professional m-apps are also produced, a "win-win-win" situation may occur. That was, for example, the case in Austria, where a startup implemented an m-app with justice information called RIS:APP (Digital Austria Website: `http://www.digitales.oesterreich` `.gv.at/site/6497/Default.aspx`). The government was so excited about that app that they helped to promote it. Eventually, this startup that programmed the m-app (without being paid for it) became very popular in Austria and is now overwhelmed with orders (G. Tschabuschnig, personal communication, December 13, 2014). In such a situation the government "wins" because they do not have to produce an m-app by their own; the startup "wins" because they have become very popular and established themselves in the market; and the third winner are the society and local firms, which can use that m-app free of charge. This is one of such success stories showing that open government data may help to enhance economic value, but there is still more that could be done to meet the expectations of open government development.

5.7   Conclusion

The development of urban m-apps based on government data becomes more and more popular. Not only government agencies use open data to create m-apps. The increasing number of

hackathons and m-app competitions animates citizens and companies in some cities to develop useful m-apps as well. However, in the future it needs to be analyzed whether in some cities the citizens do not develop their own m-apps at all, or if their m-apps are simply not linked to governmental websites. In regard to types and features, m-apps are not yet that multifaceted as they could be. They often address only one type, e.g., Public Transportation or making detectable a specific Point Of Interest. However, we could not prove our hypothesis that m-apps which cover many types and features are amongst the most downloaded ones, since very few m-apps fulfill this condition. Nevertheless, the most often downloaded m-app covers one type entirely (MyObservatory Hong Kong). It is conspicuous that m-apps of the type Mobility are more often downloaded than others. This indicates that m-apps have to be useful, above all, in the citizens' everyday life. M-apps with the features Problem Identification and Problem Resolution are rarely downloaded, possibly because citizens have not yet recognized these features' usefulness. In this case, government agencies by themselves could help to promote such m-apps and should demonstrate the impact of citizens' participation to improve transparency. Many m-apps have been developed for several operating systems. Because of missing download data it is not possible to decide whether more citizens can be reached by developing one m-app for different operating systems. Additionally, the app stores' information is sometimes very cryptic, which makes it hard to verify the developer, the type, and supported features.

Indeed, m-apps based upon open urban data make up new ways of governmental services and information. Since we are still in the beginning of a new way of citizen-oriented e-government, more research is needed in this field. For example, the way in which data (e.g., standardized data through an API) is provided could be important to achieve citizens' participation. In the near future, when m-apps with new features and types will be developed, the presented typology needs to be further extended.

Only a few citizens have programming skills, but our results show that there has already been done a lot of work in order to attract more private developers, like in Vienna and Chicago. Citizens use open urban government data to provide applications for the public. Those activities should not only be recognized by the city itself. Therefore, we argue that we need a systematic overview like our typology to foster the information exchange between smart cities.

References

Aloudat, A., Michael, K., Chen, X., & Al-Debei, M. M. (2014). Social Acceptance of Location-based Mobile Government Services for Emergency Management. *Telematics and Informatics*, *31*(1), 153–171. doi: 10.1016/j.tele.2013.02.002

Baraniuk, C. (2013). The Civic Hackers Reshaping Your Government. *New Scientist*, *218*(2923), 36–39. doi: 10.1016/S0262-4079(13)61625-5

Belanger, F., Carter, L. D., & Schaupp, L. C. (2006). U-Government: A Framework for the Evolution of E-Government. *Electronic Government: An International Journal*, *2*(4), 426–445. doi: 10.1504/eg.2005.008333

Bettencourt, L. M. (2014). The Uses of Big Data in Cities. *Big Data*, *2*(1), 12–22. doi: 10.1089/big.2013.0042

Boyd, D., & Crawford, K. (2012). Critical Questions for Big Data: Provocations for a Cultural, Technological, and Scholarly Phenomenon. *Information Communication and Society*, *15*(5), 662–678. doi: 10.1080/1369118X.2012.678878

Briscoe, G., & Mulligan, C. (2014). *Digital Innovation: The Hackathon Phenomenon.* London, UK: Creative Works London.

Carroll, J. M., & Ganoe, C. H. (2009). Supporting Community with Location-sensitive Mobile Applications. In M. Foth (Ed.), *Handbook of Research on Urban Informatics: The Practice and Promise of the Real-Time City* (pp. 339–352). Hershey, PA: IGI Global.

Castells, M. (1989). *The Informational City.* Oxford, UK, Cambridge, MA: B. Blackwell.

Chan, C. M. L. (2013). From Open Data to Open Innovation Strategies: Creating E-Services Using Open Government Data. In *Proceedings of the 46th Hawaii International Conference on System Sciences, Wailea, HI, January 7-10, 2013* (pp. 1890–1899). Washington, DC: IEEE Computer Society.

Charalabidis, Y., Loukis, E., & Alexopoulos, C. (2014). Evaluating Second Generation Open Government Data Infrastructures Using Value Models. In *Proceedings of the 47th Hawaii International Conference on System Sciences, HICSS 2014, Waikoloa, HI, January 6-9, 2014* (pp. 2114–2126). Washington, DC: IEEE Computer Society.

Cho, J.-s., & Chun, S. A. (2010). Ubiquitous Government: Mobile Portal for Seoul Metropolitan Government. In *Proceedings of the 11th Annual International Conference on Digital*

Government Research (pp. 247–248). New York, NY: ACM.

de Lange, M., & de Waal, M. (2013). Owning the City: New Media and Citizen Engagement in Urban Design. *First Monday*, *18*(11), 1–17. doi: 10.5210/fm.v18i11.4954

de Reuver, M., Stein, S., & Hampe, J. F. (2013). From E-Participation to Mobile Participation: Designing a Service Platform and Business Model for Mobile Participation. *Information Polity*, *18*(1), 57–73. doi: 10.3233/IP-2012-0276

Desouza, K. C., & Bhagwatwar, A. (2012). Citizen Apps to Solve Complex Urban Problems. *Journal of Urban Technology*, *19*(3), 107–136. doi: 10.1080/10630732.2012.673056

DiFranzo, D., Graves, A., Erickson, J. S., Ding, L., Michaelis, J., Lebo, T., & Hendler, J. (2011). The Web is My Back-end: Creating Mashups With Linked Open Government Data. In D. Wood (Ed.), *Linking Government Data* (pp. 205–219). New York, NY: Springer Science + Business Media.

Ding, L., Peristeras, V., & Hausenblas, M. (2012). Linked Open Government Data. *IEEE Intelligent Systems*, *27*(3), 11–15. doi: 10.1109/MIS.2012.56

Garcia, A. C. B., Vivacqua, A. S., & Tavares, T. C. (2011). Enabling Crowd Participation in Governmental Decision-making. *Journal of Universal Computer Science*, *17*(14), 1931–1950. doi: 10.3217/jucs-017-14-1931

Goggin, G. (2011). Ubiquitous Apps: Politics of Openness in Global Mobile Cultures. *Digital Creativity*, *22*(3), 148–159. doi: 10.1080/14626268.2011.603733

Hollands, R. G. (2008). Will the Real Smart City Please Stand Up? *City*, *12*(3), 303–320. doi: 10.1080/13604810802479126

Hung, S.-Y., Chang, C.-M., & Kuo, S.-R. (2013). User Acceptance of Mobile E-Government Services: An Empirical Study. *Government Information Quarterly*, *30*(1), 33–44. doi: 10.1016/j.giq.2012.07.008

Jaokar, A. (2012). *Apps for Smart Cities.* Retrieved April 2, 2020, from `http://www.opengardensblog.futuretext.com/archives/2012/03/a-manifesto-apps-for-smart-cities.html`

Jetzek, T., Avital, M., & Bjørn-Andersen, N. (2013). Generating Value from Open Government Data. In *Proceedings of the 34th International Conference on Information Systems, ICIS 2013, Milan, Italy, December 15-18, 2013* (pp. 1–20). Milan, Italy: AISeL.

Katz, M. L., & Shapiro, C. (1994). Systems Competition and Network Effects. *Journal of*

Economic Perspectives, *8*(2), 93–115. doi: 10.1257/jep.8.2.93

Kitchin, R. (2014). The Real-time City? Big Data and Smart Urbanism. *GeoJournal*, *79*(1), 1–14. doi: 10.1007/s10708-013-9516-8

Krippendorff, K. (2018). *Content Analysis. An Introduction to Its Methodology* (4th ed.). Thousand Oaks, CA: SAGE.

Kuhn, K. (2011). Open Government Data and Public Transportation. *Journal of Public Transportation*, *14*(1), 83–97. doi: 10.5038/2375-0901.14.1.5

López-de Ipiña, D., Vanhecke, S., Peña, O., De Nies, T., & Mannens, E. (2013). Citizen-Centric Linked Data Apps for Smart Cities. In *Ubiquitous Computing and Ambient Intelligence. Context-Awareness and Context-Driven Interaction. Proceedings of the 7th International Conference, UCAmI 2013, Carrillo, Costa Rica, December 2-6, 2013* (Vol. 8276, pp. 70–77). Berlin/Heidelberg, Germany: Springer LNCS, volume 8276.

Mainka, A., Hartmann, S., Orszullok, L., Peters, I., Stallmann, A., & Stock, W. G. (2013). Public Libraries in the Knowledge Society. Core Services of Libraries in Informational World Cities. *Libri*, *63*(4), 295–319. doi: 10.1515/libri-2013-0024

Mainka, A., Hartmann, S., Stock, W. G., & Peters, I. (2014). Government and Social Media. A Case Study of 31 Informational World Cities. In *Proceedings of the 47th Hawaii International Conference on System Sciences, HICSS 2014, Waikoloa, HI, January 6-9, 2014* (pp. 1715–1724). Washington, DC: IEEE Computer Society.

Millard, J. (2010). Government 1.5: Is the Bottle Half Full or Half Empty? *European Journal of ePractice*(9), 35–48. Retrieved from `https://joinup.ec.europa.eu/sites/default/files/document/2014-06/ePracticeJournalVol.9-March2010.pdf`

Moon, M. (2002). The Evolution of E-Government Among Municipalities: Rhetoric or Reality? *Public Administration Review*, *62*(4), 424–433. doi: 10.1111/0033-3352.00196

Neuendorf, K. A. (2002). *The Content Analysis Guidebook.* Thousand Oaks, CA: SAGE.

OECD/ITU. (2011). *M-Government: Mobile Technologies for Responsive Governments and Connected Societies.* Paris, France: OECD Publishing.

Open Knowledge International. (n.d.). *Open Data Handbook.* Retrieved October 1, 2018, from `http://opendatahandbook.org/guide/en/`

Sandoval-Almazán, R., Gil-Garcia, J. R., Luna-Reyes, L. F., Luna, D. E., & Rojas-Romero, Y. (2012). Open Government 2.0: Citizen Empowerment Through Open Data, Web and

Mobile Apps. In *Proceedings of the 6th International Conference on Theory and Practice of Electronic Governance, ICEGOV 2012, Albany, NY, October 22-25, 2012* (pp. 30–33). New York, NY: ACM.

Schaupp, L. C., & Carter, L. (2005). E-voting: From Apathy to Adoption. *Journal of Enterprise Information Management*, *18*(5), 586–601. doi: 10.1108/17410390510624025

Scholl, H. J. (2012). Five Trends that Matter: Challenges to 21st Century Electronic Government. *Information Polity*, *17*(3-4), 317–327. doi: 10.3233/IP-2012-0280

Scholl, H. J., & Scholl, M. C. (2014). Smart Governance: A Roadmap for Research and Practice. In *iConference 2014 Proceedings, Berlin, Germany, March 4-7, 2014* (pp. 163–176). Urbana, IL: IDEALS.

Shadbolt, N., & O'Hara, K. (2013). Linked Data in Government. *IEEE Internet Computing*, *17*(4), 72–77. doi: 0.1109/MIC.2013.72

Shapiro, J. M. (2006). Smart Cities: Quality of Life, Productivity, and the Growth Effects of Human Capital. *Review of Economics and Statistics*, *88*(2), 324–335. doi: 10.1162/rest.88.2.324

Stock, W. G. (2011). Informational Cities: Analysis and Construction of Cities in the Knowledge Society. *Journal of the American Society for Information Science and Technology*, *62*(5), 963–986. doi: 10.1002/asi.21506

Tilson, D., Sorensen, C., & Lyytinen, K. (2012). Change and Control Paradoxes in Mobile Infrastructure Innovation: The Android and iOS Mobile Operating Systems Cases. In *Proceedings of the 45th Hawaii International Conference on System Sciences, HICSS 2013, Wailea, HI, January 7-10* (pp. 1324–1333). Washington, DC: IEEE Computer Society.

Trimi, S., & Sheng, H. (2008). Emerging Trends in M-Government. *Communications of the ACM*, *51*(5), 53–58. doi: 10.1145/1342327.1342338

6 Open Government: Transforming Data into Value-Added City Services

6.1 Introduction

Establishing open data in the government sector was recognized in the European Union (EU) since the end of the 1980s (Janssen, 2011). So the concepts of open government and open data are not new, but with the development of ICT and digitization we arrive at new possibilities which may result in value-added data or services. These concepts aim at enhancing transparency, participation, and collaboration between the public and political agencies (Lathrop & Ruma, 2010; McDermott, 2010). In 2003, the EU introduced the Public Sector Information Directive (van der Waal et al., 2014). In this case, restrictions for using and reusing public data have been eliminated, but the data access was charged by governments. The pricing was calculated as cost covering, but this is not really "open data". Today, we understand open data as (online) accessible data which is free of charge or with just marginal costs of use (Jetzek, Avital, & Bjørn-Andersen, 2013). When we talk about open data, which is generated by the government, we can refer to "open government data" (Open Knowledge International, n.d.-a). Until now, we can find a lot of open government data initiatives on the national level, e.g., `data.gov` (USA), `data.gov.uk` (UK), on the international level `open-data.europa.eu` (European Union Open Data Portal), and on the city level `open.wien.at` (Vienna, Austria), or `nycopendata.socrata.com` (New York City, USA). To open government data causes a lot of challenges which need to be faced. In addition, it is not clear whether these efforts result in a more open, transparent, and collaborative government.

Just opening datasets is not the whole concern of open government; they also like to animate citizens, startups, and other stakeholders to reuse the data. For this reason, workshops or hackathons (hack marathons) are organized with the goal to reuse open government data collectively (Baraniuk, 2013; Briscoe & Mulligan, 2014). Here, we can differ between top-down initiatives headed by government agencies, e.g., "apps4austria" in Austria, or bottom-up run by engaged citizens, e.g., the "Open City" volunteers in Chicago. In many cases, the output of those hackathons is mobile applications (m-apps) which intent to solve urban problems. Hackathons have established

themselves as common solutions for building m-apps based on open government data, but the outcomes attract just little attention in academic research (Johnson & Robinson, 2014). Thus, we do not know whether the output of hackathons results in a value-added city service.

The chapter is structured into five parts. After the introduction, the aim of open government data initiatives and our research approach is presented (section 6.2). This will be followed by the used methods (section 6.3) and the results of interviews conducted with experts from politics and universities in Paris, Amsterdam, and Barcelona (section 6.4.1) as well as an investigation of the hackathon movement and output on a global scale (section 6.4.2). In section 6.4.3, the open data initiatives and hackathons of the three cities (Paris, Amsterdam, and Barcelona) are analyzed. Finally, the chapter ends with the conclusion (section 6.5).

6.2   Open Government Data Initiatives

In our context, data means quantitative values resulting from measurements and other sources. Open data refers to data, which is freely accessible online, while there are no technical or legal restrictions to reuse such data (Jetzek et al., 2013). Open government data is defined as open data produced by the government (Open Knowledge International, n.d.-a) as a subset of public sector information. Finally, open urban government data is open government data on the municipal level.

There are two types of sources for open urban government data: official statistics and sensor-based data. Official statistics include data on population, business and economics, jobs, crimes and justice, and health. Additionally, there are city-specific official data collections such as the urban forest map of San Francisco with detailed data about trees in the city. Sensor networks (Kitchin, 2014) consist of sensors which are embedded in specific structures and measure - in real time - levels of light, humidity, temperature, air pressure, movements, speeds, etc., and of transponders monitoring empty spaces in car parks, data from closed circuit television (CCTV), or the progress of trains and buses along a route (Kuhn, 2011). All in all, sensor-based "big data" with relevance for the city (Bettencourt, 2014).

This open urban government data can be combined with user-generated content, for example, GPS-based data from mobile devices and posts on micro-blogging services, such as Twitter,

since cities' e-governments allow citizens to give feedback on mobile or Web applications and use social media channels (Mainka, Hartmann, Stock, & Peters, 2015; Mergel, 2013)(e.g., Facebook, YouTube, Flickr). It is also possible that private companies open parts of their data, e.g., on the companies' products or services with relation to the city (Immonen, Palviainen, & Ovaska, 2014).

Combining this data, we see many services programmed by governmental agencies, by private developers (Mainka, Hartmann, Meschede, & Stock, 2015a) or which evolved from hackathons (Johnson & Robinson, 2014). Reviewing the literature of the last decades, not everybody could imagine that citizens would act as developers for governmental services—without being paid for it. What we see today is a game between open data support by governments and data reuse by residents and other stakeholders. Its gain is called public, social, or economic value and an enhanced quality of life. Public value is in our history often a reason for volunteering, for example, citizens acting as bodyguards in neighborhood safety patrols. Citizens may "provide more and better services than they would have received" by their government (Bellone & Goerl, 1992, p. 134). Today, we have a kind of data bodyguards, who help themselves and their community to handle open data and transform it into value-added services, for example, smartphone apps. Nevertheless, the new possibilities arriving with ICT and digital open data confront us with different challenges which need to be faced. In the Apps for Smart Cities Manifesto, we read, "to harness the true potential of Smart cities, the city must become a platform i.e. an enabler for developers, creativity and applications. In doing so, the city becomes like the internet i.e. a connector and an enabler for citizens which aims to empower the citizen" (Jaokar, 2012, para. 1). Urban m-apps are indicators for the evolution of "ubiquitous government" (Belanger, Carter, & Schaupp, 2006) or "smart government". "Smart Government will share resources and information and interoperate with other governments, citizens, NGOs and for-profit businesses much more smoothly than today" (Scholl, 2012, p. 324).

The shared resources include "big data" as well as "accurate, comprehensive, and reliable information" (Scholl & Scholl, 2014, p. 167). Open urban government data shows its assets best in combining it with further open data and open tools such as OpenStreetMap.org in the sense of mashups. In addition, urban m-apps include location-based participation, "for example helping to redesign the park you're walking in, or the hospital organization which kept you waiting and you think you have a solution" (Millard, 2010, p. 8). But citizens' participation goes far beyond

the simple commenting of communal problems and includes the production of urban m-apps as well. Desouza and Bhagwatwar (2012) call such applications to solve even complex urban problems citizen apps.

Reviewing the ongoing research on governmental development in association with information and communication technology, diverse terminologies are used. In our context, m-government is the use of mobile technologies (e.g., mobile phones, smartphones, and tablets) in e-government. M-government enables location-based services (Carroll & Ganoe, 2009), which are "personalized services delivered to a mobile device user at a remote location" (Trimi & Sheng, 2008, p.54).

To make open data reusable, standards have already been established, e.g., by a W3C eGovernment Interest Group (`www.w3.org/egov`). They should help the government to open their data and other stakeholders to reuse this data. Concerning OECD/ITU (2011), we are in need of application developers (programming the interfaces between the device and the network) as well as content developers and enablers (compiling content into mobile-ready formats). Hence, citizens become "data prosumers (both consumers and providers of data)" (Charalabidis, Loukis, & Alexopoulos, 2014, p. 2114). Thus, "factors as the cost and availability of Internet access, the language in which the data is presented, the technical or professional requirements for interpreting and making use of the data, and the availability of training in data use and visualization, among others" are important for the success of open government data (Gurstein, 2011, para. 17). Additional factors are the adoption by citizens in their mobile phone use, social factors, income level, and trust of service, but not demographic factors (Y. Liu et al., 2014; Reddick, 2014; Venkatesh, Sykes, & Venkatraman, 2014). The critical success of an m-government service or m-app is the service's perceived usefulness (Hung, Chang, & Kuo, 2013).

The development of urban m-apps should be embedded in an "open data based business ecosystem" (Immonen et al., 2014, p. 88), which consists of elements such as key partners, co-creation, revenue strategies, customers and markets, data structure, business development, and the value added (Immonen et al., 2014). The objective of a business ecosystem is to ensure the sustainability of m-apps (and not a quick development of an app followed by stopping the product some weeks later). Figure 6.1 gives an overview on issues of developing urban m-apps.

To build m-apps based on open urban government data in order to enhance collaboration, quality of life, and to solve urban problems is a common topic in many cities around the world (Mainka,
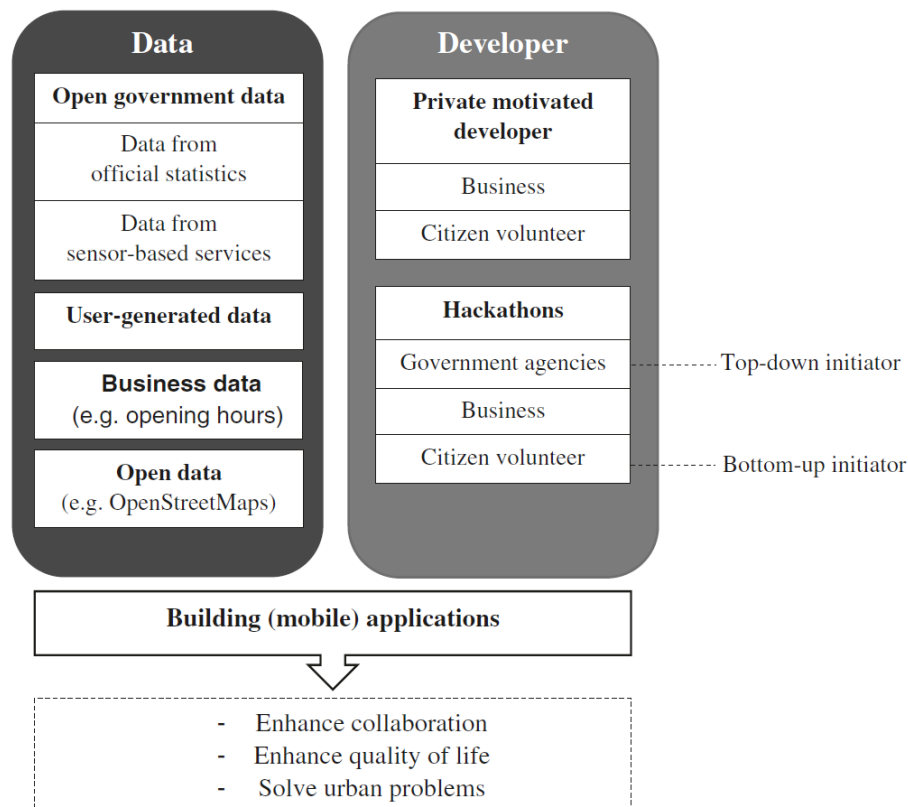
Figure 6.1: Entities related to the development of m-apps based on open urban government data

Hartmann, Meschede, & Stock, 2015a). Some cities are fast adopters of this approach, and other cities are latecomers or still fear the challenges which emerge with open government data initiatives (Janssen, 2011). Other cities start hackathons without certainty of its usefulness (Johnson & Robinson, 2014). Since there is just little research on this development, we want to locate the challenges of opening data and analyze in a case study the cities Paris, Barcelona, and Amsterdam. Therefore, we interviewed persons from politics and research to get insights about the current development and its obstacles. Furthermore, we analyzed the hackathon movement in 24 cities to identify best practice examples and detect whether these hackathons help governments to overcome fears and barriers.

6.3   Methods

For the investigation of the challenges of open government, we choose expert interviews, because this method is appropriate "for an orientation in the field" (Flick, 2009, p. 528). In our approach, the interviews are used to identify the challenges this development poses. The interviews are

based on a semi-structured method with open and closed questions (Creswell, 2012). The inter-viewed experts are familiar with topics such as urban planning, e-government, public institutions, and ICT. In total, eight experts from government agencies and universities participated in the interview. Two experts are from Barcelona, two from Paris, and four from Amsterdam. The interviews have been conducted between December 2013 and March 2014. The results do not aim at reflecting the opinion of a whole city but to give an insight into how open government is understood from experts in different European cities (section 6.4.1).

The hackathon movement was analyzed through a simple Web content research. Since hackathons are related to online available resources, promotions and reviews are hosted on online platforms, e.g., blogs or online news as well. Additionally, we refer to a prior conducted content analysis on m-apps based on open urban government data (Mainka, Hartmann, Meschede, & Stock, 2015a). Here, a set of 24 cities was analyzed by searching for m-apps based on open data on the cities' governmental Web sites. These cities are our base for the analysis of hackathon outcomes around the globe (section 6.4.3). The cities Amsterdam, Barcelona, and Paris are deeper analyzed concerning their open data initiatives and hackathon movements (section 6.4.2).

6.4   Results

6.4.1   Challenges of Open Urban Government Data

Today, we see a lot of barriers and opportunities to make open urban government data accessible. In this section, we want to take a deeper look at current barriers which hamper governments to open their data. In their study, Huijboom and Van Den Broek (2011, p. 12) have mentioned, for example, a closed government culture, privacy legislations, "confidentiality, risk avoidance and fear of political escalation" as the main reasons. To better understand where these fears and unwillingness come from, we asked the experts which challenges they define as the biggest within the open government trend. According to a prior literature review, the challenges were structured into the following six categories:

1. *Political Challenge:* Politicians fear to lose their monopoly in public affairs. To shift from a close to a more open government, "a deep reform of public administration ways of thinking

and behavioral patterns, organizational structures, and operational approaches" are needed (Moro, 2005, p. 110).

2. *Legal Challenge:* Security reasons, privacy, and copyright are often used as arguments to protect data from the public (Huijboom & Van Den Broek, 2011).

3. *Governance Challenge:* Governments' motivation to open their data and to collaborate includes the participation of business and citizens as well (Huijboom & Van Den Broek, 2011). In addition, it is questionable in which form the data should be opened.

4. *Human Resource Challenge:* Diverse skills are needed from government and stakeholders. It is a highly complex task to prepare the data to be reused in a variety of ways (Dawes & Helbig, 2010). Government agencies are in need of talents who are able to prepare the data to be open and reusable.

5. *IT Infrastructure Challenge:* Information and communication technology is the essential driver of digital open data. Thus, it is considerable for a government to be connected through an enhanced IT infrastructure to make online services available to the public.

6. *IT Budget Challenge:* How governments spend their funds may differ in every country and depends on their overall available budget. The financing plays a role especially when governments have implemented charging models for their data (Huijboom & Van Den Broek, 2011). To open those data will entail a financial lack.

The literature review points out that open government is not a new idea, but becoming an open government is still in process. The experts were asked to indicate which of the mentioned challenges they perceive as the main challenges to the provision of public data as open data by their (1) municipality and (2) central government. Additionally, a brief motivation of their decision was given by the interviewees. The experts had to choose two challenges which they see as the main ones. For the most interviewees, the political challenge was identified as one of the biggest challenges. It could also be described as a "strategic challenge". If they open data, they can lose the control about urban services. In Web 2.0 services, the users provide the information, which is a very important development. Accordingly, "the government won't be the monopolist of data" (Alain Rallet, 11 December 2013, Paris). Another aspect is the priority of this topic within the municipality. "Open data is not one of the most important topics for the politics"

(Marta Carrasco Bonet, 4 December 2013, Barcelona). However, one of the major problems in the political challenge could be the fear to lose power. "The politicians think that information is power and they do not want to lose this power. They are not aware of the fact that cross information makes sense. Not just open data but also internal data sharing will improve a lot" (Joan Batlle-Monterrat, 4 December 2013, Barcelona).

As a legal challenge, most experts mentioned privacy rights. It is not clear who will be the owner of open data and who will be accountable for them. Furthermore, the experts are consistent in their concerns about the governance challenge. The data needs to be collected and shared in a reusable form which is a very big issue. The challenges "human resource", "IT infrastructure", and "IT budget" are deeply related to each other. Thus, depending on the budget, talents can be hired who implement and maintain the IT infrastructure. Unlike in the literature, where the IT infrastructure is a challenge for suburbs or not connected regions, the experts live and work in cities with enhanced IT infrastructures. Therefore, they associate this question with the internal IT infrastructure of their government. The IT infrastructure is especially a challenge in Amsterdam where "the national government had several 'disaster' in IT infrastructure projects in the past few years" (Marco Bontje, 21 January 2014, Amsterdam).

If we take a look at the main challenges for the municipal government and the central government, there are just marginal differences. It highly depends on the political structure in each city and nation. If the central government is accountable for the IT budget, then IT budget could not be a challenge for the municipality and vice versa. In the case of Amsterdam, we can see that the experts count the IT infrastructure not just as a challenge for the central but also for the municipal government.

6.4.2   The Hackathon Movement

In the last few years, a new trend has appeared on how governments and citizens work together to reuse open urban government data and build useful services with it. In order to realize this, events are hosted which are named "hackathon", "app contest" (Johnson & Robinson, 2014), or "app competition". But what is it all about? Do hackathons or similar contests help to develop value-added services? To find evidence about these aspects, we analyzed hackathons in 24 cities, which are prototypical cities of the knowledge society (Mainka, Hartmann, Meschede,

& Stock, 2015a). First, we will specify the types of those events and their aim, and identify the participants. According to a prior research on m-apps based on open urban governments (Mainka, Hartmann, Meschede, & Stock, 2015a), we will investigate if and how these hackathons are related to successful m-apps based on open urban government data.

The term hackathon combines the two words "hack" and "marathon" which is also a hint at the temporal construction of those events, in which the term "hack" refers to smart programs or programmers and not to criminal hack attacks. In general, those events are often hosted to solve specific problems or to address stated topics, e.g., tourism and culture, democracy, mobility, security, energy, waste, transportation, and water efficiency (Apps for Amsterdam, 2012; Cleanweb Worldwide, 2012). The idea is to bring people from different backgrounds together and see whether they are able to create value-added products. The initiative can come from the government (top-down) as well as from the hacker community (bottom-up). However, the aim to host such events is mostly to build a bridge between government, citizens, and economy. Vienna stated that the citizens are the most needed and emphasize that especially statisticians as well as librarians are wanted participants (Open Knowledge Forum Österreich, 2013). There is no limitation on the participation level, e.g., the "apps4austria" competition invites companies, institutions, and administrative organizations to participate as well (Digitales Österreich, 2013). But not only governments and citizens organize hackathons, there are also new companies that emerge to host these events. One example is angelhack which is operating since 2011 and organizes hackathons for other companies, e.g., Adobe in San Francisco (AngelHack, 2011).

Hackathons are often hosted in and by cities and regions all over the world, e.g., Amsterdam, as well as for bigger areas, e.g., the whole country, such as in Finland (Apps4Finland) or the whole European Union (Apps for Europe, 2013). However, it has its origins in the USA where the first hackathon has been held in 2011 (Headd, 2011).

Another aspect which can differ between events is whether the hackathon is awarded or just for fun. Furthermore, which status do the developed applications or services have. Are prototypes ready for use? In some cases, ideas to solve problems are highly welcomed and awarded, e.g., for the Stockholm Award. This award is part of the "Vision 2030, where Stockholm will be a vibrant, humane and creative world-class city, the competition was to bring the City a step in the right direction" (Studentcompetitions, 2012).

If the resulting ideas or applications will bring a social or economic value after the hack, will be decided by the market. The ideas and products have to be accepted and used. In some cases, the developer gets some assistance by the city or the initiators of the hackathon. This can be financial or technical aid, or arrangements in order to connect the developer with existing project groups. An example of "crowdfunding" is the platform "sf.citi" (`https://sfciti.org/`) by San Francisco. They try to support developers and products by organizing funds through the public. For example, citizens can fund the projects they prefer on platforms like "citizenvestor" (Hunter, 2013).

The challenge is not to develop a m-app, but to make it successful. Therefore, the products of civic hacking have to be promoted after these events so that they get recognition by a larger quantity of citizens. For this purpose, Chicago provides a good example. They call for residents to become a member of "The Civic User Testing Group" (CUTGroup) which is a project by the "Smart Chicago Collaborative".

The increasing popularity of open data also changes the quality of the data. Now, governments see that the data is used and they try to face the new challenges. Thus, new jobs need to be created as well; for example, a Chief Data Officer was proved for the city of San Francisco (Hunter, 2013). Hackathons and app challenges have even become so popular that guides, e.g., "How to run a hackathon" and books, e.g., "Civic Apps Competition Handbook" were published to support hosting these events.

6.4.3   Open Government Data Initiatives and Hackathons in Amsterdam, Barcelona, and Paris

The biggest challenge to become an open government mentioned by the interviewed experts is the political challenge (see section 6.4.1). The cities Amsterdam, Barcelona, and Paris have already started to open their urban government data online. Of course, there are differences in the amount of open data sets and addressed topics, but strategies and plans to join open data initiatives are already transformed into real action. Amsterdam supports a metadata platform (`www.amsterdamopendata.nl`), which links to the open datasets of available geo data (`maps.amsterdam.nl/open_geodata`) and statistical data (`www.ois.amsterdam.nl/feiten-en-cijfers`) of different government institutions. In contrast, the open data portals

from Barcelona and Paris host the datasets on one portal. All cities use different licensing types, e.g., creative commons or own licenses. They have in common that the data is allowed to be reused in further projects, e.g., in new applications. All cities mention in their terms of use that the city is the owner of the data but is not responsible for the accuracy of it. The major part of the data is available in machine-readable formats, e.g., CSV, JSON, or ODATA, and for geographical data in Shapefiles (SHP) or GeoJSON. Amsterdam and Barcelona also offer PDF files or even images. Some of these "datasets" are scanned documents, e.g., administrative bylaws, which are not machine-readable. Table 6.1 gives an overview of the open data portals, datasets, data formats, and the categorized themes of data for each city.

The interviewed experts see that human resource, IT budget, and IT infrastructure are related topics. Barcelona, for example, has established new jobs which are responsible for the open government movement in their city. These positions are called for instance "Smart City Director & Deputy CIO" or "Mobile, e-Government & Data Director". In contrast, Paris follows a defined action plan which is dedicated to the modernization of public action directed by the prime minister of France. A particular institution was founded, called Etalab (`www.etalab.gouv.fr`), which is responsible for the national open data development. In Amsterdam, the Amsterdam Smart City platform was founded to bring partners from business, research, government, and citizens together.

Barcelona's open data initiatives are based on tools developed by Microsoft(Microsoft, 2014). Thus, they have datasets, e.g., ODATA, which are mostly used in Microsoft environments. In addition, the governmental internal IT infrastructure is based on Microsoft products. Whether Barcelona receives benefits from Microsoft for using their tools and operating systems is not clear. They also collaborate with Cisco concerning their smart city initiatives, e.g., implementing sensors in the city (Cisco, 2011). In addition, the cooperation in research and technology between IBM and the Barcelona Supercomputing Center helps the city to become a vanguard of open government (IBM, 2015). To adapt m-government services, citizens and tourists may use one of the 700 Wi-Fi hot spots all over the city. Amsterdam also collaborates with companies to improve its open data initiatives. Together with the navigation system company TomTom, they built an open dataset to detect free parking slots in the city (Balch, 2013). This community- driven approach is also reflected at their open data portal where the Amsterdam Economic Board, the Waag Society, the Vrije Universiteit, and the Universiteit van Amsterdam work together.

Table 6.1: Open datasets in Amsterdam, Barcelona, and Paris (retrieved June 2015)

City Amount of open datasets Open data portal Licence	Data format	Themes
Amsterdam 424 `www.amsterdamopendata.nl` Own licence (data is allowed to be used and re-used for commercial and non-commercial purpose. City of Amsterdam has to be cited as source holder)	(Images) PDF XLS CSV GeoJSON GeoRSS SHP	Management and organization Population Services Economics and haven Education, youth and diversity Energy Geography Environment and water Public order and safety Public space and green Sport and recreation Urban development Tourism and culture Traffic and infrastructure Elections Work and income Housing and environment Care and welfare
Barcelona 323 `opendata.bcn.cat` Creative commons licences 3.0	PDF CSV XML ODATA	Administration Economy and business Population Territory Urban environment
Paris 130 `opendata.paris.fr` Own license inspired by the open database license (ODbL) v1.0 (data is allowed to be used and re-used under share-alike conditions)	CSV XLS JSON GeoJSON SHP	Culture Urban planning Citizens Environment Movement Service

In Paris, the open data initiatives are inspired by the Open Knowledge Foundation. This foundation is a non-profit organization and supports others, e.g., governmental organizations, to join in the open data movement. Direct corporations on the city level as in Barcelona could not be detected in Paris, but national government institutions work together with OpenDataSoft (`www.opendatasoft.com`) in France.

Having all the data online allows these cities to run own hackathons which may reuse open urban government data. The majority of the detected hackathons are initiated by NGOs, universities, governments, or companies. In Amsterdam, we can find hackathons such as the Open Data FWD,

which is a project of the Department of Infrastructure, Traffic and Transportation (DIVV) of the City of Amsterdam, and Waag Society, or Apps for Amsterdam which focuses on getting Open Data apps on the market and is organized by the Waag Society in corporation with the Economic Development Board Amsterdam (EDBA). In Barcelona, no hackathon could be found which is dedicated to work on urban government data. Nevertheless, a hack community is present in the city, and other hackathons such as Hackathon for Social Good, Journalism Hackathon, or A Smart Cities Hackathon are held there. Also, workshops for hackers are offered during the Barcelona Smart City App Hack. Bottom-up initiatives are hosted by a community called the Databeers. They arrange meet-ups at irregular intervals. Equally in Paris, no open urban government data hackathon could be located. However, national or commercial hackathons are hosted in Paris, too.

Thus, the questions arise as follows: Are open data initiatives and hackathons useful to build value-added city services? In the case of Amsterdam, we have to answer "yes". They have a lot of open data available and host hackathons. For example, the Apps for Amsterdam hackathon in 2012 has announced the "Parkshark API" and "Bike like a Local" as winners of their contest. In the case of the Parkshark API, not only the city of Amsterdam can benefit from it, because less cars drive through the streets searching a parking slot which helps to reduce carbon emissions. The citizens are winners as well, since they now can find cheaper and faster parking slots nearby. But also the developers of the m-app benefit of this competition. Their product has become famous which has led to commercial orders.

Our investigation has brought to light that most hackathons address people who are programmers or designers, which is not in common with the cities open data vision. Thus, the majority of the citizens will not feel affiliated to join hackathons or app competitions. Acknowledging our prior study on m-apps built on open urban government data (Mainka, Hartmann, Meschede, & Stock, 2015a), m-apps developed by NGOs, private companies, or citizens have been produced in all three cities. In some cases, the cities' government emerged as the developer of some m-apps. Figure 6.2 illustrates the total amount of m-apps which are based on open urban data and found on governmental Web sites as well as the amount of these m-apps developed by a governmental institution. However, in the case of Paris, most of the m-apps could not be identified as being based on open data, wherefore they had to be excluded.
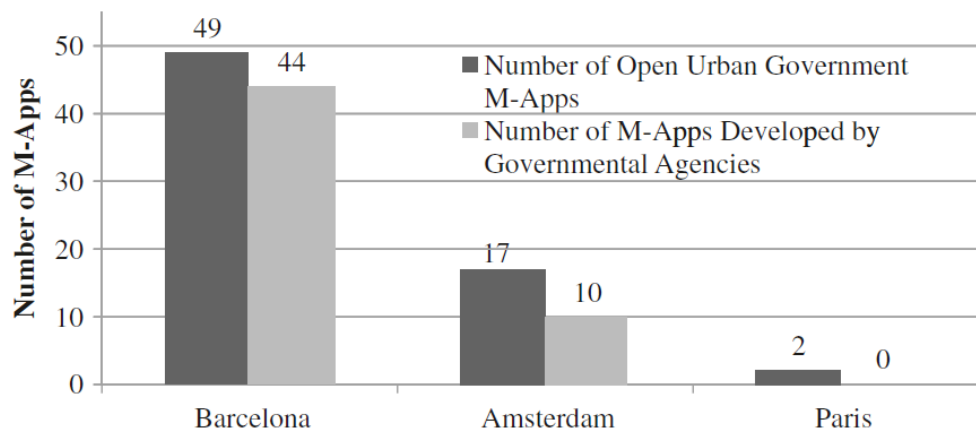
Figure 6.2: M-apps found on governmental websites of Amsterdam, Barcelona, and Paris as well as amount of m-apps developed by governmental agencies

6.5   Conclusion

Is the government able to transform data into value-added city services? Have we already arrived at an open government stage? As reviewed in the literature, the initiatives and ideas that governments should be more open and citizen oriented are not new. But a new development is the reuse of open urban data in mobile applications.

A lot of open data could be or already is available, such as sensor-based data in car parks or GPS information to locate traffic jams. That this data is reused is evidenced by the detected m-apps based on open urban government data and the burgeon hackathons around the world. Considering the challenges of opening data such as the governance challenge, IT budget and infrastructure challenge, or legal challenge, one could think that we are at the beginning of a new movement. However, the maturity of this development depends on the respective city. Barcelona, for example, has opened its data under creative commons licenses to the public. Now citizens, NGOs, and anybody else may use this data.

In some cases, we see that the initiatives of opening the data or initiating a hackathon may come from the government, in others from the community. As the first hackathons from San Francisco brought out some helpful applications, others started to adapt this idea. Today, we can find app challenges in almost every bigger city. This movement is developing and changing rapidly. Some m-apps do not exist anymore, others have been further developed and updated, and some others have not been changed or improved for a long time (e.g., Play Amsterdam: last update 06/06/11).

However, it still remains unclear whether hackathons are indeed able to make a difference and bring the citizens into the governmental processes. What we actually see is that people come together as a community and develop governmental services. This could help to make the whole city and its residents smarter.

Finally, comparing all analyzed cities, we see major differences in handling open urban government data. The hackathon movement and the availability of citizens' apps are common. There are many different kinds of hackathons and competitions, which are also co-operating with each other. Every day a new event could be hosted and others are not organized anymore. Of course, not all applications, projects, and ideas can achieve success, but more important than launching successful applications is to build a collective community that aims at solving problems together, regardless whether they are city officials or ordinary people. The main aim is to transform government, to reuse open data, and to open the data for anybody. In fact, this can be achieved with the help of hackathons and app competitions. Above all, producing useful services from which everybody will benefit should be forwarded in future.

References

AngelHack. (2011). *The AngelHack Story.* Retrieved November 28, 2014, from `https://angelhack.com/angelhackteam/`

Apps for Amsterdam. (2012). *Second Apps for Amsterdam Contest: Smart Apps Awarded.* Retrieved November 28, 2014, from `http://www.appsforamsterdam.nl/`

Apps for Europe. (2013). *About Us.* Retrieved November 28, 2014, from `www.appsforeurope.eu/about-us`

Balch, O. (2013). *Can Open Data Power a Smart City Revolution?* Retrieved April 5, 2019, from `www.theguardian.com/sustainable-business/open-data-power-smart-city`

Baraniuk, C. (2013). The Civic Hackers Reshaping Your Government. *New Scientist*, *218*(2923), 36–39. doi: 10.1016/S0262-4079(13)61625-5

Belanger, F., Carter, L. D., & Schaupp, L. C. (2006). U-Government: A Framework for the Evolution of E-Government. *Electronic Government: An International Journal*, *2*(4), 426–445. doi: 10.1504/eg.2005.008333

Bellone, C. J., & Goerl, G. F. (1992). Reconciling Public Entrepreneurship and Democracy. *Public Administration Review*, *52*(2), 130–134. doi: 10.2307/976466

Bettencourt, L. M. (2014). The Uses of Big Data in Cities. *Big Data*, *2*(1), 12–22. doi: 10.1089/big.2013.0042

Briscoe, G., & Mulligan, C. (2014). *Digital Innovation: The Hackathon Phenomenon.* London, UK: Creative Works London.

Carroll, J. M., & Ganoe, C. H. (2009). Supporting Community with Location-sensitive Mobile Applications. In M. Foth (Ed.), *Handbook of Research on Urban Informatics: The Practice and Promise of the Real-Time City* (pp. 339–352). Hershey, PA: IGI Global.

Charalabidis, Y., Loukis, E., & Alexopoulos, C. (2014). Evaluating Second Generation Open Government Data Infrastructures Using Value Models. In *Proceedings of the 47th Hawaii International Conference on System Sciences, HICSS 2014, Waikoloa, HI, January 6-9, 2014* (pp. 2114–2126). Washington, DC: IEEE Computer Society.

Cisco. (2011). *Cisco Collaborates With Barcelona to Support '2020 Vision' for Sustainable Urban Management and Economic Growth.* Retrieved from `newsroom.cisco.com/press-release-content;jsessionid=01230049AD3CA4E7D7A1C6438DD16818?type=webcontent&articleId=5918850`

Cleanweb Worldwide. (2012). *About.* Retrieved November 28, 2014, from `nyc.cleanweb.co/about/`

Creswell, J. W. (2012). *Qualitative Inquiry and Research Design: Choosing Among Five Approaches* (3rd ed.). Thousand Oaks, CA: Sage.

Dawes, S. S., & Helbig, N. (2010). Information Strategies for Open Government: Challenges and Prospects for Deriving Public Value from Government Transparency. In M. A. Wimmer, J.-L. Chappelet, M. Janssen, & H. J. Scholl (Eds.), *International Conference on Electronic Government, EGOC 2010, Lausanne, Switzerland, August 29 - September 2, 2010* (pp. 50–60). Berlin, Heidelberg, Germany: Springer LNCS, volume 6228.

Desouza, K. C., & Bhagwatwar, A. (2012). Citizen Apps to Solve Complex Urban Problems. *Journal of Urban Technology*, *19*(3), 107–136. doi: 10.1080/10630732.2012.673056

Digitales Österreich. (2013). *apps4austria.* Retrieved November 28, 2014, from `https://www.digitales.oesterreich.gv.at/apps4austria`

Flick, U. (2009). *An Introduction to Qualitative Research.* Thousand Oaks, CA: Sage.

Gurstein, M. B. (2011). Open Data: Empowering the Empowered or Effective Data Use for Everyone? *First Monday*, *16*(2). doi: 10.5210/fm.v16i2.3316

Headd, M. (2011). *Open Government Hackathons Matter.* Retrieved April 5, 2019, from `govfresh.com/2011/08/open-government-hackathons-matter/`

Huijboom, N., & Van Den Broek, T. (2011). Open Data: An International Comparison of Strategies. *European Journal of ePractice*(12), 4–16. Retrieved from `https://joinup.ec.europa.eu/sites/default/files/document/2014-06/ePractice%20Journal-%20Vol.%2012-March_April%202011.pdf`

Hung, S.-Y., Chang, C.-M., & Kuo, S.-R. (2013). User Acceptance of Mobile E-Government Services: An Empirical Study. *Government Information Quarterly*, *30*(1), 33–44. doi: 10.1016/j.giq.2012.07.008

Hunter, F. (2013). *The Civic Innovation Ecosystem Blooms in 2012. What's Next?* Retrieved November 28, 2014, from `innovatesf.com/category/open-data/`

IBM. (2015). *IBM and Barcelona Supercomputing Center – Centro Nacional de Supercomputación Celebrate a Decade of Collaboration.* Retrieved from `https://www-03.ibm.com/press/us/en/pressrelease/46566.wss`

Immonen, A., Palviainen, M., & Ovaska, E. (2014). Requirements of an Open Data Based Business Ecosystem. *IEEE Access*, *2*, 88–103. doi: 10.1109/ACCESS.2014.2302872

Janssen, K. (2011). The Influence of the PSI Directive on Open Government Data: An Overview of Recent Developments. *Government Information Quarterly*, *28*(4), 446–456. doi: 10.1016/j.giq.2011.01.004

Jaokar, A. (2012). *Apps for Smart Cities.* Retrieved April 2, 2020, from `http://www.opengardensblog.futuretext.com/archives/2012/03/a-manifesto-apps-for-smart-cities.html`

Jetzek, T., Avital, M., & Bjørn-Andersen, N. (2013). Generating Value from Open Government Data. In *Proceedings of the 34th International Conference on Information Systems, ICIS 2013, Milan, Italy, December 15-18, 2013* (pp. 1–20). Milan, Italy: AISeL.

Johnson, P., & Robinson, P. (2014). Civic Hackathons: Innovation, Procurement, or Civic Engagement? *Review of Policy Research*, *4*(31), 349–357. doi: 10.1111/ropr.12074

Kitchin, R. (2014). The Real-time City? Big Data and Smart Urbanism. *GeoJournal*, *79*(1), 1–14. doi: 10.1007/s10708-013-9516-8

Kuhn, K. (2011). Open Government Data and Public Transportation. *Journal of Public Transportation*, *14*(1), 83–97. doi: 10.5038/2375-0901.14.1.5

Lathrop, D., & Ruma, L. (2010). *Open Government: Collaboration, Transparency, and Participation in Practice.* Sebastopol, CA: O'Reilly Media.

Liu, Y., Li, H., Kostakos, V., Goncalves, J., Hosio, S., & Hu, F. (2014). An Empirical Investigation of Mobile Government Adoption in Rural China: A Case Study in Zhejiang Province. *Government Information Quarterly*, *31*(3), 432–442. doi: 10.1016/j.giq.2014.02.008

Mainka, A., Hartmann, S., Meschede, C., & Stock, W. G. (2015). Mobile Application Services Based Upon Open Urban Government Data. In *iConference 2015 Proceedings, Newport Beach, CA, March 24-27, 2015* (pp. 1–15). Urbana, IL: IDEALS.

Mainka, A., Hartmann, S., Stock, W. G., & Peters, I. (2015). Looking for Friends and Followers: A Global Investigation of Governmental Social Media Use. *Transforming Government: People, Process and Policy*, *9*(2), 237–254. doi: 10.1108/TG-09-2014-0041

McDermott, P. (2010). Building Open Government. *Government Information Quarterly*, *27*(4), 401–413. doi: 10.1016/j.giq.2010.07.002

Mergel, I. (2013). Social Media Adoption and Resulting Tactics in the U.S. Federal Government. *Government Information Quarterly*, *30*(2), 123–130. doi: 10.1016/j.giq.2012.12.004

Microsoft. (2014). *Customer Stories.* Retrieved June 2, 2015, from `https://customers.microsoft.com/Pages/CustomerStory.aspx?recid=270`

Millard, J. (2010). Government 1.5: Is the Bottle Half Full or Half Empty? *European Journal of ePractice*(9), 35–48. Retrieved from `https://joinup.ec.europa.eu/sites/default/files/document/2014-06/ePracticeJournalVol.9-March2010.pdf`

Moro, G. (2005). Citizens' Evaluation of Public Participation. In OECD (Ed.), *Evaluating Public Participation in Policy Making* (pp. 109–125). Paris, France: OECD.

OECD/ITU. (2011). *M-Government: Mobile Technologies for Responsive Governments and Connected Societies.* Paris, France: OECD Publishing.

Open Knowledge Forum Österreich. (2013). *OpenDataHackathon 2011.* Retrieved November 28, 2014, from `https://www.barcamp.at/OpenDataHackathon_2011`

Open Knowledge International. (n.d.). *Open Data Handbook.* Retrieved October 1, 2018, from `http://opendatahandbook.org/guide/en/`

Reddick, C. G. (2014). Citizens and Mobile Government Adoption: A Comparison of Activities

and Uses. *International Journal of Civic Engagement and Social Change*, *1*(1), 13–26. doi: 10.4018/ijcesc.2014010102

Scholl, H. J. (2012). Five Trends that Matter: Challenges to 21st Century Electronic Government. *Information Polity*, *17*(3-4), 317–327. doi: 10.3233/IP-2012-0280

Scholl, H. J., & Scholl, M. C. (2014). Smart Governance: A Roadmap for Research and Practice. In *iConference 2014 Proceedings, Berlin, Germany, March 4-7, 2014* (pp. 163–176). Urbana, IL: IDEALS.

Studentcompetitions. (2012). *Open Stockholm Award Winners Bring Stockholm Closer Towards Vision 2030.* Retrieved November 28, 2014, from `studentcompetitions.com/posts/open-stockholm-award-winners-bring-stockholm-closer-towards-vision-2030`

Trimi, S., & Sheng, H. (2008). Emerging Trends in M-Government. *Communications of the ACM*, *51*(5), 53–58. doi: 10.1145/1342327.1342338

van der Waal, S., Węcel, K., Ermilov, I., Janev, V., Milošević, U., & Wainwright, M. (2014). Lifting Open Data Portals to the Data Web. In S. Auer, V. Bryl, & S. Tramp (Eds.), *Linked Open Data — Creating Knowledge out of Interlinked Data* (pp. 175–195). Berlin, Germany: Springer.

Venkatesh, V., Sykes, T. A., & Venkatraman, S. (2014). Understanding e-Government portal use in rural India: Role of demographic and personality characteristics. *Information Systems Journal*, *24*(3), 249–269.

7 Open Urban Data and the Sustainable Development Goals. A Small-scale Case Study on German Open Data Portals

7.1 Introduction

In 2015, The United Nations adopted the Sustainable Development Goals (SDGs) - 17 goals "to end poverty, protect the planet and ensure prosperity for all" (United Nations, 2015c, para. 1). Sustainable development is defined 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). These needs originate from different perspectives, including social, environmental and economic aspects. To reconcile sustainability and development is an ambitious task. While, on the one hand, there is the need to sustain nature, environment, and culture, on the other hand, society and economy seek for development (National Research Council, 1999). Sustainable development can hence be seen as a compromise between these elements (Kates, Parris, & Leiserowitz, 2005).

The SDGs are an attempt to unite the various foci into one agenda (Table 7.1). In contrast to former similar strategic plans like the Millennium Development Goals, the agenda does not only focus on evolution in developing countries but demands action of all countries, even though different objectives shape different societies regarding social, economic and environmental goals (Sachs, 2012). The 17 SDGs include 169 more concrete targets. The interpretation of the targets can differ depending on the corresponding country. For example, SDG 1 includes the aim to reduce poverty according to national definitions.

An ongoing challenge is the detailed assessment of the SDGs and their targets all over the world. It has been agreed on 232 indicators to measure the progress of each goal. The Inter-agency and Expert Group on SDG Indicators (IAEG-SDGs) developed the global indicator framework and classified each indicator into three tiers depending on methodological performance and availability of data (United Nations Statistics Division, 2017). The crucial aspect for defining the state-of-the-art concerning each indicator is the availability of sufficient information. Moreover, "the

Table 7.1: The Sustainable Development Goals (United Nations, 2015c)

No.	Goal
1	No poverty
2	Zero hunger
3	Good health and well-being
4	Quality education
5	Gender equality
6	Clean water and sanitation
7	Affordable clean energy
8	Decent work and economic growth
9	Industry, innovation and infrastructure
10	Reduced inequalities
11	Sustainable cities and communities
12	Responsible consumption and production
13	Climate action
14	Life below water
15	Life on land
16	Peace, justice and strong institutions
17	Partnerships for the goals

indicator framework should not only define what to measure but also how to measure it" (Hák, Janoušková, & Moldan, 2016, p. 566). Data that is machine-readable, as well as available and reusable for everyone, i.e. open data, can hence play a key role in assessing the SDGs (Gorin, Manley, & Ariss, n.d.).

Several initiatives and organizations focus on reporting on the progress of the SDGs on a global scale. For example, the SDG National Reporting initiative aims at facilitating information-sharing on the SDGs among policymakers, data managers, and international organizations (SDG National Reporting Initiative, 2018). The World Bank provides global development data that is free and openly accessible. One of their projects is the Atlas of Sustainable Development Goals, a detailed report and visualization of the SDGs' targets (World Bank Data Team, 2018). Other initiatives evaluate the general availability of data and statistics for sustainable development, often compared across different countries. The Open Data Inventory (ODIN) by the non-profit, non-governmental organization Open Data Watch monitors the coverage and openness of official statistics regarding social, economic and environmental information and ranks several countries in this regard (Open Data Watch, 2017b).

Open data, and in particular open governmental data is being published in an increasing number of countries and their subordinate administrative units. Reference is made to the Open Definition,

which states that the data must be available and usable freely and without restriction (Open Knowledge International, n.d.-b). Furthermore, organizations stand behind the idea of open data and this as a basis for free knowledge. The Sunlight Foundation has published ten principles of open data (Sunlight Foundation, 2017), and the Open Knowledge Foundation has devoted itself to this topic in its Open Data Handbook (Open Knowledge International, n.d.-a). In the recent years there has been a change in administration with regard to openness towards citizens. This movement is called open government (McDermott, 2010), and its beginning is often associated with a memorandum from former US President Barack Obama in 2009 (Obama, 2009) in which he calls on administrations to act openly and transparently and thus also make datasets available. Also, more and more countries are creating legal requirements for this type of data publication, usually within the framework of freedom of information laws (Shepherd, 2015).

Various methods have been developed to measure the dissemination of open data in a country and thus create a basis for comparisons between countries. Such indices are presented in the following section. A relationship with the SDGs can thus be established at national level. Some categories of open data can be directly assigned to targets, while others are slightly more difficult to assign. However, open administrative data is not only published at the national level but also at subordinate levels. This data is thus also available at the city or municipal level, which allows a more detailed examination of the development and condition of these levels.

In this contribution, we propose the use of open governmental data and related measurement methods to make the achievement of SDGs easy and transparent to measure. For this purpose, a mapping of the categories or indicators to the targets is aimed at, which reflects the relationships between SDGs and open data. Since open data can also be found at lower administrative levels, this opens up a new possibility: the consideration of SDGs at the urban and municipal level. National evaluations reflect only the overall condition, without going into individual particularly good or bad examples. Citizens are increasingly aware of the environment in which they live and want to participate in the development of their city (Chiesura, 2004). However, it is not always easy to participate as a citizen. Be it that the administration is not yet so open or that ideas and starting points within the framework of a pursuable plan are missing. Information and Communication Technology can act as a facilitator of such plans and foster citizen participation, as "the use of modern computer technology can contribute significantly to the empowerment of citizens through the collection, processing, enrichment and presenting information implicitly

contained in open datasets" (Lusa, Dos Santos Rabello, & Cervi, 2015, p. 125). Others believe that open data can also contribute to foster aid effectiveness (Linders, 2013). The SDGs can serve as a template for citizen participation. These are general goals that improve living together in the city for each and set out a plan. We want to take this fact into account by not only using open datasets to measure the achievement of the objectives but also by looking at them, in particular at the regional level. The resulting comparisons of cities and municipalities can serve as an incentive to improve the situation and as an impetus, e.g. competitions to improve one's city.

7.2   Open Urban Data, Citizen Participation and Sustainable Development

Today, more than half of the world's population lives in cities. The United Nations estimated that by 2050 the share of urban residents will grow even more up to two thirds (United Nations, 2019). Hence, cities play a significant role in achieving sustainable development. This was also acknowledged by the United Nations by embedding a goal on sustainable cities and communities (SDG 11). Referring to this goal as the *urban sustainable development goal (USDG)*, Klopp and Petretta (2017) argue that an ongoing challenge for the SDGs is the poor availability of urban data. In contrast, opening datasets at the city level can contribute to innovations and value-added city services (Mainka, Hartmann, Meschede, & Stock, 2015b, 2015a; Ojo, Curry, & Zeleti, 2015), and thereby may facilitate sustainable development. Through the transformation to a smart city, factors such as participation, equity, mobility, and fairness can be improved (Bibri & Krogstie, 2017).

The Open Data Charter Measurement Guide (Brandusecu & Lämmerhirt, 2018, p. 4) directly addresses this issue: "It is important to note that this guide is equally useful to assess government open data initiatives on a regional or at a city level". In the developing process of this guide and the corresponding mapping, also subordinate levels were thought of. While the above quotation is only about open data initiatives, it can be transferred to the SDGs on a regional level. Besides the actual embedding in the urban sustainable development goal – SDG 11 – cities are linked to every other SDG as well, as the addressed obstacles cannot be tackled without cities.

Data and their evaluations are required to assess the achievement of the SDGs and to calculate the scores of the corresponding indicators. These are often collected through surveys or expert interviews and are then reviewed. This can also be done at the city or the municipal level. Ideally, the data can be found in the open data portals or can be requested via them. They are therefore freely available. Validation from the administration's point of view usually already takes place when or even before publishing data on a portal. Other experts can be citizens who are familiar with their city and can review the data records published by the administration. This creates a new form of citizen participation that deals with the processing of open data to achieve higher goals.

Hence, the opening of datasets has enormous potential to foster citizen awareness. Especially at the city level, several initiatives can be recognized that contribute to enhanced participation in the matter of a community. For example, citizens collaboratively build particulate matter sensors on their own for measuring the air quality in their city themselves (`https://luftdaten.info/en/home-en/`). The data is then embedded in maps for visualizing the air quality. Besides, all data records are stored in an open format and can be retrieved at any time. Through Citizen Science projects like this, initiated by the Open Knowledge Foundation Germany (`https://okfn.de/en/`), citizens are sensitized regarding environmental and social issues that are part of the SDGs and become producers of open data themselves. Issues that have to be considered in such approaches are data quality and privacy as well as the long-term impact of the produced data (Chen et al., 2017). Nonetheless, what can be achieved with such citizen-driven projects can be seen in the OpenStreetMap (`https://www.openstreetmap.org/`). This is a map that is continuously updated and expanded by volunteers from all over the world and is available to everyone freely and openly. Similar activities on other topics may produce records created by citizens for their fellow citizens that provide information about their city that would otherwise not exist. In this context SDG 17 also plays an important role. The partnerships for achieving the goals can also be related to national and municipal data providers as well as to citizens who collect data themselves, help with their evaluation, processing, and visualization and can thus directly participate in shaping processes. Citizen participation can, therefore, be seen as part of one of the objectives and thus also as a supportive means of achieving the other goals.

In the following section, we introduce measurement tools for the coverage and openness of open data and describe our mapping approach of the underlying data categories with the SDGs. The

result of this mapping is presented in the subsequent section. Then, we concentrate on the results of our small-scale study regarding open datasets in German cities. Finally, we discuss the overall findings.

7.3   Materials and Methods

In 2015, the Open Data Charter was founded by open data experts from governments, organizations, society and the private sector. It has been adopted by 54 national and local governments around the world and comprises the following six principles:

1. Open By Default

2. Timely and Comprehensive

3. Accessible and Usable

4. Comparable and Interoperable

5. For Improved Governance & Citizen Engagement

6. For Inclusive Development and Innovation

According to the Open Data Charter (Brandusecu & Lämmerhirt, 2018) there exist five main measurement tools evaluating the prevalence of open government data: the Open Data Barometer (ODB), the Global Open Data Index (GODI), the OECD OURdata Index (OURdata), the Open Data Inventory (ODIN) and the European Open Data Maturity Assessment (EODMA). Three of these – ODB, GODI and ODIN – provide a classification into several data categories, which were chosen for further analysis. For better comprehensibility, the three open data measurement tools are presented in the following.

Open Data Barometer (ODB). The ODB is a collaborative project by the World Wide Web Foundation (World Wide Web Foundation, 2015). It evaluates the readiness for open data initiatives, the implementation of open data programs and the impact that open data is having on business, politics and civil society. Covered data categories range from national statistics to international trade data and crime statistics. Beside secondary data, the

ODB uses an expert survey for evaluation. In 2016, Great Britain ranked first according to the ODB. Results and datasets are available under a Creative Commons license at `opendatabarometer.org`.

Global Open Data Index (GODI). GODI was developed by Open Knowledge International and measures the openness of Open Government Data from a civic perspective, which means data should be useful for the public (Open Knowledge International, 2017). In the 2016 version, GODI aims explicitly at achieving comparability between datasets. Experts review data concerning several categories and indicators with different weightings are used. With an overall score of 90%, Taiwan scored best in 2016. The results are available in different formats under a public domain data license at `index.okfn.org/download`.

Open Data Inventory (ODIN). ODIN was initiated by the non-profit, non-governmental organization Open Data Watch and assesses 180 countries regarding the coverage and openness of official national statistics (Open Data Watch, 2017b). In contrast to the previously presented tools, ODIN explicitly analyses data categories that are oriented towards progress on the SDGs. By default, all categories and used indicators are weighted equally but can be customized by users. In 2017, the highest overall score was achieved by Denmark, whereas in 2016, Sweden occupied the first rank. All results and datasets are available under a Creative Commons license at `odin.opendatawatch.com`.

The Open Data Measurement Guide (Brandusecu & Lämmerhirt, 2018) provides the methodology for the mapping of open data indicators against the six principles of the Open Data Charter. This framework is a basis for our mapping, in which we use the categories from the three measurement tools and link them to the SDGs. In a first step, all data categories of GODI, ODB, and ODIN were sighted manually and checked for overlaps and similarities (Figure 7.1). For each tool, the latest available version was used for the analysis. In a second step, the concrete targets of the SDGs were analyzed regarding the applicability of the aforementioned data categories.

In addition to the mapping, our goal is to compare the discussed open data categories with the actual availability of open datasets in cities. As a starting point, we concentrated on German large cities (cities with at least 100,000 inhabitants) and their open data portals. For the introduction of open data, the size of the city or municipality does not play an important role. The approach we
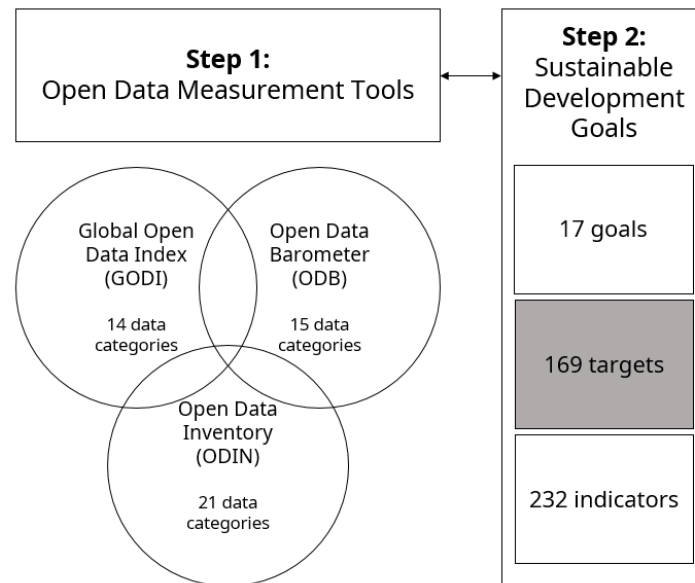
Figure 7.1: Mapping open data categories with SDGs

present is therefore not limited to large cities but can be applied equally to municipalities of any size. The big cities in this analysis only serve as a starting point for our investigation. Germany is in the upper midfield in country comparisons such as those of the Open Data Barometer or the Open Knowledge Foundation Index. More and more municipalities provide open data portals or are joining forces to store data records in portals. Some pioneers started implementing open data and open government measures at a very early stage and share their experiences with other municipalities. The country comparisons mentioned show that the situation has improved compared to previous years and that the existence of open data is developing further. However, much remains to be done to catch up with the leading open data nations. Regarding German large cities, there are 79 cities that meet this criteria. For these, we checked the availability of an open data portal on the city level with the help of the Open Data Atlas (`http://opendata .tursics.de/`), which lists the current status of open data portals in German-speaking countries. We identified 27 out of the initial 79 cities having an open data portal. In a next step, we retrieved each portal and investigated the embedded data categories. Therefore, we listed each category and the number of available datasets. Four cities were excluded from the analysis because the listed portals either did not represent a general open data portal (Münster and Braunschweig concentrate on geodata), or the concrete number of datasets could not be identified (Berlin and Mannheim), ending up with a final set of 23 cities. The presented results refer to available data as of January 29, 2019. A list of the included open data portals is presented in Appendix A.2.

7.4   Open Data Measurement Tools and the Sustainable Development Goals

Table 7.2 presents our findings on the overlaps of three open data measurement tools concerning their covered data categories. For each category, the SDGs are noted whose targets address aspects of this category.

Some of the categories are directly linked to an SDG. For example, the category health is embedded with a corresponding goal (SDG 3: good health and well-being). Both ODB and ODIN evaluate countries regarding the provision of health sector datasets. ODIN further differentiates between health facilities, health outcomes, and reproductive health. Also, vital statistics like birth and death rates are of importance for measuring progress on SDG 3. Similarly to health, gender equality received its own SDG 5. In contrast, actual gender statistics are only considered by ODIN. Representative datasets provide information on violence against women, the proportion of women in government or data on child marriages.

SDG 4 addresses quality education for all. Among its targets (4.1) is the intention to ensure primary and secondary education for all girls and boys. Beside SDG 4, education plays a significant role for economic growth and is hence also embedded in SDG 8, target 8.1, which aims at reducing the proportion of youth not in employment, education or training. The Open Data Barometer evaluates countries regarding their performance on education data. Similarly, a category on education outcomes is integrated into the Open Data Inventory. On the contrary, the Global Open Data Index does not include a category regarding education statistics.

The Open Data Inventory is the only measurement tool integrating a particular category on poverty and income statistics, thus directly addressing SDG 1. Income statistics are further deemed relevant for SDG 11, which addresses the reduction of inequalities within and among countries.

Environmental data is handled differently in the three measurement tools. ODB includes a general category on environmental statistics which entails data like carbon emissions, particulate matter, and deforestation. With air and water quality, GODI provides two more specific categories. ODIN on the other hand again combines water and air quality to one category on

Table 7.2: Open data categories and related Sustainable Development Goals

GODI	ODB	ODIN	SDGs
Social statistics			
		Population & vital statistics	3
	Education	Education facilities	4, 8
		Education outcomes	
		Health facilities	
	Health	Health outcomes	3
		Reproductive health	
		Gender	5
	Crime statistics	Crime & justice	16
		Poverty & income	1, 10
Economic statistics			
National statistics	National statistics	National accounts	8
		Labor	8, 9
		Price indexes	
Budget	Budget		
Spending	Government spend	Government finance	1, 2, 11, 16, 17
Procurement			
Company register	Company registration		
		Money & banking	
	International trade	International trade	2, 10
		Balance of payments	
Environmental statistics			
Land ownership	Land ownership		
National maps	Mapping data		
Administrative boundaries		Land use	9
Locations			
		Resource use	12
		Energy use	7
Water quality	Environment	Pollution	3, 6, 9, 11, 14, 15
Air quality			
		Built environment	6, 11
	Public Transport		9, 11
Other statistics			
National law	Legislation		5, 8, 10, 14, 15
Draft legislation			
	Contracting		
Election results	Election results		

pollution. Besides, ODIN further evaluates data coverage and openness regarding land, resource, and energy use. Environmental data does not only play a role for goals directly linked to the environment but rather is vital for several targets, which becomes apparent in the long list of SDGs listed in Table 7.2 for this data category. Apparently, water quality is directly linked to safe and

affordable drinking water and hence to SDG 6. Similarly, the connection to SDG 14 (life below water) and SDG 15 (life on land) is self-evident. But as water and air quality are essential for health, a target of SDG 3 addresses the reduction of deaths and illnesses from air, water, and soil pollution. What's more, industry and innovation are also linked to environmental factors. SDG 9, therefore, includes, inter alia, increased use of clean and eco-friendly technologies. The same holds true for cities, which shall reduce their environmental impact (SDG 11). ODIN further covers a category on the built environment which includes the proportion of people with access to water and sanitation and is hence strongly linked to SDG 6. Besides, this category can also be mapped to SDG 11, as housing quality indicators pertain to safe and sustainable cities and human settlements.

Some open data categories cannot be dedicated directly to one single SDG, but are anchored on a lower level in different targets, e.g., legislation (GODI and ODB) or government spending (GODI, ODB, and ODIN). Legislation data plays a significant role for measuring progress on sustainable development, as "governments at all levels have had to develop an understanding of sustainable development and to consider how it should be integrated into everyday decisions and actions in their respective regions, countries, and municipalities" (Ross, 2010, p. 1104). For the SDGs, legislation data was deemed relevant in particular for the goals 5, 8, 10, 14 and 15. For example regarding gender equality (SDG 5), one of the targets (5.c) aims at adopting "policies and enforceable legislation for the promotion of gender equality and the empowerment of all women and girls at all levels." Similarly, SDG 14 entails a target on implementing the national law for the conservation and sustainable use of oceans and their resources. Further appearances of legislation information among the targets can be found in SDG 8 regarding labor rights, in SDG 10 regarding the elimination of discriminatory laws and SDG 15 regarding national legislation for the prevention or control of invasive alien species.

Similar to legislation data, information on government spendings is anchored in several targets. For example, among the targets of SDG 2 is the increasing investment in rural infrastructure and agricultural research to enhance agricultural productive capacity in developing countries. All three measurement tools provide a corresponding category. While ODIN covers a general category on government finance which includes actual revenues and expenditures, GODI and ODB distinguish between government budget and spending; GODI further incorporates a separate category for procurement.

7.5 Open Data Portals in Large German Cities

In order to apply open data for measuring progress on the SDGs in cities, the prevalence of appropriate data is essential. With our small-scale case study we analyzed the situation in German large cities as a starting point. In Germany, only about one third (27 out of 79) of the large cities provides an open data portal according to the Open Data Atlas. Most cities show similarities in the selection of their data categories but differ immensely in the number of datasets provided for these categories.

One reason for this is the lack of a mandatory standard for the data categories. Work has been carried out on guidelines to develop a common national metadata standard. At the time of this decision, however, the first open data portals already existed, which differed in various points such as data categories. Subsequently, the existing German portals or also international portals were taken as examples for the introduction of new open data portals, if municipalities had decided to implement open data.

At the European level, a common metadata standard (DCAT-AP: `https://joinup.ec.europa.eu/release/dcat-ap/12`) was created which, among other things, provides for a list of 14 categories for data records (Table 7.3). However, this is not a strict requirement, but can be adapted to national differences. In such an adaptation, mapping to the DCAT-AP specifications should also take place, so that cross-country compatibility and comparability is ensured. These local adaptations should contain these mappings directly, and they should also be made available on the European Data Portal. The specifications for the controlled vocabulary in DCAT-AP, which covers different areas, are available in all languages of the European Union, so that uniform national terms and spellings are also standardized.

In June 2018, the German adaptation DCAT-AP.de (`https://www.dcat-ap.de/`) was established as a formal exchange standard for open general administrative data. Implementation in open data portals is already underway and is scheduled for 2019. The maintenance manual for DCAT-AP.de stipulates that data at the national, federal and municipal level will comply with this standard. This will lead to the fact that the mapping in Table 7.2 may be subject to additions and maybe changes, but will subsequently be applied to all open data portals in all countries that operate their portals according to the DCAT-AP standard. Further, a mapping of

Table 7.3: Data categories proposed by the DCAT-AP metadata standard

Abbreviation	Title
AGRI	Agriculture, fisheries, forestry and food
ECON	Economy and finance
EDUC	Education, culture and sport
ENER	Energy
ENVI	Environment
GOVE	Government and public sector
HEAL	Health
INTR	International issues
JUST	Justice, legal system and public safety
OP_DATPRO	Provisional data
REGI	Regions and cities
SOCI	Population and society
TECH	Science and technology
TRAN	Transport

Table 7.2 with the SDGs to the proposed categories of DCAT-AP will be performed. For regional peculiarities, the mapping of the local adaptations (for Germany, for example, DCAT-AP.de) is available, so that a two-stage assignment exists here.

In particular, this point in the various mappings shows how important common standards are in these subject areas in order to achieve evaluations and the best possible comparability. Only when a metadata standard such as DCAT-AP is mandatory in open data portals on all hierarchical levels of a country can a comparative analysis be carried out without very time-consuming and error-prone intellectual processing.

This does not exclude national peculiarities, as the local adaptations of DCAT-AP show. Each country can define its standard based on this meta-standard, which is, however, compatible with DCAT-AP and has a mapping. For cross-country comparisons, these local characteristics and mappings are to be included in the evaluation when it comes to checking whether the individual objectives have been achieved.

Table 7.4 shows the data categories for each city with the number of open datasets for each topic. Some categories directly match with the open data categories presented in the mapping of the previous section. For example, education, health, environment and legislation can be found in the Open Data Barometer. Taking a look at the number of datasets for these categories, we can observe some differences between the analyzed cities. For example, with 2802 datasets, Hamburg provides by far the largest amount of data for the category environment. Thereby,

Table 7.4: Availability of categories and datasets in German open data portals

	HH	M	K	F	D	L	BO	W	BN	KA	GE	C	AC	HAL	KR	FR	HRO	MH	P	WAN	UL	J	MO
Population	13	42	57	12	16	0	16	2	61	12	20	0	29	14	6	45	13	1	4	0	44	15	52
Education	2	2	14	1	14	0	4	3	24	5	4	8	0	1	4	19	13	0	3	0	19	8	31
Transportation	80	33	50	6	11	0	7	22	63	2	2	5	3	4	1	12	22	3	3	1	17	9	46
Geography and Geology	45	12	72	8	17	0	5	52	66	3	6	0	6	22	21	29	42	8	10	8	20	0	26
Culture	12	11	28	4	15	11	5	10	33	9	18	0	5	0	12	28	35	0	1	2	38	4	35
Environment	2802	1	25	2	20	18	3	4	39	3	2	6	2	31	1	7	25	1	1	9	22	38	7
Politics	13	3	44	37	19	0	32	7	31	5	2	0	21	6	1	87	24	6	7	4	22	2	10
Health	19	1	5	2	4	0	1	1	4	2	0	0	1	0	1	6	12	0	0	0	11	0	5
Social	10	5	18	5	26	37	25	2	20	10	15	8	1	0	9	7	9	0	2	0	28	0	1
Economy	6	14	3	6	4	29	0	3	0	9	7	0	3	2	0	37	41	0	1	0	24	9	0
Legislation	3	0	3	0	17	0	0	8	3	1	0	0	0	0	0	3	1	0	0	3	7	0	0
Public Administration	12	1	26	0	10	37	8	11	75	10	2	2	11	4	1	14	44	0	0	6	19	8	81
Infrastructure, Construction and Housing	2997	4	16	12	29	12	5	25	78	9	40	0	11	11	4	17	66	0	12	2	24	38	24
Consumer Protection	0	0	0	0	0	0	0	1	0	2	0	0	0	0	0	0	16	0	0	0	7	0	0
Sum	6014	129	361	95	202	144	111	151	497	82	118	29	93	95	61	311	363	19	44	35	302	131	318

most sets consist of data on environmental measurements (2600), followed by public plans (133) and geodata (67). In comparison, all other cities provide between one and 39 datasets for this topic, resulting in a median of 7. For the category education, we could find the highest amount of datasets in Moers (31). In contrast, four cities do not provide any open data on education. For this category, the median value is 4. With a median of 1 and 0, respectively, data in the categories health and legislation is rarer. Most datasets for these topics could be found on the open data portals of the cities Hamburg with 19 datasets for the category health and Düsseldorf with 17 datasets on legislation.

Another category that can be found both in our mapping (ODIN) and in the open data portals of the examined cities is population data. Considering the median of 14, data for this category is the most prevalent among the German cities. Only three cities do not provide data for this category. The largest amount of datasets (57) could be found on the portal of Cologne.

The numbers from the currently available evaluation show that such an evaluation can function and that sufficient data are available to implement measurement of the objectives. However, at this point we cannot say anything about the quality of the data and the possible values for the achievement of the objectives, as further mappings and investigations are necessary. Also, the numbers in the categories for the different cities are very unevenly distributed. The focus in this analysis was on German cities and even of these only a small proportion has open data portals. This clearly shows that many municipalities still have to provide for the introduction of open data in their open government strategies so that we can use open governmental data as the basis for a comprehensive calculation of the achievement of the Sustainable Development Goals.

The results also show a clear discrepancy among cities that already have open data portals. If we take SDG 4 (Quality Education) as an example and look at the data sets in the Education category, a comparison between Hamburg and Moers shows that there is a striking difference in the number of existing data sets (2 compared to 31). In future work on this topic, it will, therefore, be necessary to assign the SDGs at the data set level from their targets or indicators and thus establish a closer link to specific open data sets.

7.6   Discussion and Conclusion

The assignment of open data categories to SDGs proposed in this paper is the first step towards an alternative, transparent calculation of an index for the status of achievement of the goals. The basis here is open governmental data, which must be available for the calculation. This also implies that the absence of an open government culture in a country makes the assessment impossible.

As soon as one starts comparing values for different countries, the fundamental question of comparability arises. Are the values for the SDGs of the individual directly comparable or do other factors have to be taken into account? The country profiles currently generated by the UN have additional development metrics that can be used to better classify the results. Also, all countries are classified into different categories, so that comparability in these categories is possible if necessary. This would also have to be done in the case of an adjustment at the city level, so that, for example, the number of inhabitants or the GDP are included in such a calculation or comparison.

To get an estimation on the progress of the SDGs, a platform for merging global open datasets would be useful. In some countries, there are already national portals, which harvests the data from the municipal portals and thus offer an interface for searching for data records from all parts of the country. On the European level, there exists the European open data portal (`https://www.europeandataportal.eu/`), which also harvests the national open data portal from Europe and thus allows a more global insight. This idea further thought could lead to the creation of a worldwide portal that enables the search for all data records in all open data portals. The difficulties lie in the use of different portal software, different interfaces for accessing the

data and different handling of metadata. In addition to that, barriers in opening governmental data exist (Conradie & Choenni, 2014), that should not be disregarded. However, further standardization in these areas will make this goal achievable in the future. The mapping of the data categories to the SDGs is not solved, however. This requires additional categorization based on our proposed mapping. Ireland already launched a portal (`http://irelandsdg.geohive.ie/`) which specifically lists datasets for the SDGs and the concrete indicators. Projects like this could further contribute to adequately measuring progress on the SDGs. In order to ensure comparability with other countries and to apply this on the city level, it is necessary to develop common standards for categories and data attributes.

A mapping can be conducted in a separate application which generates reports based on the country profiles which are already created by the UN for the SDGs. However, this application accesses (automatically) the data source (the possibly available global open data portal), extracts and processes the data and uses it to generate characteristic values that can represent the achievement of the individual goals per country. As already mentioned, it is possible in this context not only to access national, aggregated data but also to carry out a measurement for individual regions, cities and municipalities. This means that interested and committed citizens can also find out how their city has achieved one or all of the 17 goals. The data on which the calculation is based can also be viewed, and thus the values can be traced. This leads to more transparency and thus to verifiability and acceptance of the calculated values and rankings.

In this paper, we proposed a mapping of the open data categories of three measurement tools to the UN Sustainable Development Goals. In this way, several overlaps and similarities of the open data categories and SDGs became apparent, though with varying intensity depending on the respective measurement tool. While ODIN explicitly covers categories for social, economic and environmental development, ODB and GODI do not have this focus. Therefore, in particular, the categories of ODIN could be linked to the SDGs. For some categories a direct equivalent is anchored in the SDGs, this holds true for example regarding health, education or gender. Some further open data categories can be applied to several development targets, e.g., legislation data or statistics on government spending. Still, the number of open data categories oriented towards sustainable development can be further extended, as there is an excellent potential of open data to measure the progress of each SDG and its targets.

Section 7.5 shows the use of a controlled vocabulary metadata standard for the data categories. The use of such standards is a next important step to achieve measurement of target achievement and comparability based on open data. A mapping between the mapping generated in this paper (Table 7.2) and the categories from DCAT-AP (Table 7.3) is needed. Furthermore, local standards and their mapping to DCAT-AP must be taken into account in cross-country analyses. The path via categories and category measurements, therefore, represents a multi-stage procedure that can be integrated into a process for data collection and data analysis by using standards. The next step is to examine the SDGs more closely and classify them into appropriate needs for datasets.

The Sustainable Development Goals can then be assigned more precisely to the categories from the various indices with the DCAT-AP categories. This is particularly true in cases where a target is assigned to more than one category, what then leads to a further step, which will take place after the introduction of DCAT-AP and the corresponding mapping. To evaluate the achievement of the SDG or make calculations for a degree of progress, a data basis is required. The data basis must be comparable for the survey of different municipalities, federal states or states. The next step is, therefore, the use or creation of model data catalogs, which create standardization. This involves not only the names and sorting of the datasets into categories but also which datasets should be available in each portal. That means, for example, that for each municipality there is a record of student numbers, which can be found quickly and easily. A further mapping will follow, namely that of the targets or indicators to the data records described in sample data catalogs. An iterative process is needed, as the sample data catalogs must also develop and evolve. Such a development is taking place in the federal state of North Rhine-Westphalia in Germany: with support and expertise from Vienna (Austria), such a model data catalog is being created and its use tested (`https://blog-smartcountry.de/wie-foerdern-wir -open-data-in-kommunen-der-naechste-schritt/`). Mapping with Sustainable Development must keep pace and be adapted accordingly. In this way, the calculation of the individual goals will be possible successively with open datasets that can be found uniformly, are described and are available in a comparable form for different municipalities.

Further, for applying the presented mapping in order to measure progress on the SDGs in cities and, in particular, to compare cities with each other, the availability of datasets is essential. With our small-scale study we provide a first insight into the challenges that exist for this approach.

Cities might provide datasets that are not comparable to each other. Currently, the prevalence of data categories in German cities adheres in some parts to the ODB, which in turn can be applied to the SDGs to some extent. The availability of actual datasets for the individual categories varies immensely. Further, in our study we could not evaluate the actual quality and suitability of existing datasets. This should be considered in further studies.

The SDG index is undergoing changes in its development. Sources for indicators change, new indicators are added, and some indicators are removed or replaced by others. There is, therefore, an additional challenge to take these dynamic changes into account and to adapt the framework to the changes in the different versions of the SDG index. To show changes over time, the different versions of the SDG index must be brought in line with the mapping and the data records for the respective year. The results obtained for the national level can be compared with the official country profiles of the SDG index to get an impression as to what extent equal results are achieved. In the event of deviations from the official results, it remains to be investigated on which data basis and according to which methodology both values were calculated. Differences in the values obtained make it possible to initiate a discussion about transparency in the calculation of the values. There are no comparison values for the subordinate levels. More empirical studies are to be carried out to what extent the calculated values correspond to the condition of cities.

This contribution represents a first step on the way to a framework that enables the use of open governmental data to measure the achievement of SDG targets. In doing so, the focus is placed in particular on the local reference. It does not remain the status quo that the objectives are only considered at national level. It is precisely through the availability of open datasets of cities and municipalities that these goals can be considered for an area that is manageable and where the effects can be experienced and shaped directly by the local citizens. At the same time, the 17 goals offer a template for possibilities for local citizen participation to make one's city more livable, fairer and better for one's fellow citizens and also for oneself.

References

Bibri, S. E., & Krogstie, J. (2017). Smart Sustainable Cities of the Future: An Extensive Interdisciplinary Literature Review. *Sustainable Cities and Society*, *31*, 183–212. doi:

10.1016/j.scs.2017.02.016

Brandusecu, A., & Lämmerhirt, D. (2018). *Open Data Charter Measurement Guide.* Retrieved August 1, 2018, from `https://open-data-charter.gitbook.io/odcmeasurement-guide/executive-summary`

Chen, L. J., Ho, Y. H., Lee, H. C., Wu, H. C., Liu, H. M., Hsieh, H. H., ... Lung, S. C. C. (2017). An Open Framework for Participatory PM2.5 Monitoring in Smart Cities. *IEEE Access*, *5*, 14441–14454. doi: 10.1109/ACCESS.2017.2723919

Chiesura, A. (2004). The Role of Urban Parks for the Sustainable City. *Landscape and Urban Planning*, *68*(1), 129–138. doi: 10.1016/j.landurbplan.2003.08.003

Conradie, P., & Choenni, S. (2014). On the Barriers for Local Government Releasing Open Data. *Government Information Quarterly*, *31*(Supplement 1), S10-S17. doi: 10.1016/j.giq.2014.01.003

Gorin, J., Manley, L., & Ariss, A. (n.d.). *Sustainable Development Goals and Open Data.* Retrieved June 30, 2018, from `http://blogs.worldbank.org/ic4d/sustainable-development-goals-and-open-data`

Hák, T., Janoušková, S., & Moldan, B. (2016). Sustainable Development Goals: A Need for Relevant Indicators. *Ecological Indicators*, *60*, 565–573. doi: 10.1016/j.ecolind.2015.08.003

Kates, R. W., Parris, T. M., & Leiserowitz, A. A. (2005). What is Sustainable Development? Goals, Indicators, Values, and Practice. *Environment*, *47*(3), 8–21. doi: 10.1080/00139157.2005.10524444

Klopp, J. M., & Petretta, D. L. (2017). The Urban Sustainable Development Goal: Indicators, Complexity and the Politics of Measuring Cities. *Cities*, *63*, 92–97. doi: 10.1016/j.cities.2016.12.019

Linders, D. (2013). Towards Open Development: Leveraging Open Data to Improve the Planning and Coordination of International Aid. *Government Information Quarterly*, *30*(4), 426–434. doi: 10.1016/j.giq.2013.04.001

Lusa, D. A., Dos Santos Rabello, R., & Cervi, C. R. (2015). Open Smart City View - An Architecture for Open Government Data Manipulation and Presentation at City Level. In *Proceedings of the 14th International Conference on WWW/INTERNET 2015, Maynooth, Ireland, October 24-26, 2015* (pp. 119–126). Maynooth, Ireland: IADIS.

Mainka, A., Hartmann, S., Meschede, C., & Stock, W. (2015b). Open Government: Transforming

Data into Value-added City Services. In M. Foth, M. Brynskov, & T. Ojala (Eds.), *Citizen's Right to the Digital City: Urban Interfaces, Activism, and Placemaking* (pp. 199–214). Singapore: Springer.

Mainka, A., Hartmann, S., Meschede, C., & Stock, W. G. (2015a). Mobile Application Services Based Upon Open Urban Government Data. In *iConference 2015 Proceedings, Newport Beach, CA, March 24-27, 2015* (pp. 1–15). Urbana, IL: IDEALS.

McDermott, P. (2010). Building Open Government. *Government Information Quarterly*, *27*(4), 401–413. doi: 10.1016/j.giq.2010.07.002

National Research Council. (1999). *Our Common Journey: A Transition Toward Sustainability.* Washington, DC: The National Academies Press.

Obama, B. (2009). Memorandum for the Heads of Executive Departments and Agencies. Freedom of Information Act. *Presidential Studies Quarterly*, *39*(3), 429. doi: 10.1111/j.1741-5705 .2009.03698.x

Ojo, A., Curry, E., & Zeleti, F. A. (2015). A Tale of Open Data Innovations in Five Smart Cities. In *Proceedings of the 48th Hawaii International Conference on System Sciences, HICSS 2015, Kauai, HI, January 5-8, 2015* (pp. 2326–2335). Washington, DC: IEEE Computer Society.

Open Data Watch. (2017). *Open Data Inventory 2017 Methodology Report.* Retrieved October 1, 2018, from `http://odin.opendatawatch.com/Downloads/otherFiles/ODIN-2016 -Methodology.pdf`

Open Knowledge International. (n.d.-a). *Open Data Handbook.* Retrieved October 1, 2018, from `http://opendatahandbook.org/guide/en/`

Open Knowledge International. (n.d.-b). *The Open Definition.* Retrieved October 1, 2018, from `https://opendefinition.org/`

Open Knowledge International. (2017). *Global Open Data Index. Methodology.* Retrieved October 1, 2018, from `https://index.okfn.org/methodology/`

Ross, A. (2010). It's Time to Get Serious - Why Legislation is Needed to Make Sustainable Development a Reality in the UK. *Sustainability*, *2*(4), 1101–1127. doi: 10.3390/su2041101

Sachs, J. D. (2012). From Millennium Development Goals to Sustainable Development Goals. *The Lancet*, *379*(9832), 2206–2211. doi: 10.1016/S0140-6736(12)60685-0

SDG National Reporting Initiative. (2018). *Facilitating Information-sharing on SDG Reporting.*

Retrieved October 1, 2018, from `https://www.sdgreporting.org/`

Shepherd, E. (2015). Freedom of Information, Right to Access Information, Open Data: Who is at the Table? *The Round Table. The Commonwealth Journal of International Affairs*, *104*(6), 715–726. doi: 10.1080/00358533.2015.1112101

Sunlight Foundation. (2017). *Ten Principles for Opening Up Government Information.* Retrieved October 1, 2018, from `https://sunlightfoundation.com/policy/documents/ten-open-data-principles/`

United Nations. (2015). *Sustainable Development Goals.* Retrieved January 5, 2018, from `http://www.un.org/sustainabledevelopment/sustainable-development-goals/`

United Nations. (2019). *World Urbanization Prospects: The 2018 Revision.* New York, NY: United Nations. Retrieved August 1, 2018, from `https://population.un.org/wup/Publications/Files/WUP2018-Report.pdf`

United Nations Statistics Division. (2017). *IAEG-SDGs. Inter-Agency Expert Group on SDG Indicators.* Retrieved October 1, 2018, from `https://unstats.un.org/sdgs/iaeg-sdgs/`

WCED. (1987). *Report on the World Commission on Environment and Development. Our Common Future.* Oxford, UK: Oxford University Press. Retrieved August 5, 2018, from `http://www.un-documents.net/our-common-future.pdf`

World Bank Data Team. (2018). *The 2018 Atlas of Sustainable Development Goals: An All-new Visual Guide to Data and Development.* Retrieved October 1, 2018, from `http://blogs.worldbank.org/opendata/2018-atlas-sustainable-development-goals-all-new-visual-guide-data-and-development`

World Wide Web Foundation. (2015). *Open Data Barometer. ODB Methodology.* Retrieved October 1, 2018, from `https://opendatabarometer.org/2ndEdition/about/method.html`

8 Including Citizen Participation Formats for Drafting and Implementing Local Sustainable Development Strategies

8.1 Introduction

With the Agenda 2030 and the Sustainable Development Goals (SDGs), the United Nations make an attempt towards ending poverty, protecting the planet and ensuring prosperity for all (United Nations, 2015c). The 17 goals, adopted in 2015, aim at promoting sustainable development regarding all its manifestations, i.e., environmental, economic, and social dimensions. Sustainable development can be defined 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). Rather than focusing on development in developing countries, the Agenda 2030 demands action of all countries. For this purpose, a sustainable development strategy (or sustainability strategy) can serve as a political control instrument and management tool. A sustainable development strategy includes methods and tools for strategically implementing and monitoring sustainable development on the national, regional, or local level. Governance for sustainable development has grown immensely in the past years, and several national sustainable development strategies have been adopted (Quental, Lourenço, & Da Silva, 2011).

Likewise, many cities and municipalities around the world aim at strategically becoming more sustainable with regard to the economic, environmental and social dimension, and to implement the SDGs on the local level. With goal 11 - "Sustainable cities and communities" - the role of cities and their responsibility in a global world is also stressed within the SDGs. Hence, with more than half of the world's population living in cities (United Nations, 2019), this "Urban Sustainable Development Goal (USDG)" (Klopp & Petretta, 2017) gives attention to the global trend towards urbanization. Besides, the content of SDG 11 and its targets is linked to all other SDGs, which implies the importance of local governments for contributing to a sustainable development. During the third UN Conference on Housing (Habitat III) in 2016, the New Urban Agenda was adopted which provides a guideline for future urban development. In particular,

it refers to SDG 11 and thus further highlights the role of cities for sustainable development (United Nations, 2016a). Local municipalities and cities are places where the implementation of sustainable development strategies is put into practice. The design of such a strategy should not be seen as a fixed product, but rather a continuous process, which includes the stages analysis, decisions, planning, implementations and reviews (Meadowcroft, 2007). Smart sustainable cities can thereby contribute to the SDGs by an integrated information ecosystem (Corbett & Mellouli, 2017). Furthermore, smart cities foster an improvement of participation and equity (Bibri & Krogstie, 2017).

The process of adopting a sustainable development strategy should include the participation of different stakeholders (Meadowcroft, 2007). In general, democratic governance is not limited to top-down concepts, but also entails bottom-up approaches, including citizens into decisions and policy-making. Concepts of open government foster transparency, participation, and collaboration (McDermott, 2010). By allowing deliberative processes and including citizens into the debate, progress towards a sustainable development can be made. Similarly, the SDGs, which were themselves developed with the support of citizens' involvement (Fox & Stoett, 2016; Howard & Wheeler, 2015), "will not be achieved without significant public awareness and engagement" (Sriskandarajah, 2018, p. 302). The formulation of the SDGs also includes the importance of participation, for example, SDG 16 (Peace, Justice and Strong Institution) entails target 16.7 "Ensure responsive, inclusive, participatory and representative decision-making at all levels" (United Nations, 2015a). For citizens, participation can result in advantages such as achieving education and democratic skills, and to some extend gaining control over the policy process, whereas governments may benefit by learning from the citizens, building trust and making better informed policy decisions (Irving & Stransbury, 2004). Local governments can further improve sustainable development initiatives by collaborating with citizens (Hawkins & Wang, 2012). Citizen participation is of particular importance for sustainable development, as the concept is normatively charged and represents a changing society with increasing social and environmental interactions (Meadowcroft, 2004).

The goal of this study is to contribute to the debate of citizen participation and local sustainable development governance, by performing a case study. We analyzed sustainable development strategies at the local level in order to assess the current use of citizen participation formats for adopting these. We concentrated on the German pilot project "Global Sus-

tainable Municipalities North Rhine-Westphalia" (`https://www.lag21.de/projekte/details/global-nachhaltige-kommune/`) initiated by the working group "LAG 21 NRW" which advises municipalities in the development of sustainability management systems. They use a participative planning approach that has been applied in more than 50 German municipalities as well as more than 20 countries all over the world (`https://www.lag21.de/themen/integrierte-nachhaltigkeitsstrategien/`), which demonstrates the international relevance of the pilot project.

This article is organized as follows: The next section provides an overview on citizen participation formats as described in the literature and presents our research questions. After that, the case study is depicted, as well as the methodological approach. Subsequently, the results are presented, followed by our model of citizen participation for adopting a local sustainable development strategy, as well as a discussion and conclusion of the findings.

8.2   Citizen Participation Formats

Citizen participation can take several forms. There exists a variety of different participation formats, including different target groups and objectives, as well as facilitating different levels of power on the parts of the participating citizens. The "Ladder of Citizen Participation" (Arnstein, 1969) differentiates between eight types of participation and non-participation: manipulation, therapy, informing, consultation, placation, partnership, delegated power and citizen control. In that order, an increasing power of citizens can be detected. Furthermore, various participation formats are suitable for problems and topics on different abstraction levels. With regard to the design and implementation of sustainable development strategies, not every participation format may be a meaningful contribution to each of the phases. Based on the format of choice, the citizens' decision-making power differentiates. Hence, "one of the main challenges is to measure the degree of influence that citizens have had on a decision-making process" (Marzouki, Mellouli, & Daniel, 2017, p. 207).

The Handbook of Citizen Participation (Nanz & Fritsche, 2012) gives an overview on several global participation formats and summarizes their goals and typical fields of application and served as a starting point for our literature review. In particular, each method of participation

is assigned to objectives and desired effects of the process. These objectives are adapted from the "Ladder of Citizen Participation" (Arnstein, 1969) and presented in Table 8.1.

The right column of Table 8.1 entails examples of citizen participation formats for each objective. The main goal of a *National Issues Forum* is information sharing at the local level and an exchange of opinions, but less consulting decision-makers. Hence, the decision-making power of citizens remains low. Citizen participation within a National Issues Forum aims at enabling citizens to use and adopt democratic skills during structured discussion panels (Nanz & Fritsche, 2012). Citizens discuss specific, predefined political topics, whereby a moderator instructs them. Prior to the discussions, citizens are encouraged to read information on the specified topics, in addition, questionnaires can be distributed before and after the event (Gastil & Dillard, 1999).

Table 8.1: Objectives of citizen participation formats (Nanz & Fritsche, 2012)

Objective	Description	Examples
INFORMATION	Used, when the citizen participation procedure aims at informing the public about a certain topic or circumstance. Thereby, the citizens may strengthen their knowledge and competencies, as well as their democratic skills.	National Issues Forum, Deliberative Polling, Consensus Conference
INFLUENCE/ INITIATION	Some citizen participation formats aim at raising awareness on a topic and initiating public debates thereon. The goal is to shape public opinions, whereby influence should not be understood as manipulation, rather than the initiation of opinion-forming processes. Influence can also be present in the form of mediating in controversial debates and thereby strengthen social cohesion.	Deliberative Polling, Consensus Conference, Appreciative Inquiry, Open Space Conference, World Café, Scenario Conference, Future Search Conference, Future Workshop, Charrette, Planning for Real
CONSULTATION	The advisory role of a participation process may not lead to actual decisions, but will be acknowledged and evaluated by relevant stakeholders. Citizens formulate their recommendations based on their experiences within the participation process.	Scenario Conference, Future Search Conference, Future Workshop, Charrette, Planning for Real, 21st Century Town Meeting, Participatory Budgeting
DECISION	If citizens have the possibility to co-decide on concrete plans, they have direct influence on political decisions. The decision-making power has to be guaranteed already before the participation process takes place.	21st Century Town Meeting, Participatory Budgeting

Deliberative Polling is an approach which entails the use of two polls in different stages: one ad hoc poll on a certain topic distributed to a random sample of citizens, followed by an event which aims at informing the participants, as well as a second poll after the event. During the event, participants have the opportunity to discuss the topic with experts, politicians or other relevant stakeholders (Nanz & Fritsche, 2012). The main goal of this method is information-sharing, but also to measure changes of the participants' opinions after the information event (Goodin & Dryzek, 2006). A large amount of citizens, who should be randomly chosen and form a representative cross-section of the population, can take part in these events. However, the decision-making power of participating citizens remains low, as the priority lies on information-sharing. Furthermore, the outcome of such events depends also on the selection of the invited experts, who discuss with the participants (Brady, Fishkin, & Luskin, 2003).

Similarly, the idea of a *Consensus Conference* is to bring science and practice together. A dialogue between experts and laypersons, in particular regarding technology assessment, but increasingly further social and economic topics is desired through this method (Nanz & Fritsche, 2012). Mostly, the format is open to the public and accompanied by the media. Before the event takes place, information material is shared with the participants. Similar as in Deliberative Polls, the influence of citizens in this process is of an indirect nature, as the discussions may help politicians to obtain new perspectives on concerns and opportunities regarding certain technologies. "Consensus conferences do not promise any miracles, and it is very important to make this clear to the citizens before engaging on the work" (Andersen & Jaeger, 1999, p. 336).

The format of an *Appreciative Inquiry* originates from change management in organizations and can be used in order to focus on those elements that work well, and not to solely highlight shortcomings and problems (Meyer-Emerick, 2012; Nanz & Fritsche, 2012). The format aims at creating a vision for change based on existing strengths and to define reasons for success. The idea is to create motivating effects by concentrating on the positive conditions. In 2009, the city of Cleveland organized an Appreciative Inquiry entitled "Sustainable Cleveland 2019", aiming at transforming Cleveland to a sustainable city. The project was deemed successful and "using a strength based approach enabled building momentum on an established, successful base with a positive vision" (Meyer-Emerick, 2012, p. 57).

The goal of an *Open Space Conference* is to find a solution for a guiding theme or problem (e.g. sustainable development). There are no predefined topics or rules for this approach and different abstraction levels are possible for the issues dealt with during an Open Space Conference. As a result the outcome of this format is not predefined and dependent on the participating citizens and their preferences (Herrington, 2006; Lent, McCormick, & Pearce, 2005; Nanz & Fritsche, 2012). The format shows some similarities to a *barcamp*, which is an open event for knowledge sharing. The concrete timeline and content of a barcamp is developed at the beginning of the event together with all participants. Everyone is encouraged to contribute with a presentation or discussion on a certain topic (Dennerlein et al., 2015).

The intention of a *World Café* is to create an informal atmosphere for conversations similar to visiting a café. This approach is intended to help groups of different sizes to "engage in constructive dialogue, to build personal relationships, and to foster collaborative learning" (Tan & Brown, 2005, p. 84) by using seven design principles, including the encouragement of everyone to contribute to the discussion. Thereby, this format can support the initiation of public debates and strengthens social cohesion. Often, approaches like a World Café are used as a starting point for collecting and sharing knowledge in combination with other citizen participation methods (Nanz & Fritsche, 2012).

Scenario Conferences or *Workshops*, *Future Search Conferences*, and *Future Workshops* are approaches that are suitable for illustrating the future development of a city. The scenario technique is used to develop different scenarios of the future by designing and simulating several comprehensible pictures of the future (Nanz & Fritsche, 2012). The approach aims at forecasting long-term developments with regard to different framework conditions and to derive recommended actions based on these. Scenario Workshops are also suitable for finding a new way to organize and manage certain problems (Andersen & Jaeger, 1999). In Denmark, a Scenario Workshop was already used in 1991 for an urban ecology project, in which different scenarios described the potential life of a particular family in the future. The result was a national plan for urban ecology (Andersen & Jaeger, 1999).

In a Future Search Conference, the participants develop measures and action plans for future projects. Within a predefined schedule, the main focus is not set on problems, but future development. This approach is often used for creating a new orientation of a municipality (Nanz

& Fritsche, 2012). Participants discuss the past, the present, the future, as well as their common values and specify action plans (Weisbord & Janoff, 1996). Already in the context of the Local Agenda 21, Future Search Conferences were used each in a German and a British municipality to adopt the Local Agenda 21 process. Although a consensus vision was achieved in both municipalities, the quality of the results was deemed low, as most ideas were not translated into action. A major problem was thereby seen in a missing link to formal decision-making processes of the Council (Oels, 2009).

Future Workshops are especially used in the German-speaking countries and are composed by the three phases criticism (experiences of participants via brainstorming, identification of deficits), imagination (developing creative solutions without claim to reality) and realization (the best approaches are planned in more detail, search for collaborators and realization measures) (Müllert, 2009; Nanz & Fritsche, 2012). The concept is based on the openness of the results and creativity. Similar as the Future Search Workshop and Scenario Conference, it is often used for developing a vision for the future of an organization or municipality. Scenario Conferences or Workshops, Future Search Conferences and Future Workshops have the potential to contribute to concrete solutions and hence are coined not only by an influential component, but also a consulting element.

In a *Charrette* (or *Design Charrette*), an interdisciplinary design team (including citizens and other interest groups) as well as experts come together for developing urban planning concepts. Mostly, these are concrete tasks of spatial development (Nanz & Fritsche, 2012). The idea of a Charrette has its origins in the town planning movement New Urbanism and is mostly organized in three phases: an information-sharing activity, the actual Charrette event and an implementation phase (Bond & Thompson-Fawcett, 2007). Practical implementations of this approach still have room for improvements (Bond & Thompson-Fawcett, 2007), as a result municipalities should critically review the appropriateness of such processes.

The approach *Planning for Real* has the goal to improve the quality of life in certain spaces, e.g. public parks or districts. All interested citizens are invited to take part in the redesign process of their living space by contributing to the planning and implementation phases (Nanz & Fritsche, 2012). The name Planning for Real (`http://www.planningforreal.org.uk/`) is a registered trademark of an organization with the same name and its use needs their approval.

Techniques offered by the organization include 3D models and other planning and evaluation models which can be applied to specific design tasks. Many municipalities use the concept of Planning for Real to react to existing citizen initiatives who aim at changing certain aspects in their neighbourhood or region (Nanz & Fritsche, 2012). In order to identify the local needs and to support the redesign process this approach can be helpful.

The methods *Participatory Budgeting* and 21st *Century Town Meeting* address concrete topics and problems, which leads to a relatively high degree of decision-making power of the citizens. In a 21st Century Town Meeting, which is constructed for a large number of citizens, participants form groups, whereby each group performs face-to-face discussions with an independent moderator. This person collects the most important ideas and comments, while all results are subsequently collected centrally and sent to all groups for commenting and voting via keypad polling (Lukensmeyer & Brigham, 2005; Nanz & Fritsche, 2012). Developed by America*Speaks*, this approach is mainly used in the United States. Twenty-first Century Town Meetings have been used for a wide range of topics at the national, regional and local scale, including Social Security reform and regional planning (Lukensmeyer & Brigham, 2005). In practice, the realization is complex: "The 21st Century Town Meeting is more than a single event. It is an integrated process of citizen, stakeholder, and decision maker engagement over the course of many months" (Lukensmeyer & Brigham, 2005, p. 51). This results in high costs and a tremendous (technical) effort to realize this method.

As the name suggests, a Participatory Budgeting aims at developing a municipal budgeting (or parts of it) while consulting also citizens. This process should be open for all interested persons and proceeds in three ideal-typical phases: information (presenting planned budget), consultation (citizens discuss aspects of the budget) and account (representatives of local politics explain which elements from the citizens were included, which not) (Nanz & Fritsche, 2012). Participatory Budgeting can take place offline, online or in the form of hybrid models (Mkude, Pérez-Espés, & Wimmer, 2014). Mostly, citizens only have a consultative role, but do not make actual decisions (Nanz & Fritsche, 2012). A similar approach is the idea of a *Neighbourhood Fund*. A determined budget is available, for which citizens can recommend projects for funding.

Applications of citizen participation formats with a focus on sustainability topics have been investigated in several countries. For example, Hunsberger, Gibson, and Wismer (2005) used three

case studies to explore citizen involvement in environmental assessment in Canada. In these cases, citizens were able to determine agendas for monitoring and managing issues of environmental concern, to develop policies and regulatory recommendations and to implement management plans. The authors conclude that "increased citizen participation in follow-up activities such as monitoring could help to improve the quality and local relevance of environmental assessment, while at the same time advancing the process toward sustainability goals" (Hunsberger et al., 2005, p. 624). Besides, common obstacles like establishing credibility and receiving funding should not be neglected.

In Sweden, Eckerberg and Mineur (2003) investigated two case studies regarding local sustainability indicators. One of these cases, located in Stockholm, involved citizens in the process of formulating indicators for the local Agenda 21. The other case, located in Sundsvall, did not involve citizens in the process, but started an information campaign in this regard. This lack of citizen participation was deemed problematic. The authors argue that there is a gap between policy makers and citizens which is hard to bridge. Still, citizens should be involved more in local strategies on sustainable development, especially due to commitments to further democratisation in the municipalities (Eckerberg & Mineur, 2003).

Abel and Stephan (2000) analyzed 16 local programs in the United States with an environmental focus and citizen participation elements of the organization Renew America. They used qualitative interviews to investigate, inter alia, the role of citizens in these programs. Most participants in these processes were citizens who have already been active before. In addition, only a few cases of citizen participation led to an actual influence on decision-making. The authors conclude that several obstacles of citizen participation in environmental decision-making have to be overcome in order to be successful (Abel & Stephan, 2000).

One main challenge of municipalities is to develop a framework for meaningful local participation in the context of sustainability (Meadowcroft, 2004). Therefore, we developed a model for demonstrating further possibilities to include citizen participation formats for adopting local sustainable development strategies. More specific, we aim at answering the following research questions:

RQ 1a.   What citizen participation formats are currently being used for adopting local sustainable development strategies?

RQ 1b.   During which phases of adopting a local sustainable development strategy are citizen participation formats currently being applied?

RQ 2a.   What citizen participation formats are possible for adopting local sustainable development strategies?

RQ 2b.   During which phases of adopting a local sustainable development strategy are citizen participation formats possible?

RQ 2c.   To what extend are citizens able to contribute to decision-making when participating in the adoption process of sustainable development strategies?

The first part of our analysis concentrates on the application of citizen participation formats and important lessons learned from the pilot project (RQ 1). As participation is a crucial part of the SDGs, RQ 1 assesses the current status of German municipalities and their application of citizen participation formats for sustainable development strategies. With the second part of our analysis (RQ 2), we intend to go beyond the current status and to present a model that systematically demonstrates potential formats, phases, and the specific decision-making power of participating citizens.

8.3   Global Sustainable Municipalities NRW, Germany

In Germany, the federal government adopted its first national sustainable development strategy in 2002. Since then, the strategy is regularly revised, due to constantly changing conditions and requirements. In 2017, the federal government adopted "the most extensive enhancement of the Strategy" and also embedded the SDGs in the framework (German Federal Government, 2017, p. 2). Furthermore, the importance of citizen participation for sustainable development is emphasised in the strategy. The administrative division of Germany is coined by federalism. The central government and the 16 states have different tasks and authorities. Most states consist of counties (districts and district-free cities). Districts are further subdivided into municipalities, whereby cities are municipalities with city rights. The Basic Law for the Federal Republic of Germany (`https://www.gesetze-im-internet.de/englisch_gg/`) empowers local governments with the autonomous regulation of local affairs and requires them to fulfill their own administrative tasks

(Gabriel, Ahlstih, Brettschneider, & Kunz, 2018). Because of its limited size, municipalities are not always able to solve all the tasks of the local community by themselves and can be supported by the corresponding district. In contrast, some tasks are subject to the local self-government of a municipality and the state should not interfere in these, which is covered by the principle of subsidiarity. As local governments are a matter of the corresponding state, each with its own local government legislation (Vetter, 2009), it is important to consider the specific state and its regulations.

The federal state North Rhine-Westphalia (NRW) adopted its first sustainable development strategy in 2016 and was the first German state that defined and explicitly formulated its contribution to the Agenda 2030 and the SDGs. Beyond that, the design of the sustainable development strategy was coined by broad participation opportunities of science, economy and civil society, as well as the state's municipalities (Brunkhorst & Obenland, 2017). By referring to SDG 11, the state government of North Rhine-Westphalia also emphasizes the importance to implement a sustainability management at the local level (Die Landesregierung Nordrhein-Westfalen, 2016). Similarly, the Association of German Cities (Deutscher Städtetag, 2015) recommended cities to commit themselves to the SDGs. Several German cities acknowledge the importance of public awareness and engagement in relation to the SDGs. They use citizen participation formats for disseminating information on sustainable development and the SDGs and thus raise awareness on these topics (Meschede, 2019). Generally, efforts of giving citizens more say in local politics started in the 1990s in all German states, whereas the degree of change in the local government institution was among the greatest in North Rhine-Westphalia (Vetter, 2009).

The pilot project "Global Sustainable Municipalities NRW" aims at supporting selected municipalities in North Rhine-Westphalia to systematically develop their sustainable development strategy. The working group "LAG 21 NRW" advises municipalities in developing sustainability management systems by using a participative approach. By bringing together the participating municipalities, an exchange of ideas and experiences is initiated. We concentrated on this project, as it provides a prototypical, systematical approach to design and implement a local sustainable development strategy. In the project, the journey of building a sustainable development strategy is regarded as an ideal-typical continuous improvement process (CIP), which is depicted in Figure 8.1 (LAG 21 NRW & SKEW, 2018). An organizational structure with predefined roles and responsibilities forms the starting point of the process. Based on an initial

Figure 8.1: Ideal-typical process of adopting a sustainable development strategy (adapted from (LAG 21 NRW & SKEW, 2018))

assessment of the municipality's current state - by both quantitative indicators and qualitative evaluations - a participating community in the project creates a first draft of the strategy, which entails a mission statement, thematic guidelines, strategic and operative goals, measures, as well as planned resources. This is followed by the formulation of the strategy and its formal resolution by the municipality's council. After the implementation of the strategy via concrete projects, a further evaluation of the strategy and its efforts takes place. This process is consistent with the strategy's purpose of serving as a structure for decision-making and also offering specific goals, indicators and actions (Meadowcroft, 2007).

8.4   Materials and Methods

The analysis in this paper is divided into two parts. The first part reports on a case study of the German pilot project "Global Sustainable Municipalities NRW" described in the previous section with the goal to assess the current status of the use of citizen participation formats for adopting local sustainable development strategies (RQ 1). For the qualitative analysis of this project we rely on (1) published reports of the participating municipalities as well as (2) qualitative interviews with responsible persons of the project. Figure 8.2 summarizes the types of sources used for the analysis.
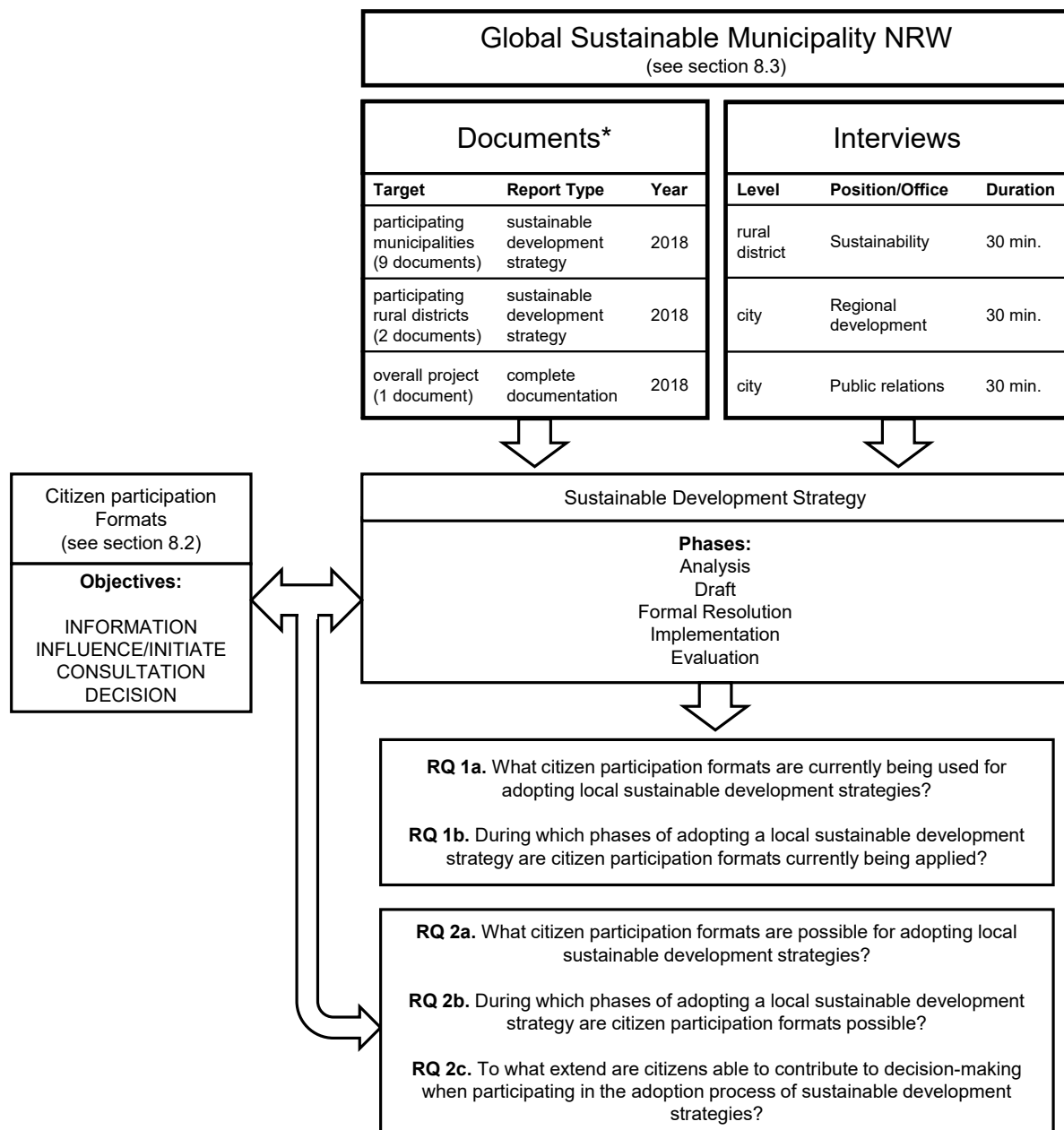
Figure 8.2: Materials used for the analysis

Each participating city or district in the pilot project had to document their path towards the sustainable development strategy. A rough structure for this report was given by the project lead (LAG 21). It entails a description of the corresponding municipality, information on involved stakeholders, details about each phase of the adoption process of the strategy (Figure 8.1) and the sustainable development strategy itself with the defined goals, measures and indicators. Nine of the analyzed strategies are from municipalities, and two from districts. In addition, a complete documentation of the overall project is available. The documents were read by

the authors and each reference on citizen participation, discussed topics and other aspects like knowledge sharing or communication modes were marked. In a second step, we reached out to the responsible contact persons for these sustainable development strategies, in order to learn more from their experiences and challenges with citizen participation formats during the design process of the sustainable development strategy. We conducted interviews via telephone with three responsible persons from two municipalities and one district, for which we used a semi-structured questionnaire (see Appendix A.3). The interviews took place in October, 2019, each of which lasted about 30 minutes.

The second part of the analysis goes beyond assessing the current status and intends to develop a model of citizen participation formats in local sustainable development strategies, aiming at demonstrating general possibilities to include citizen participation formats in the process of adopting a local sustainable development strategy (RQ 2). In order to develop the model, we used qualitative content analysis (Krippendorff, 2018; Mayring, 2015) using the software AT-LAS.ti (`https://atlasti.com/de/`). We used existing literature on citizen participation formats (section 8.2) to develop the codes by analysing goals, objectives, requirements, possible topics and stakeholder involvement. Subsequently, we used these codes on the documents described in the first part of the analysis (sustainable development strategies) and coded the different phases based on the ideal-typical CIP (Figure 8.1) towards a sustainable development strategy with the help of the codes developed from the participation formats.

8.5 Results

8.5.1 The Role of Citizen Participation for German Local Sustainable Development Strategies

The municipalities and districts that participated in the project "Global Sustainable Municipalities NRW" are coordinated in similar organizational structures, but with variations considering the concrete realization of this structure. The organizational structure forms the basis for the analysis phase and all subsequent stages (Figure 8.1). The project required a threefold division into an organization team (1-2 persons from public administration being primary responsible), a core team (5-8 persons from different municipal offices) and a coordinating group (15-20 persons

from economy, science, politics, public administration and civil society) (LAG 21 NRW & SKEW, 2018). The organization team of six municipalities and districts consisted of administrative staff of a department of environment and sustainability or similar. Other departments that were represented in the organization teams were planning, building and housing, urban development, finance, public relations, as well as social work. Table 8.2 summarizes the organizational structure, knowledge sharing, citizen participation approaches as well as challenges and prerequisites resulting of the project "Global Sustainable Municipalities NRW".

In contrast to the organization team, the coordinating groups consisted of a larger selection of representatives. For ten municipalities and districts, reference was made to civil society as an integral part of the coordinating group. However, in most cases, these participants of civil society took part in the process of developing the sustainable development strategy in their function as representatives of associations and organizations. One interview revealed that the corresponding municipality acknowledges the knowledge of experts and committed citizens as essential for the concrete topics of a sustainable development strategy and thus did not include citizens in a broader and more open form of participation for drafting the strategy. The same municipality also did only inform the citizens on the sustainable development strategy after formally deciding on it.

In contrast, other municipalities informed civil society already in the early stages of adopting the sustainable development strategy, e.g. via the official website of the city or social media channels. For example, another interviewee reported about an early involvement of the broad public during a citizen workshop. Information was shared on the purpose of the strategy and based on these citizens were able to co-decide on the prioritized action fields for the draft. The participants were split into four groups and discussed pre-identified strengths and weaknesses of the municipality. The overall results were collected and shared with all participants. With the help of a questionnaire, the participants were then asked to rate twelve thematic fields due to their relevance for the sustainable development strategy. The five topics with the highest rating formed the basis for the strategy. In addition, the municipality invited children and adolescents to an event in order to discuss concrete measures embedded in the draft of the strategy. Two further municipalities also invited interested citizens to sustainability conferences in the early stage of drafting the sustainable development strategy. For one of these, the main goal was to share information on the current status of the strategy and to define preliminary measures

Table 8.2: Citizen participation in the pilot project "Global Sustainable Municipalities NRW"

Aspect	Global Sustainable Municipalities NRW
Organizational structure	
Municipal departments represented in the organization teams	environment and sustainability
	planning, building and housing
	urban development
	finance
	public relations
	social work
Knowledge sharing	
Informing citizens on the strategy	website
	social media
	citizen workshops
Communication with other municipalities	workshops with the participating municipalities of the project
	town twinning
	network meetings
	vertical communication between district and municipalities
Sustainable development strategy	
Citizen participation embedded in the goals of the strategy	to produce general guidelines for citizen participation
	to develop municipal budget with citizen participation
	to plan residential areas in dialogue with citizens
	to promote open data and standardized participation formats
Citizen participation approaches	
Phases	analysis (prioritization of thematic foci)
	draft (mission statement)
	draft (measures)
	implementation (create participation guidelines)
	evaluation (updating strategy)
Participation formats	public citizen workshop
	World Café
	sustainability conference
Target groups	all interested citizens
	children and adolescents
	experts
Challenges and prerequisites	
General challenges	limited budget
	lack of personnel
Prerequisites for the success of participation	good moderation needed
	definition of target groups necessary
	documentation of the participation procedure needed

for the draft. Several organisations and associations were present in order to provide necessary background information regarding sustainability topics. The other municipality organized two conferences, one for including the civil society's ideas into the mission statement; the other for presenting the preliminary draft and to develop concrete measures and projects.

Nine municipalities included citizen participation as a goal itself into their sustainable development strategy and plan to use deliberative formats for implementing the strategy. The involvement ranges from concrete plans to develop the municipal budget by including participatory methods to the more general goal of producing guidelines for citizen participation in the municipality. The interviews further revealed that the implementation phase is in particular deemed relevant for citizen participation.

A special role is taken by the two participating districts in the project. One interviewee emphasized that the districts are not as close to the citizens as cities, hence citizen participation implies different challenges for these. However, the district can act as an example for the municipalities who can adopt the strategy on their own and adjust it to local circumstances. The interviewee from the district indicated that some municipalities are already adapting their strategy or even take the district as an example by taking part in the second round of the project "Global Sustainable Municipalities NRW". The other district included several citizen participation formats for evaluating their current sustainable development strategy and creating an updated version. For this purpose, the district used online surveys, expert discussions as well as Future Workshops and an expert conference on mobility. In addition, the district planned to develop an online presence, aiming at enabling a facilitated information and communication process with regard to monitoring sustainable development.

Beside the chances of including citizen participation formats, some challenges have to be considered. The interviews found a lack of personnel and a limited budget as the main challenges with regard to systematically involve citizens into the decision-making process of the sustainable development strategy.

8.5.2   A Model of Citizen Participation Formats for Building Local Sustainability Strategies

Figure 8.3 summarizes our model of citizen participation formats for adopting a local sustainable development strategy. The participation formats are categorized due to their potential of creating added value in the ideal-typical steps of developing and implementing a local sustainable development strategy (see Figure 8.1). Furthermore, the figure entails the four objectives of the participation formats (see Table 8.1) and thus displays the citizens' potential decision-making power during the process. In the following, the potential use of the presented citizen participation formats are described with regard to different phases in the process of building a sustainable development strategy.

Analysis and Draft

The analysis phase is intended to assess the current status of a municipality in the matter of sustainable development. For the quantitative analysis a municipality can rely on indicators and statistics. In contrast, the qualitative analysis includes the gathering of existing local activities and projects, strategies and concepts, as well as political resolutions. The results of the quantitative and qualitative assessment of the current state can be used for performing a SWOT analysis in order to systematically define strengths, weaknesses, opportunities and threats of the municipalities efforts towards sustainable development.

Based on the analysis phase, the sustainable development strategy can be drafted. The strategy entails formulations on different abstraction levels. A mission statement depicts the municipality's will to contribute to a sustainable development and defines the fundamental principles in doing so. Thematic guidelines describe the basic tendency of the strategy's content and thematic priorities. Strategic goals define the municipality's orientation regarding the thematic priorities over the long term, whereas operational goals are derived from these strategic goals and are formulated for the short to medium term. Measures designate responsible actors and ways how to achieve the goals. Resources refer to the measures and explicitly define financial and personnel means.

For the analysis and drafting phase, several citizen participation formats can be suitable. An
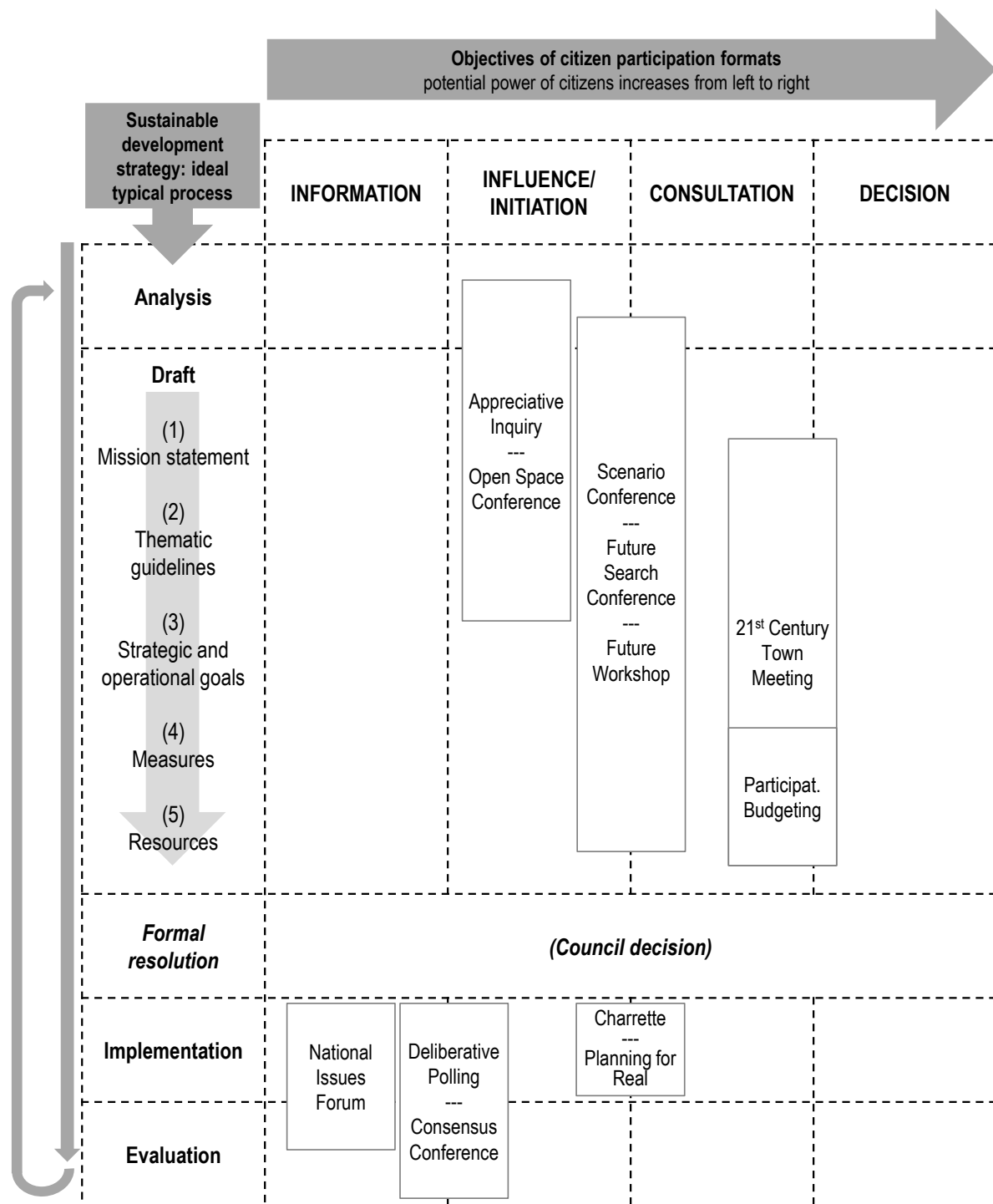
Figure 8.3: Model of citizen participation formats in different phases of adopting a local sustainable development strategy

Appreciative Inquiry can be used for creating a positive vision regarding a municipality's sustainable development. This approach is in particular useful during the first stages of analyzing existing conditions and creating a mission statement for the sustainable development strategy. The concentration on existing strengths and the implied motivational character entails an influ-

ential element on the participating citizens and can initiate a debate on sustainable development. However, the decision-making power remains low in most cases. Similarly, Open Space Conferences can be useful in the early stages towards a sustainable development strategy, similar as an Appreciative Inquiry. In particular, the development of a mission statement could be enhanced with the participation of citizens and their ideas and preferences. The format is less useful for developing concrete goals and measures, as it cannot be predicted how the outcome will be shaped. Therefore, the decision-making power of this approach remains relatively low as well.

Scenario Conferences or Workshops, Future Search Conferences and Future Workshops are approaches that are suitable for illustrating the future development of a city and can hence especially serve for drafting a sustainable development strategy. A Scenario Workshop or Conference can be used for finding a new way to organize and manage problems in a new way and can hence be applied for organizing local sustainability activities in a novel way. Similarly, the approach of a Future Search Conference is often used for creating a new orientation of a municipality, which could be the strategy to become a sustainable community. Future Workshops are often used for developing a vision for the future of an organization or municipality, and hence can be an appropriate method for drafting a sustainable development strategy. Depending on the abstraction level of the given tasks, the above approaches can be applied to different levels of drafting a sustainable development strategy: from developing a mission statement, to formulating strategic and operational goals and for defining concrete measures and resources. However, for applying these methods to the more concrete elements of the draft (operational goals, measures and resources) different participant groups may have to be recruited than for the more abstract concepts: particular experts and interest groups are involved in these concrete measures and resources and assessing the suitability of these has to be ensured.

The methods 21st Century Town Meeting and Participatory Budgeting address more concrete topics and problems, which lead to a relatively high degree of decision-making power of participating citizens. Theoretically, a 21st Century Town Meeting can support the whole process of drafting a sustainable development strategy and may ensure the participation of a large amount of citizens. In practice, this approach implies high efforts and costs and endures for a relatively long time span. Hence, many municipalities may not be able to provide the necessary prerequisites for realizing this method. Consulting citizens for planning the resources of a sustainable development strategy can be realized by variations of Participatory Budgeting.

Implementation and Evaluation

The formal resolution of a sustainable development strategy by a council decision serves its political legitimization. After the formal resolution, a municipality has to ensure the implementation of the corresponding goals and targets within different fields of municipal development. The implementation phase is followed by a broad evaluation of the strategy's effects. It is intended to analyse causes for success or failure of the implemented program and serves the update of the strategy. Often, the first step is to inform the broad public about the adoption of the strategy. A National Issues Forum can be used to distribute information on the adopted strategy. The objective of this approach is informing citizens, hence it does not lead to actual decision-making, but aims at enabling citizens to use and adopt democratic skills by discussing predefined topics. If citizen participation and the strengthening of democratic skills itself is among the goals of the sustainability strategy, a National Issues Forum could also be used as a concrete implementation of this goal. Partly, the format can also be used to gather feedback on the implementation of the sustainable development strategy which can serve as a starting point for the evaluation phase.

The process of a Deliberative Polling might also be used for assessing citizens' view on concrete topics and issues of a sustainable developing strategy, and to inform about the strategy in depth. The approach entails an information event which can be used for distributing information on the adopted sustainable development strategy and for giving the opportunity to discuss the embedded topics and issues with experts and politicians. As a large amount of randomly chosen citizens can take part in these events, a broad range of feedback can be gathered on the strategy. However, the decision-making power of participating citizens remains low, as the priority lies on information-sharing. A Consensus Conference aims at bringing science and practice together, mainly regarding issues of technology assessment, but also social or economic topics. The role of technology and digitization is a major issue for sustainable development, hence, a Consensus Conference can be used to discuss the application of such technology as an implementation issue of the sustainable development strategy. The influence of citizens on decision-making is of an indirect nature, as the discussions can help politicians to obtain new perspectives on concerns and opportunities regarding certain technologies.

When a sustainable development strategy entails concrete planning concepts, a Design Charrette can enhance the implementation process of the strategy. An interdisciplinary design team

consisting of experts and citizens comes together for developing urban planning concepts, which can arise out of the sustainable development strategy. The decision-making power of individual participants is relatively high as the ideas developed during the design process may directly flow into the actual implementation. Similarly, the approach Planning for Real can lead to actual implementations and thus contributes to the decision-making power of the involved citizens in the form of consultation. All interested citizens can take part in the redesign process of their living space, which can be among the goals of the sustainable development strategy.

8.6   Discussion and Conclusion

In this paper, we analyzed the use of citizen participation approaches for adopting local sustainable development strategies. The analysis is split into two parts. First, we concentrated on the pilot project "Global Sustainable Municipalities NRW" as a case study. We could detect several approaches to include citizen participation formats into the different phases of adopting a local sustainable development strategy. Most approaches aim at sharing information on the sustainable development strategy with the broad public. To some extend participating citizens are invited to share their ideas and visions in order to include these ideas into the mission statement or measures of the draft. Most municipalities include citizen participation as a goal itself into their sustainable development strategy. In this regard, the establishment of strategic guidelines for participation opportunities is predominant. This goes in line with SDG 16 and its target 16.7 to ensure inclusive, participatory and representative decision-making at all levels (United Nations, 2015a). The involvement of citizen participation as a goal of the sustainable development strategy shows that municipalities are aware of the significance of including civil society into decision-making. On the other hand, the goal to establish strategic guidelines for citizen participation also shows that there is a demand for systematic overviews on different participation formats.

In the second part of the analysis we developed a general model for citizen participation for adopting a sustainable development strategy which entails possible participation formats for each of the phases. We aimed at analyzing the concrete phases during which the participation methods can be applied. With the presented model, we demonstrated possibilities to include citizen participation methods in the whole process of drafting and implementing local sustain-

able development strategies. We also intended to assess the decision-making power of citizens participating in the potential formats. It becomes apparent that different participation models can serve different purposes and are coined by diverse objectives. This results in varying potential of decision-making power on the part of the participating citizens. While open and abstract formats without predefined outcomes, like Open Space Conferences, Appreciative Inquiries, Scenario Conferences, Future Conferences, and Future Workshops can be useful in the early stages towards a sustainable development strategy and support in creating a vision for a city or municipality, events like 21st Century Meetings or Participatory Budgeting can address more concrete issues like measures or resources of a strategy. Concurrently, these methods represent the highest potential decision-making power of citizens. For implementing the strategy, formats like a National Issues Forum, as well as a Design Charrette or Planning for Real can be appropriate, whereas the two latter represent more specific design problems, that can lead to a higher degree of decision-making power of the participating citizens. Deliberative Polling and Consensus Conferences can be appropriate during both implementing and evaluating an existing strategy. Depending on the defined topics, goals and measures in a sustainable development strategy, further participation approaches are suitable for the implementing process. Especially when citizen participation itself is a goal in the strategy, different additional approaches are conceivable.

Although the described model and the listed participation formats may not be exhaustive, it gives a first overview on differences among the approaches and the corresponding appropriateness for the several phases, as well as the respective decision-making power. The goal of this study was not to work out challenges, terms and conditions for citizen participation in general, though these issues might be mentioned marginally, as they naturally occur when discussing participation approaches. For example, in most formats the question arises whether a true representation of the public voice is possible. For deeper discussions of advantages and disadvantages of citizen participation formats, we refer to the relevant literature, for example (Hawkins & Wang, 2012; Howard & Wheeler, 2015; Irving & Stransbury, 2004; Marzouki et al., 2017; McDermott, 2010; Meadowcroft, 2004; Nanz & Fritsche, 2012). We also did not discuss costs and other prerequisites like the length of the different participation methods, nor did we include a deeper discussion of the selection process of the participants in the considerations. In practice, a municipality that wants to design its sustainable development strategy by including citizen participation formats,

has to review existing methods according to local circumstances. The model can serve as a starting point for doing so. Furthermore, the model does not intend to propose the use of citizen participation in each phase of drafting and implementing a local sustainable development strategy, but rather suggests possibilities that provide a first orientation. It is also possible to combine several participation methods with each other and to adapt the approaches to one's own needs. Often, approaches like a World Café are used as a starting point for collecting and sharing knowledge in combination with other citizen participation methods (Nanz & Fritsche, 2012). On the part of the analyzed municipalities, existing challenges are a limited budget or a lack of personnel for the organization of citizen participation approaches. This limitation has to be considered, when planning a sustainable development strategy by including participatory formats.

The proposed model relies on an ideal-typical CIP as proposed in the pilot project "Global Sustainable Municipalities NRW", but can be transferred to other communities and cities around the world, as the reviewed citizen participation methods are used globally. The model can help municipalities to get an orientation on possible formats and the corresponding level of decision-making. The concrete implementation is yet dependent on national, regional and local prerequisites. The model could also be used at the regional level, but our results showed that different challenges have to be considered, as the citizens are present at the local level. A municipality does not necessarily have to adopt the ideal-typical process of developing a sustainable development strategy (Figure 8.1) one-to-one. Nonetheless, it helps to strategically plan the adoption of the strategy. In the future, it would be interesting to explicitly evaluate the use of the proposed approaches of citizen participation for drafting and implementing local sustainable development strategies. Furthermore, a comparison of the presented results with other regional or national strategies would add additional value. In particular, assessing the participating citizens' view with regard to the perceived benefits and drawbacks is of importance to fully understand the success of the applied formats as well as the recognized level of decision-making power. Similarly, analyzing the concrete outcome of participation formats with regard to local sustainable development strategies is an important issue. For example, the following questions arise: What kind of documentation is available from the participation events? Do the results of the events translate into concrete actions? The proposed model in this article can be a starting point for systematically analysing these questions.

References

Abel, T. D., & Stephan, M. (2000). The Limits of Civic Environmentalism. *American Behavioral Scientist*, *44*(4), 614–628. doi: 10.1177/00027640021956413

Andersen, I. E., & Jaeger, B. (1999). Scenario Workshops and Consensus Conferences: Towards More Democratic Decision-making. *Science and Public Policy*, *26*(5), 331–340. doi: 10.3152/147154399781782301

Arnstein, S. R. (1969). A Ladder of Citizen Participation. *Journal of the American Institute of Planners*, *35*(4), 216–224. doi: 10.1080/01944366908977225

Bibri, S. E., & Krogstie, J. (2017). Smart Sustainable Cities of the Future: An Extensive Interdisciplinary Literature Review. *Sustainable Cities and Society*, *31*, 183–212. doi: 10.1016/j.scs.2017.02.016

Bond, S., & Thompson-Fawcett, M. (2007). Public Participation and New Urbanism: A Conflicting Agenda? *Planning Theory and Practice*, *8*(4), 449–472. doi: 10.1080/14649350701664689

Brady, H. E., Fishkin, J. S., & Luskin, R. C. (2003). Informed Public Opinion about Foreign Policy: The Uses of Deliberative Polling. *The Brookings Review*, *21*(3), 16. doi: 10.2307/20081112

Brunkhorst, S., & Obenland, W. (2017). *SDGs für die Bundesländer*. Bonn, Germany: Global Policy Forum.

Corbett, J., & Mellouli, S. (2017). Winning the SDG Battle in Cities: How an Integrated Information Ecosystem Can Contribute to the Achievement of the 2030 Sustainable Development Goals. *Information Systems Journal*, *27*(4), 427–461. doi: 10.1111/isj.12138

Dennerlein, S., Gutounig, R., Kraker, P., Kaiser, R., Rauter, R., & Ausserhofer, J. (2015). Knowledge Strategies in Organisations: A Case for the Barcamp Format. In *Proceedings of the European Conference on Knowledge Management, ECKM 2015, Udine, Italy, September 3-4, 2015* (pp. 222–230). Udine, Italy: University of Udine.

Deutscher Städtetag. (2015). *2030-Agenda für Nachhaltige Entwicklung: Nachhaltigkeit auf kommunaler Ebene gestalten*. Retrieved August 1, 2018, from `http://www.staedtetag.de/fachinformationen/staedtetag/075357/index.html`

Die Landesregierung Nordrhein-Westfalen. (2016). *Nachhaltigkeitsstrategie für*

Nordrhein-Westfalen.   Retrieved   September   10,   2019,   from   `https://www`
`.nachhaltigkeit.nrw.de/fileadmin/user_upload/Nachhaltigkeitsstrategie_PDFs/`
`NRW_Nachhaltigkeitsstrategie_Broschuere_DE_Online_Version_22032017.pdf`

Eckerberg, K., & Mineur, E. (2003). The Use of Local Sustainability Indicators: Case Studies in Two Swedish Municipalities. *Local Environment*, *8*(6), 591–614. doi: 10.1080/1354983032000152716

Fox, O., & Stoett, P. (2016). Citizen Participation in UN Sustainable Development Goals. *Global Governance*, *22*(4), 555–574. doi: 10.1163/19426720-02204007

Gabriel, O. W., Ahlstih, K., Brettschneider, F., & Kunz, F. (2018). Transformations in Policy Preferences of Local Officials. In T. N. Clark & V. Hoffmann-Martinot (Eds.), *The New Political Culture* (p. 219 -234). New York, NY; Abingdon, UK: Taylor & Francis.

Gastil, J., & Dillard, J. P. (1999). Increasing Political Sophistication Through Public Deliberation. *Political Communication*, *16*(1), 3–23. doi: 10.1080/105846099198749

German Federal Government. (2017). *German Sustainable Development Strategy (Summary).* Retrieved September 9, 2019, from `https://www.bundesregierung.de/Content/EN/`
`StatischeSeiten/Schwerpunkte/Nachhaltigkeit/Anlagen/2017-04-12-kurzpapier-n`
`-en.pdf?__blob=publicationFile&v=7`

Goodin, R. E., & Dryzek, J. S. (2006). Deliberative Impacts: The Macro-Political Uptake of Mini-Publics. *Politics and Society*, *34*(2), 219–244. doi: 10.1177/0032329206288152

Hawkins, C. V., & Wang, X. H. (2012). Sustainable Development Governance: Citizen Participation and Support Networks in Local Sustainability Initiatives. *Public Works Management and Policy*, *17*(1), 7–29. doi: 10.1177/1087724X11429045

Herrington, N. (2006). Open Space Conferences: A New Way of Working. *Management in Education*, *20*(5), 13–14. doi: 10.1177/089202060602000503

Howard, J., & Wheeler, J. (2015). What Community Development and Citizen Participation Should Contribute to the New Global Framework for Sustainable Development. *Community Development Journal*, *50*(4), 552–570. doi: 10.1093/cdj/bsv033

Hunsberger, C. A., Gibson, R. B., & Wismer, S. K. (2005). Citizen Involvement in Sustainability-centred Environmental Assessment Follow-up. *Environmental Impact Assessment Review*, *25*(6), 609–627. doi: 10.1016/j.eiar.2004.12.003

Irving, R. A., & Stransbury, J. (2004). Citizen Participation in Decision Making: Is It Worth

the Effort? *Public Administration Review*, *64*(1), 55–65. doi: 10.1007/s10694-015-0526-6

Klopp, J. M., & Petretta, D. L. (2017). The Urban Sustainable Development Goal: Indicators, Complexity and the Politics of Measuring Cities. *Cities*, *63*, 92–97. doi: 10.1016/j.cities .2016.12.019

Krippendorff, K. (2018). *Content Analysis. An Introduction to Its Methodology* (4th ed.). Thousand Oaks, CA: SAGE.

LAG 21 NRW, & SKEW. (2018). *Global Nachhaltige Kommune NRW. Gesamtdokumentation.* Dortmund/Bonn, Germany. Retrieved from `https://www.lag21.de/projekte/details/ global-nachhaltige-kommune/`

Lent, R. M., McCormick, M. T., & Pearce, D. S. (2005). Combining Future Search and Open Space to Address Special Situations. *The Journal of Applied Behavioral Science*, *41*(1), 61–69. doi: 10.1177/0021886304272607

Lukensmeyer, C. J., & Brigham, S. (2005). Taking Democracy to Scale: Large Scale Interventions - For Citizens. *Journal of Applied Behavioral Science*, *41*(1), 47–60. doi: 10.1177/0021886304272656

Marzouki, A., Mellouli, S., & Daniel, S. (2017). Towards a Context-based Citizen Participation Approach: A Literature Review of Citizen Participation Issues and a Conceptual Framework. In R. Baguma, R. De', & T. Janowski (Eds.), *Proceedings of the 10th International Conference on Theory and Practice of Electronic Governance, ICEGOV 2017, New Delhi, India, March 7-9, 2017* (pp. 204–213). New York, NY: Association for Computing Machinery.

Mayring, P. (2015). *Qualitative Inhaltsanalyse: Grundlagen und Techniken* (12th ed.). Weinheim/Basel, Switzerland: Beltz.

McDermott, P. (2010). Building Open Government. *Government Information Quarterly*, *27*(4), 401–413. doi: 10.1016/j.giq.2010.07.002

Meadowcroft, J. (2004). Participation and Sustainable Development: Modes of Citizen, Community and Organisational Involvement. In W. Lafferty (Ed.), *Governance for Sustainable Development: The Challenge of Adapting Form to Function* (pp. 162–190). Cheltenhan, UK; Northampton, MA: Edward Elgar.

Meadowcroft, J. (2007). National Sustainable Development Strategies: Features, Challenges and Reflexivity. *European Environment*, *17*(3), 152–163. doi: 10.1002/eet.450

Meschede, C. (2019). Information Dissemination Related to the Sustainable Development Goals on German Local Governmental Websites. *Aslib Journal of Information Management*, *71*(3), 440–455. doi: 10.1108/AJIM-08-2018-0195

Meyer-Emerick, N. (2012). Sustainable Cleveland 2019: Designing a Green Economic Future Using the Appreciative Inquiry Summit Process. *Public Works Management and Policy*, *17*(1), 52–67. doi: 10.1177/1087724X11429043

Mkude, C. G., Pérez-Espés, C., & Wimmer, M. A. (2014). Participatory Budgeting: A Framework to Analyze the Value-add of Citizen Participation. In *Proceedings of the 47th Hawaii International Conference on System Sciences, HICSS 2014, Waikoloa, HI, January 6-9* (pp. 2054–2062). Washington, DC: IEEE Computer Society.

Müllert, N. R. (2009). Zukunftswerkstätten. Über Chancen demokratischer Zukunftsgestaltung. In *Zukunftsforschung und Zukunftsgestaltung* (pp. 269–276). Salzburg, Austria: Springer.

Nanz, P., & Fritsche, M. (2012). *Handbuch Bürgerbeteiligung. Verfahren und Akteure, Chancen und Grenzen.* Bonn, Germany: Bundeszentrale für politische Bildung. Retrieved from `http://www.bpb.de/shop/buecher/schriftenreihe/76038/handbuch-buergerbeteiligung`

Oels, A. (2009). The Power of Visioning: The Contribution of Future Search Conferences to Decision-making in Local Agenda 21 Processes. In F. H. J. M. Coenen (Ed.), *Public Participation and Better Environmental Decisions: The Promise and Limits of Participatory Processes for the Quality of Environmentally Related Decision-making* (pp. 73–88). Dordrecht, Netherlands: Springer. doi: 10.1007/978-1-4020-9325-8_5

Quental, N., Lourenço, J. M., & Da Silva, F. N. (2011). Sustainable Development Policy: Goals, Targets and Political Cycles. *Sustainable Development*, *19*(1), 15–29. doi: 10.1002/sd.416

Sriskandarajah, D. (2018). A People's Agenda: Citizen Participation and the SDGs. In R. Desai, H. Kato, H. Kharas, & J. McArthur (Eds.), *From Summits to Solutions: Innovations in Implementing the Sustainable Development Goals* (pp. 302–317). Washington, DC: Brookings Institution Press.

Tan, S., & Brown, J. (2005). The World Café in Singapore: Creating a Learning Culture Through Dialogue. *Journal of Applied Behavioral Science*, *41*(1), 83–90. doi: 10.1177/0021886304272851

United Nations. (2015a). *Goal 16: Promote Just, Peaceful and Inclusive Societies*. Retrieved Oc-

tober 13, 2019, from `https://www.un.org/sustainabledevelopment/peace-justice/`

United Nations. (2015b). *Sustainable Development Goals.* Retrieved January 5, 2018, from `http://www.un.org/sustainabledevelopment/sustainable-development-goals/`

United Nations. (2016). *The New Urban Agenda.* Retrieved March 3, 2020, from `http://habitat3.org/the-new-urban-agenda`

United Nations. (2019). *World Urbanization Prospects: The 2018 Revision.* New York, NY: United Nations. Retrieved August 1, 2018, from `https://population.un.org/wup/Publications/Files/WUP2018-Report.pdf`

Vetter, A. (2009). Citizens Versus Parties: Explaining Institutional Change in German Local Government, 1989-2008. *Local Government Studies*, *35*(1), 125–142. doi: 10.1080/03003930802574524

WCED. (1987). *Report on the World Commission on Environment and Development. Our Common Future.* Oxford, UK: Oxford University Press. Retrieved August 5, 2018, from `http://www.un-documents.net/our-common-future.pdf`

Weisbord, M. R., & Janoff, S. (1996). Future Search: Finding Common Ground in Organizations and Communities. *Systems Practice*, *9*(1), 71–84. doi: 10.1007/BF02173419

9 Libraries as Promoters of Environmental Sustainability. Collections, Tools and Events

9.1 Introduction

Environmental sustainability is a concept that has gained increasing public interest in recent years. More and more public organizations are considering environmental aspects in their strategic plans (Gelderman, Semeijn, & Vluggen, 2017). Inspired by the triple bottom line (Elkington, 1997), environmental sustainability is one of three main dimensions of sustainability: social, economic, and environmental sustainability. The dimensions interact with each other and are frequently coined by political, social and cultural tensions, as different objectives shape different societies regarding social, economic and environmental goals (Sachs, 2012). Sustainable development is often seen as the pathway to sustainability (Circular Ecology, 2019), whereby the most common definition describes it 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). In 2015, the United Nations agreed on 17 goals - the Sustainable Development Goals (SDGs) - aiming at enhancing sustainability regarding all dimensions by demanding actions from all countries, developing nations, and industrial states alike. Striving for environmental sustainability and economic growth simultaneously is an ambitious task. In Europe and the USA, public perception about the importance of economic growth on the one hand and environmental protection on the other hand seems to be balanced (Drews, Antal, & Bergh, 2018). In particular, "evidence also suggests that in all countries a part of the population is undecided or has seemingly inconsistent attitudes on this issue" (p. 271). One of the reasons for this is the lack of sufficient information and knowledge on the topics. As a result, we are in need of promoters for information on environmental sustainability.

Among others, public libraries all over the world already see themselves as places for enhancing awareness and conveying information on sustainability by providing resources and learning tools (Miller, 2010) and becoming green libraries. Libraries further contribute to teaching information literacy skills, which can enhance environmental sustainability in manifold ways (Kurbanoğlu &

Boustany, 2014). According to Miller (2010, p. vii) "public libraries are challenged with the new role of connecting the public with environmental awareness and education". The Green Library Movement has already been active since the 1990s and since then the number of librarians and cities striving for environmental sustainability in libraries is growing (Antonelli, 2008). For example, the International Federation of Library Associations and Institutions (IFLA) "[a]cknowledges the importance of a commitment to sustainable development to meet the needs of the present without compromising the ability of the future" (IFLA, 2002, p. 1) in their Statement on Libraries and Sustainable Development. IFLA also supports the SDGs and became a partner of the United Nations in order to achieve progress towards these goals. The importance of this partnership is substantiated with the libraries' potential to promote information literacy and to provide access to information, whereas access to environmental information is also among the targets embedded in the SDGs (United Nations, 2019). The UN Agenda 2030 (United Nations, 2015d) addresses libraries as educational institutions and encourages them to make a valuable contribution to achieving the SDGs. The German "National Action Plan for Education for Sustainable Development" (Federal Ministry of Education and Research, 2017) and the "German Sustainable Development Strategy" (German Federal Government, 2017) consolidate this appeal on the national level.

This article seeks to contribute to the discussion on the role of public libraries for environmental sustainability in Germany by providing an extensive overview of green practices and efforts in German public libraries.

9.2   Literature Review

"The green library is a multi-faceted concept with several components, such as green buildings, green operations and practices, green programs and services, green information systems and green collections" (Kurbanoğlu & Boustany, 2014, p. 49). Although the concept of a green library has already been investigated since the 1990s and research in this regard is growing (Antonelli, 2008), the number of existing studies is still sparse. A search with the query "green librar*" reveals 52 hits in the database Scopus (field: *TITLE-ABSTRACT-KEYS*) and 32 hits

within the Web of Science Core Collection[1] (field: *TOPIC*) on December 12, 2019. An extensive overview on current green practices in libraries is provided by the IFLA Publications Series 161 entitled "The Green Library – Die Grüne Bibliothek" (`https://www.ifla.org/publications/ifla-publications-series-161`), which mainly reports on case studies from Germany and other European countries, but also gives some examples from Asia, Australia, and the US.

Current studies on green library research show many different ways in which public libraries can support and contribute to sustainability. Hauke and Werner (2013) state that libraries are sustainable institutions in themselves, as they provide media for lending and in-house use or proving spaces for learning and socialization. However, they also point to the high energy and resource requirements of libraries and their buildings.

For this reason, many studies focus on the sustainability of library buildings (Afacan, 2017; Barnes, 2012; Edwards, 2011). Rabidas (2016) emphasizes that sustainability must be taken into account right from the planning stage of a building. With the LEED (Leadership in Energy and Environmental Design) certification system developed in 2000, library buildings can be planned and upgraded sustainably (`https://new.usgbc.org/leed`). Site selection, water, and energy conservation, building materials and indoor air quality play an important role in this context. For some public libraries in Germany new library buildings are currently being planned, while environmental aspects are considered right from the beginning. For example, for the new construction of the Central and Regional Library Berlin (ZLB), integral concepts are supposed to ensure environmental sustainability (e.g. through energy efficiency), but also social and economic sustainability (Heller & Fansa, 2013). Of course, not every municipality can afford to build a new library building from scratch. In many cases, old buildings are being recycled into libraries. Examples from Austria, Germany, Italy and Switzerland have shown that it is possible to reduce the ecological footprint by adapting old buildings for libraries, while at the same time the building's cultural heritage can be conserved (Hauke & Werner, 2012). Not only is the architecture of a library building essential for environmental sustainability, but also the interior design, e.g., by applying energy-saving lighting concepts. Of course, saving energy should be an issue in all buildings, but some libraries offer their services 24/7, which makes energy-saving

---

[1]The following collections of the Web of Science Core Collection were considered due to the authors' institutional subscriptions: SCI-EXPANDED: Science Citation Index Expanded (1945-present); SCCI: Social Sciences Citation Index (1956-present); A&HCI: Arts & Humanities Citation Index (1975-present); ESCI: Emerging Sources Citation Index (2015-present)

lightning concepts even more crucial (Franz, 2013). As a positive side effect, the library may create a more pleasant atmosphere for its users and save expenses. For example, the Central Library in Hamburg, Germany, improved their lightning facilities and successfully managed to halve the annual energy consumption (Keite & Banduch, 2013).

Many authors, however, agree that there is more to the term green library (Aulisio, 2013; Hauke, 2018; Jankowska & Marcum, 2010) than a sustainable building. "Sustainability should be seen as part of the corporate identity of the library, not only concerning energy saving but as part of the strategic aims of the library" (Hauke & Werner, 2012, p. 64). Libraries are a part of an information provision system and meet educational expectations (Marcum, 2009). Providing access to information and teaching different skills (such as research or writing skills) have always been core issues of public libraries. They play a key role in raising awareness of the community and are ideal places to teach sustainability literacy (Forsyth, 2005). Information literacy can have a positive impact on the environment as these skills support making more informed decisions on environmental issues (Kurbanoğlu & Boustany, 2014). For this purpose, libraries may offer books and other media as well as events on various topics of environmental sustainability (Hauke, 2018). The selection of resources on topics regarding the environment, energy conservation or organic gardening can contribute to facilitating the access to green information (Kurbanoğlu & Boustany, 2014).

Other offers such as the rental of energy meters or thermal imaging cameras as well as the provision of recycling depots or do-it-yourself workshops within the library are also conceivable. Another approach to enhance environmental conditions is the facilitation of green transit to the library site and by library employees. For example, the provision of electric vehicles and bicycle parking spaces, as well as good access to public transport can enhance a green transit (Aldrich, Benton, Schaper, & Scherer, 2013). Some studies focus on special sustainability practices within libraries like Green Printing and copying (Singh & Mishra, 2019). A "daily green culture", e.g. by reducing waste and paper consumption, can reduce the libraries' ecological footprint (Aldrich et al., 2013). Werner (2013) has published a checklist for libraries to make it easier for them to promote sustainability. According to this checklist, attention should be paid, for example, to energy-efficient information and communication technology or the use of sustainable office materials, in order to make library operations and workflows more sustainable. The support of employees also plays an important role. Carpool offers, showers for cyclists or discounted travel

by public transport can be mentioned here (Townsend, 2014). Many libraries offer digital services with which users can, for example, download e-books or access information online. On the one hand, this helps users save time and effort and reduces trips to the libraries, thus contributing to sustainability. On the other hand, Chowdhury (2014, 2016) mentions the high energy cost in the operation of information and communication technology and among end-users and highlights the need for more research in this area.

In summary, it can be observed that there is not only one way to make libraries "green(er)". Many different approaches can be applied to the different needs of library users, employees and communities. There are several case studies reporting on library initiatives to become more green and sustainable, but there is a lack of empirical analyzes considering environmental sustainability in libraries (Meschede & Henkel, 2019). With this article, the authors aim at closing this gap for German public libraries. Hence, this article aims at investigating the importance of environmental sustainability for German public libraries by raising the following research questions:

RQ 1.   How do librarians perceive the role of German public libraries for environmental sustainability?

RQ 2.   What efforts regarding environmental sustainability can be discovered in German public libraries?

9.3   Methods

The list of libraries to be examined was compiled with the help of the "Deutsche Bibliotheksstatistik" (German Library Statistics; reporting year 2017: `https://www.bibliotheksstatistik.de`). All full-time operating public libraries and their branches located in German cities with more than 100,000 inhabitants were examined. Thereof, all public libraries with a stock size of at least 1,000,000 physical media were selected. In addition, all regional libraries were included which are classified as public libraries by the German Library Association (DBV Sections 1 to 3) and which present themselves in their mission statement as public rather than academic libraries. Only libraries under municipal or state ownership were included in the study. Due to these limitations, all scientific and ecclesiastical libraries were excluded from the investigation. A list of the examined libraries can be found in Appendix A.4. A total of 91 libraries from 80 cities

were examined. The corresponding branch offices, district or special libraries were integrated into the results of the respective main library.

In order to learn about the specific activities of public libraries, we designed a short questionnaire. It focuses on the topic of environmental sustainability and includes the general awareness-raising activities for the community on the topic, the provision of books, equipment and tools (e.g. energy meters) as well as the organization of events for sustainability. The survey also asked about offers within the libraries, such as recycling depots, and about sustainability in internal workflows (e.g. economical printing). All questionnaire items were created in accordance with existing literature on environmental sustainability in libraries. The survey was created using the online tool "Umfrage Online" (`www.umfrageonline.com`) and sent to the libraries via e-mail. The participants were invited to take part in the survey from July 9-31, 2019. In addition to closed-ended questions such as dichotomous questions and 5-point Likert scales, the survey also contained open-ended questions that made an open text answer possible. Since in some cases several employees of the same library took part in the survey, these results were summarized for the respective institutions when analyzing the data on the library level. If employees of the same library gave opposing answers, the most frequent response was used for analysis.

In addition to the questionnaire, we investigated the availability of (physical) books on environmental sustainability. Therefore, it is necessary to determine a set of books used for the analysis. As a starting point, we performed a search on the web portal of the German National Library (`https://portal.dnb.de/`). Due to legal requirements, this central archival library has to include all books and other media in German language published since 1913. The library uses a controlled vocabulary for indexing its collection. Within this system, the keyword "Nachhaltigkeit" (sustainability) is defined as the use of a regenerative system in a way that substantial characteristics remain and existence can regenerate in a natural way (German National Library, 2019). We used the advanced search of the portal to obtain only books in German language that are indexed with the keyword *sustainability*. For all resulting 3356 hits that were provided with an ISBN, we stored all metadata and keywords for the further analysis in the library catalogues. For each library we retrieved the corresponding OPAC catalogue and wrote a python script with the help of the framework *selenium* (`https://www.seleniumhq.org/`) to search for the ISBNs from our initial list. The data gathering process was conducted in June 2019. All resulting hits were then stored in an SQLite database. Therefore, different editions of books with

several ISBNs were merged into one entity for the analysis. The evaluations were performed with the python libraries *numpy*, *pandas* and *matplotlib*. Keyword networks were visualized with the help of VOSviewer version 1.16.11, whereby each keyword was translated into English beforehand. VOSviewer is a freely available tool for visualizing networks from bibliometric data, such as authors, journals, co-citations or keywords. The resulting maps are constructed by using co-occurrence data (van Eck & Waltman, 2010).

9.4   Results

A total of 141 employees from 54 (out of 91) libraries completed the entire questionnaire. Sixty-one participants only answered the questionnaire partially. The answers of these participants will not be taken into account in further analysis.

Some items of the questionnaire relate to the personal opinions and subjective views of the consulted library staff. In the beginning of the questionnaire, the participants were asked about their personal perception of the importance of living their life in an environmentally sustainable manner. They were asked to rate this question on a scale from 0 (completely unimportant) to 100 (extremely important). The average value was 79.34 ($SD = 17.88$).

Figure 9.1 shows the expectations and concrete experiences of respondents in the field of environmental sustainability in libraries. Of the 141 participants, 56 strongly agreed (five on the five-point Likert-scale) that public libraries have the mission to inform and raise the awareness of the community for the topic of environmental sustainability. On the other hand, only 13 respondents strongly agreed that their library is fulfilling this mission. The agreement that public libraries should have good prerequisites to be able to work in an environmental sustainable way results in a mean value of 4.46. However, the experiences in the own library contradict this expectation. Here, the average agreement is 2.16. Similar values can also be found for the question of whether libraries should pay attention to environmental sustainability when operating the building.

The highest degree of agreement is reached with the question whether a public library should pay attention to environmental sustainability in the internal workflows. With 3.36 on average, the agreement is also the highest regarding the actual experience.

Figure 9.1: Expectations and experiences of library employees (n=141)

9.4.1 Offers to Promote Environmental Sustainability

Book Collection

In total, 117 participants fully agreed (five on the five-point Likert-scale) with the statement that libraries should offer books or other media to promote environmental sustainability. All 54 participating libraries stated that they provide their users with books and other media on the subject of environmental sustainability; 25 libraries indicated that they cover specific topics in particular. The main topics mentioned were waste and plastic avoidance, sustainable nutrition, upcycling, gardening, and sustainable food production, as well as general information on environmental protection and climate change. Minor topics were species protection, e.g. bees and other insects, energy conservation, or mobility. In addition, 23 libraries stated that they present the books and other media to the user in a certain way. The main approach was to (temporarily) set

up shelves or organize exhibitions on the subject of environmental sustainability. Presentations in the context of environmental weeks or special events could be identified as well. Some libraries reported on special exhibitions and locations for children and students. The role of social media was also mentioned, which is often used to convey information and advice on the topic.

Besides the librarians' views on the availability of books on environmental sustainability in their library, we also investigated the actual availability of physical books on environmental sustainability in the 91 German public libraries (Figure 9.2 (b)), as described in the methods section. After merging the different editions of the initial 3356 books with the keyword *sustainability*, 2766 different books remained. From these 2766 initial books, 1388 could be found in at least one of the 91 investigated public libraries' catalogue. These 1388 books are available in 7.01 libraries on average (arithmetic mean, $SD = 14.87$), whereby the median equals 1 and the maximum value is 89, which means that only two libraries do not include this book in their collection.

The number of books available in each library differs strongly, which becomes apparent with a minimum value of 28 and a maximum number of 1079 books. On average, the public libraries include 108.05 items (arithmetic mean, $SD = 115.40$) from the investigated book list, whereas the median is at 83. Unsurprisingly, the number of books on environmental sustainability highly
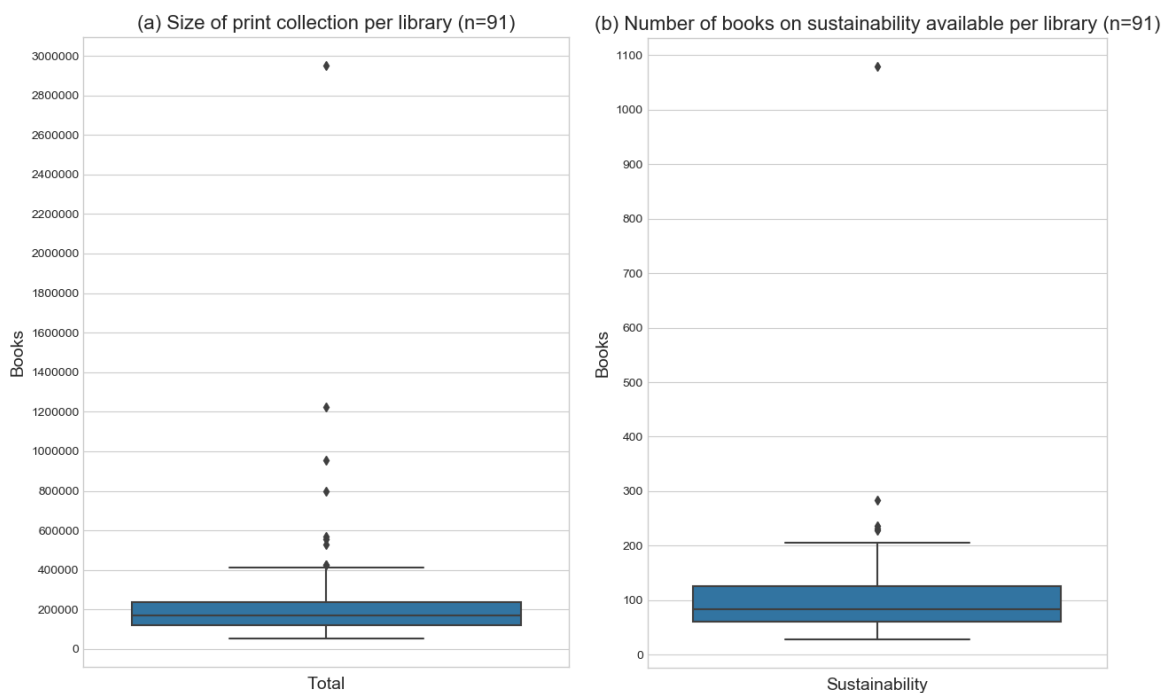

Figure 9.2: Distribution of books on environmental sustainability in public libraries in Germany

correlates with the size of the total print collection of the library ($r = 0.93$; $p < 0.01$). For example, the Central and Regional Library Berlin (ZLB) is the biggest public library in Germany and offers the broadest number of printed books (nearly 3 million) and similarly includes by far the largest number of books on sustainability of our list (1079 out of 2766, 39%). Figure 9.2 shows the distribution of (a) the total amount of printed books per library and (b) the number of books indexed with the keyword *sustainability* per library. The apparent outlier is the abovementioned ZLB. Compared to the size of the total collection, the public library of Chemnitz sticks out with 231 available books from our initial list. Interestingly, this library has a branch focusing in particular on environmental aspects. Since 1990, the branch offers over 9000 media units. A special focus lies on Education for Sustainable Development (ESD) with which they intend to address especially teachers and students (Umweltbibliothek Chemnitz, 2019).

Figure 9.3 gives an overview of the thematic foci based on the 1388 available books and the corresponding indexed keywords, whereby only those keywords were considered that are used for at least five books. Eight clusters could be detected within the keyword network, which are displayed in different colors in Figure 9.3. The heart of the network is the keyword *sustainability* which is dedicated to every book included in the analysis, as it was used as the search term. Overall, the following thematic foci were identified through the keyword clusters:

- **Mobility & urban planning**. The biggest cluster comprises 18 keywords and includes the search term *sustainability*. *Mobility* is especially linked to *urban planning*, *traffic management* and *electric mobility*.

- **Consumer behavior & lifestyle**. This cluster consists of nine items. The focus lies on consumers and their awareness and *behavior* regarding *consumption* and *waste reduction*.

- **Climate change**. The cluster on *climate change* and *climate protection* is formed by seven items. The keywords *globalization*, *future* and *social change* play a major role.

- **Environmental management of companies**. Six keywords, from *environmental management* to *Corporate Social Responsibility*, but also *digitization*, describe this cluster.

- **Urban development and energy use**. This cluster, which also contains six keywords is linked to *urban development* with regard to *energy supply* and *renewable energy*. A special focus on *Germany* and partially *Switzerland* can be detected through the keywords.

Figure 9.3: Keyword network of 1388 available books indexed with the keyword *sustainability*, created with VOSviewer version 1.6.11

- **Alternative economy**. Six items describing *socio-economic change* linked to an *alternative economy* form this cluster.

- **Construction & energy**. Five keywords in this cluster focus on *construction ecology* and *energy efficiency* of *buildings.*

- **Economic growth**. The last cluster is about the *consumer society* related to *economic growth* and *criticism* in this regard.

Equipment and Tools for Rental

Besides books, 30 of the 54 libraries stated that they provide equipment and tools to promote environmental sustainability among their users. It becomes clear here that the majority of these devices are energy meters and energy monitors (Figure 9.4). These devices are meant to help users in controlling and monitoring their electricity consumption at home and thus reducing it.

Figure 9.4: Equipment and tools for rental in German public libraries (n=54)

Thermometers or thermal imaging cameras, which can indicate heat losses in or near the house, follow at a considerable distance with only three mentions. Libraries have excellent conditions to lend not only books and other media, but also things that are not used daily. This category includes, for example, garden tools or musical instruments. Bicycles can also be borrowed from two libraries. The so-called Seed Libraries offer users the possibility of borrowing plant seeds and returning new seeds to the library once the plants have been cultivated. These were also named by two out of the 54 participating libraries.

Offers within Library Premises

A total of 28 libraries provide offers for users within their premises for the promotion of environmental sustainability (Figure 9.5). Approximately half of the participating libraries reported about bicycle racks. Plastic bags and other containers are being replaced by alternatives in 23 cases in libraries and their cafés. Recycling depots for batteries or electronic equipment can also be found in eight libraries. Repair cafés, charging stations for electric vehicles and car parks were rarely mentioned by the libraries.
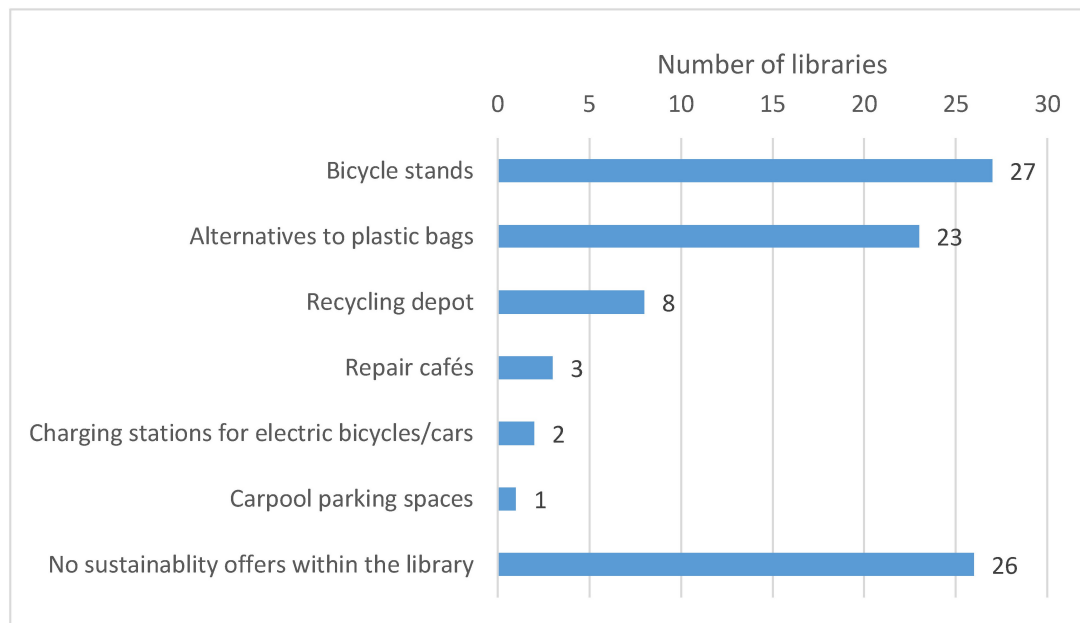
Figure 9.5: Offers for users within libraries for the promotion of environmental sustainability (n=54)

Events on Environmental Sustainability

Of the 141 participants, 129 agreed at least partially, that libraries should offer events to promote environmental sustainability. In the questionnaire, 37 libraries stated that they offer events on environmental sustainability. Figure 9.6 shows topics dealt with in such events. With 30 mentions, general information events on the topic of environmental sustainability are most frequently offered. Do-it-yourself and upcycling projects are provided by almost one third of the libraries surveyed. Events on sustainable nutrition have been identified almost as frequently. The topics of gardening and waste avoidance were each mentioned 13 times. In addition to beekeeping events, some libraries also deal with topics such as energy-saving, transportation and fair trade projects, summarized under the category "Other" in Figure 9.6.

9.4.2   Partnerships

In addition to the standardized items in the questionnaire, the libraries also had the opportunity to make comments and remarks on the subject of environmental sustainability. This gave us the opportunity to discover previously unnoticed topics or to focus on topics that were particularly important to the libraries.
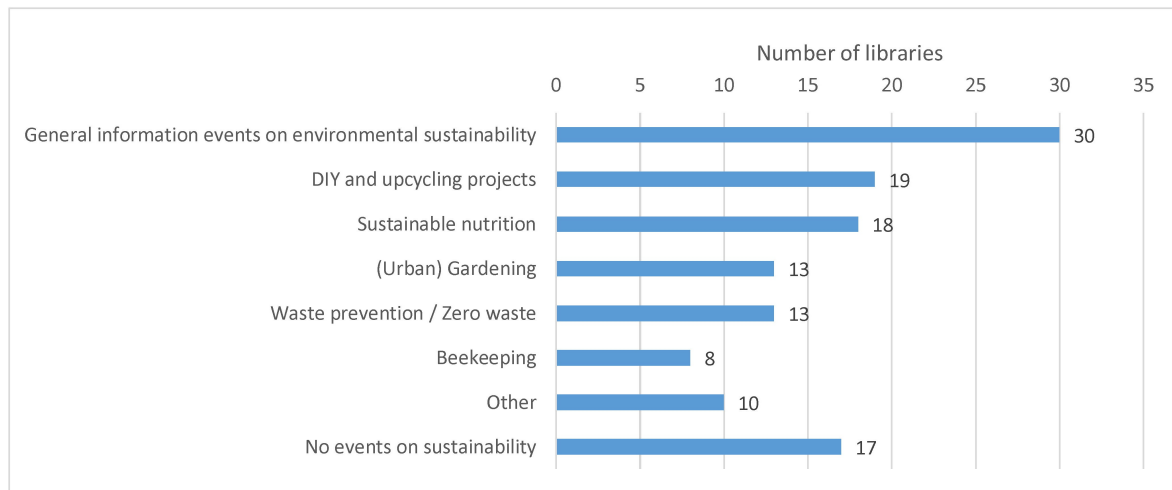
Figure 9.6: Topics of sustainability events (n=54)

Thereby, the significance of cooperation and partnerships for public libraries came to the fore. Some libraries work closely with associations and initiatives that stand for sustainability. For instance, they collaborate with the initiative "Fridays for Future", a group of young people who are committed to environmental protection and sustainability. Some libraries allow these initiatives to distribute information material on their premises, plan joint actions or receive support at information events in the library. Cooperation with schools and kindergartens as well as with consumer centers, societies of friends, municipal utilities and waste disposal companies was also mentioned.

Many libraries emphasized that further efforts in the area of environmental sustainability were planned for the future. For this purpose, among other things, internal working groups would be formed. Future plans range from the introduction of electronic files to the purchase of library bicycles for employees. However, it was also mentioned that the budget and staff would need to be increased in order to further improve sustainability.

9.5   Discussion

The presented analysis gives an overview of the efforts of German public libraries in raising awareness for and practicing environmental sustainability. Thereby, we contribute to the debate on green and sustainable libraries by providing a broader picture of the efforts of German public libraries in this regard, whereas existing studies mainly focus on single case studies.

From the initial list of 91 public libraries, 54 participated in our questionnaire. In general, we could identify a gap between the expectation of the libraries' potential to promote sustainability and the actual efforts made in the individual libraries. Thereby, the librarians considered the internal workflow as the most important aspect with regard to environmental sustainability in the library. In addition, the investigated libraries offer a variety of media, tools, and events to promote environmental sustainability.

9.5.1   Collections

Apparently, the provision of books on this topic seems to be the most obvious medium to be provided in a library. The topics of the books that we could find in the libraries' catalogues range from mobility and urban planning to consumer behavior, climate change, environmental management of companies, energy use in urban development, alternative economy, energy use in construction and economic growth. The librarians especially mentioned topics like plastic avoidance, nutrition and more general topics like environmental protection and climate change. Especially, current trends like the zero waste movement come to the fore. Thereby, the topics mentioned by the librarians and the topics found in the libraries' catalogue largely coincide. Looking at the number of books available in the library catalogues, the median value of 83 (out of 2766 considered books) seems to be low. But here, the total size of the libraries' collection should be taken into account before drawing conclusions. Further, we only considered books indexed with the keyword *sustainability* according to the German National Library. Further books dealing with the topic that lack this keyword were not included in the analysis, but might still be available in the libraries.

9.5.2   Tools

Many libraries go beyond offering books on environmental sustainability, but also provide useful tools and equipment for rental as well as offers within the library. Considering the rental of tools, the most frequently mentioned items are energy meters or monitors. Other items such as gardening tools, bicycles or plant seeds are only mentioned by a handful of libraries. Within the library, offers of bicycle stands, alternatives to plastic bags and recycling depots predominate. Only a few libraries provide repair cafés or charging stations for electric vehicles. From the

provision of these offers, it becomes clear that public libraries in Germany already provide several tools and equipment that might help users to become aware of and to perform a more sustainable lifestyle.

9.5.3 Events

The same holds true for events organized by public libraries addressing sustainability and its subtopics. A lot of libraries inform about environmental sustainability in general information events. Besides, a wide range of specialized events could be identified, addressing, for example, upcycling, sustainable nutrition, urban gardening, waste prevention or beekeeping. The public library can be an excellent venue for workshops and discussions for the civil society as it stands for openness and accessibility. In this context, but also in order to generally promote environmental sustainability, partnerships are of particular importance. Many public libraries already cooperate with schools, organizations and political parties in order to organize events and distribute information. For example, the initiative "Netzwerk Grüne Bibliothek" (network green libraries) addresses the importance of partnerships and invites everyone interested in supporting libraries on their way to environmental sustainability to join the network (Netzwerk Grüne Bibliothek, 2019). Today's significance of social media is considered as well. Therefore, together with "bibTalk Stuttgart", the network started a social media campaign in summer 2019, invoking libraries to report on their "green" engagement via the hashtag #WeGreenItUp. The topics of the resulting social media posts largely coincide with those identified in our analysis.

9.5.4 Limitations

This work has some limitations. Firstly, only a part of the German libraries was included in the study (see section 9.3). We focused on public libraries and did not examine scientific or church libraries. In addition, only libraries of large cities with more than 100,000 inhabitants were examined. About 60% of these libraries fully completed the questionnaire. Therefore, we cannot draw a full picture of environmental sustainability in German public libraries. Considering the availability of books on environmental sustainability, we narrowed the investigation on those being indexed with the keyword *sustainability*, which limits the analysis as described above.

Moreover, only the physical library holdings were examined. Further investigations could also focus on the digital holdings, as they are constantly growing.

9.6   Conclusion

In spite of the aforementioned limitations of this study, our analysis revealed interesting insights into public libraries' efforts to contribute to environmental sustainability. The results show that German public libraries are on their way to further contributing to building a sustainable future. Libraries as places accessible for every citizen have the potential to raise awareness on the topic. Thereby, a lot of effort is put into children's education and sensitization. One participant of our questionnaire emphasized that the process of lending books itself contributes to a sustainable society, which supports current literature on green libraries. Beyond that, "[l]ibraries practiced sustainability long before the concept of sustainability gained a wider acceptance, by maintaining knowledge and information from one generation to the next" (Kurbanoğlu & Boustany, 2014, p. 49). In addition, a library offers many more possibilities to disseminate information and sensitize the public. There is still much more potential to provide further tools to promote sustainability. Thereby, challenges like a tight budget or a lack of personnel have to be considered. In particular, sustainability leadership is necessary to green a library systematically. "Leadership is required to facilitate an organizational culture shift. 'Going green' can be the impetus for change" (Aldrich et al., 2013, p. 18).

The results of this article can be used for further, in-depth analyses and best practices in the field of green library research. For example, it would be interesting to further investigate the libraries' efforts to promote environmental sustainability. The mere provision of books, tools, and events does not necessarily lead to a more sustainable lifestyle of the library users. Therefore, an examination of the public's perception of the available offers and efforts of the libraries would be useful. The role of social media for promoting environmental sustainability via libraries is a further interesting subject. Beside environmental aspects, the importance of libraries for the social and economic dimensions of sustainability should not be omitted, not least because of the interdependency of these three dimensions (Heller & Fansa, 2013). The contribution of public libraries to the SDGs should hence be further investigated systematically in future research.

References

Afacan, Y. (2017). Sustainable Library Buildings: Green Design Needs and Interior Architecture Students' Ideas for Special Collection Rooms. *Journal of Academic Librarianship*, *43*(5), 375–383. doi: 10.1016/j.acalib.2017.07.002

Aldrich, R. S., Benton, S., Schaper, L., & Scherer, J. A. (2013). Sustainable Thinking. Passageway to Better Buildings, Budgets and Beyond. In P. Hauke, K. Latimer, & K. U. Werner (Eds.), *The Green Library - Die grüne Bibliothek. IFLA Publications, Nr 161* (pp. 15–37). Berlin/Munich, Germany: De Gruyter, Saur.

Antonelli, M. (2008). The Green Library Movement: an Overview of Green Library Literature and Actions From 1979 to the Future of Green Libraries. *Electronic Green Journal*, *1*(27), 1–11. Retrieved from `https://escholarship.org/uc/item/39d3v236`

Aulisio, G. (2013). Green Libraries Are More Than Just Buildings. *Electronic Green Journal*, *1*(35), 1–10. Retrieved from `https://escholarship.org/uc/item/3x11862z`

Barnes, L. L. (2012). Green Buildings as Sustainability Education Tools. *Library Hi Tech*, *30*(3), 397–407. doi: 10.1108/07378831211266546

Chowdhury, G. (2014). Sustainability of Digital Libraries: A Conceptual Model and a Research Framework. *International Journal on Digital Libraries*, *14*(3-4), 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), 2379–2391. doi: 10.1002/asi.23599

Circular Ecology. (2019). *Sustainability and Sustainable Development Guide.* Retrieved July 23, 2019, from `http://www.circularecology.com/sustainability-and-sustainable-development.html`

Drews, S., Antal, M., & Bergh, J. C. J. M. V. D. (2018). Challenges in Assessing Public Opinion on Economic Growth Versus Environment: Considering European and US Data. *Ecological Economics*, *146*, 265–272. doi: 10.1016/j.ecolecon.2017.11.006

Edwards, B. W. (2011). Sustainability as a Driving Force in Contemporary Library Design. *Library Trends*, *60*(1), 190–214. doi: 10.1353/lib.2011.0030

Elkington, J. (1997). *Cannibals with Forks: The Triple Bottom Line of 21st Century Business.*

North Mankota, MN: Capstone.

Federal Ministry of Education and Research. (2017). *National Action Plan on Education for Sustainable Development.* Retrieved November 10, 2018, from `https://www.bne-portal.de/sites/default/files/downloads/publikationen/BMBF_NAP_BNE_EN_Screen_2.pdf`

Forsyth, E. (2005). Public Libraries and the Millennium Development Goals. *The IFLA Journal*, *31*(4), 315–323. doi: 10.1177/0340035205061389

Franz, M. (2013). „... dass sich Menschen wohlfühlen“. Energiesparende Konzepte aus dem Buchhandel übertragen auf Bibliotheken. In P. Hauke, K. Latimer, & K. U. Werner (Eds.), *The Green Library - Die grüne Bibliothek. IFLA Publications, Nr 161* (pp. 152–159). Berlin/Munich, Germany: De Gruyter, Saur.

Gelderman, C. J., Semeijn, J., & Vluggen, R. (2017). Development of Sustainability in Public Sector Procurement. *Public Money and Management*, *37*(6), 435–442. doi: 10.1080/09540962.2017.1344027

German Federal Government. (2017). *German Sustainable Development Strategy (Summary).* Retrieved September 9, 2019, from `https://www.bundesregierung.de/Content/EN/StatischeSeiten/Schwerpunkte/Nachhaltigkeit/Anlagen/2017-04-12-kurzpapier-n-en.pdf?__blob=publicationFile&v=7`

German National Library. (2019). *Nachhaltigkeit.* Retrieved June 30, 2018, from `http://d-nb.info/gnd/4326464-5`

Hauke, P. (2018). From Information Literacy to Green Literacy: Training Librarians as Trainers for Sustainability Literacy. In *IFLA World Library and Information Congress, IFLA WLC 2018, Kuala Lumpur, Malaysia, August 24-30, 2018* (pp. 1–10). Kuala Lumpur.

Hauke, P., & Werner, K. U. (2012). The Second Hand Library Building: Sustainable Thinking Through Recycling Old Buildings into New Libraries. *IFLA Journal*, *38*(1), 60–67. doi: 10.1177/0340035211435394

Hauke, P., & Werner, K. U. (2013). The Second-hand Library – A Way of Reducing the Ecological Footprint. In P. Hauke, K. Latimer, & K. U. Werner (Eds.), *The green library - die grüne bibliothek. ifla publications, nr 161* (pp. 175–193). Berlin/Munich, Germany: De Gruyter, Saur. doi: 10.1515/9783110309720.175

Heller, V., & Fansa, J. (2013). Nachhaltigkeit in drei Dimensionen. Ressourcenverantwortung im Fokus der Planung für die neue Zentral- und Landesbibliothek Berlin. In P. Hauke,

K. Latimer, & K. U. Werner (Eds.), *The Green Library - Die grüne Bibliothek. IFLA Publications, Nr 161* (pp. 333–344). Berlin/Munich, Germany: De Gruyter, Saur.

IFLA. (2002). *Statement on Libraries and Sustainable Development.* Retrieved July 23, 2019, from `https://www.ifla.org/publications/statement-on-libraries-and-sustainable-development`

Jankowska, M. A., & Marcum, J. W. (2010). Sustainability Challenge for Academic Libraries: Planning for the Future. *College & Research Libraries*, *71*(2), 160–170. doi: 10.5860/0710160

Keite, U., & Banduch, R. (2013). Bücherhallen Hamburg im rechten Licht. Neue Beleuchtung in der Zentralbibliothek. In P. Hauke, K. Latimer, & K. U. Werner (Eds.), *The Green Library - Die grüne Bibliothek. IFLA Publications, Nr 161* (pp. 345–364). Berlin/Munich, Germany: De Gruyter Saur.

Kurbanoğlu, S., & Boustany, J. (2014). From Green Libraries to Green Information Literacy. In S. Kurbanoğlu, S. Špiranec, E. Grassian, D. Mizrachi, & R. Catts (Eds.), *Information Literacy. Lifelong Learning and Digital Citizenship in the 21st Century. Proceedings of the 2nd European Conference on Information Literacy, ECIL 2014, Dubrovnik, Croatia, October 20-23, 2014* (pp. 47–58). Basel, Switzerland: Springer Nature.

Marcum, J. W. (2009, 5). Design for Sustainability. *The Bottom Line*, *22*(1), 9–12. doi: 10.1108/08880450910955378

Meschede, C., & Henkel, M. (2019). Library and Information Science and Sustainable Development: A Structured Literature Review. *Journal of Documentation*, *75*(6), 1356–1369. doi: 10.1108/jd-02-2019-0021

Miller, K. (2010). *Public Libraries Going Green.* Chicago, IL: American Library Association.

Netzwerk Grüne Bibliothek. (2019). *Netzwerk Grüne Bibliothek.* Retrieved September 9, 2019, from `https://www.netzwerk-gruene-bibliothek.de/`

Rabidas, S. (2016). Green Library Buildings: A Sustainable Process. *International Journal of Advance Research and Innovative Ideas in Education*, *2*(6), 342–346. doi: 16.0415/IJARIIE-3327

Sachs, J. D. (2012). From Millennium Development Goals to Sustainable Development Goals. *The Lancet*, *379*(9832), 2206–2211. doi: 10.1016/S0140-6736(12)60685-0

Singh, P., & Mishra, R. (2019). Environmental Sustainability in Libraries Through Green

Practices / Services. *Library Philosophy and Practice (e-journal)*, article 2312. Retrieved from `https://digitalcommons.unl.edu/libphilprac/2312`

Townsend, A. K. (2014). Environmental Sustainability and Libraries: Facilitating User Awareness. *Library Hi Tech News*, *31*(9), 21–23. doi: 10.1108/LHTN-07-2014-0059

Umweltbibliothek Chemnitz. (2019). *Umweltbibliothek und Dritte-Welt-Archiv Chemnitz.* Retrieved August 6, 2019, from `https://umweltbibliothek-chemnitz.de/bibliothek-und-dwa.html`

United Nations. (2015). *Transforming Our World: The 2030 Agenda for Sustainable Development.* Retrieved January 8, 2019, from `https://sustainabledevelopment.un.org/content/documents/21252030AgendaforSustainableDevelopmentweb.pdf`

United Nations. (2019). *World Urbanization Prospects: The 2018 Revision.* New York, NY: United Nations. Retrieved August 1, 2018, from `https://population.un.org/wup/Publications/Files/WUP2018-Report.pdf`

van Eck, N. J., & Waltman, L. (2010). Software Survey: VOSviewer, a Computer Program for Bibliometric Mapping. *Scientometrics*, *84*, 523–538. doi: 10.1007/s11192-009-0146-3

WCED. (1987). *Report on the World Commission on Environment and Development. Our Common Future.* Oxford, UK: Oxford University Press. Retrieved August 5, 2018, from `http://www.un-documents.net/our-common-future.pdf`

Werner, K. U. (2013). Sustainable Buildings, Equipment, and Management. A Checklist. In P. Hauke, K. Latimer, & K. U. Werner (Eds.), *The Green Library - Die grüne Bibliothek. IFLA Publications, Nr 161* (pp. 395–404). Berlin/Munich, Germany: De Gruyter, Saur.

10 Discussion and Conclusion

In this thesis, I concentrated on urban governance for sustainable development from an Information Science perspective. While there have been some considerations to consolidate sustainable development into Information Science research (Chowdhury, 2013; Nolin, 2010; Spink, 1995a, 1995b, 1999) a holistic view on the topic has not yet been embedded in the field. In the previous chapters, I highlighted different perspectives on urban governance for sustainable development, including information dissemination, open data, and citizen participation. Thereby I built upon Nolin's (2010) definition of *Information for Sustainable Development*, which intends to deal with

1. the creation of equal access to information for everyone,

2. the adequate gathering and structuring of indicators on sustainable development,

3. the enabling of participation through various media and institutions.

By applying this threefold definition to urban governance, Sachs' (2015) call for good governance for achieving sustainable development is endorsed, as well as the growing importance of cities in this context. Likewise, a systematic view on the holistic concept from an Information Science perspective is possible. In total, I formulated seven research questions, aiming at investigating the concept of sustainable development in Information Science, and concerning the three subtopics information dissemination, open data, and citizen participation. The first research question addresses the role of Information Science research for sustainable development.

RQ 1   What is the current status of Information Science research on sustainable development?

For answering **RQ 1**, it can be beneficial first to consider the role of sustainable development in overall scientific research. In Chapter 2, general research addressing the SDGs is paramount, while Chapter 3 concentrates on an Information Science perspective. While research addressing sustainable development is continually growing in several disciplines, there are only a few articles from the LIS community. The systematic literature review presented in Chapter 3 revealed that there are some niches in which sustainable development is investigated from an Information

Science perspective, in particular libraries, as well as information systems. For both topics, the environmental dimension of sustainable development is predominant. This finding supports previous observations by Nolin (2010) and shows that a holistic view of sustainable development is still missing in Information Science. The literature review also revealed that only a few articles in LIS research are addressing the SDGs. The Agenda 2030 and the 17 goals are the most recent global action plan on sustainable development and can provide a framework for investigating the topic systematically. Chapter 2 additionally showed that research addressing the SDGs can contribute to knowledge sharing on the goals. Information and knowledge sharing are core aspects of Information Science. In the future, LIS research could further support this idea and contribute to developing adequate ways to facilitate knowledge sharing on the goals.

The following two research questions concentrate on information dissemination regarding sustainable development and thus address the first aspect of *Information for Sustainable Development*, i.e., the creation of equal access to information for everyone (Nolin, 2010).

RQ 2.a	What channels are appropriate for local governments to disseminating information regarding sustainable development?
RQ 2.b	To what extend and in which ways can public libraries disseminate information regarding sustainable development?

The information dissemination behavior of local governments has been identified as a minor topic in Information Science research on sustainable development (Chapter 3). There are several channels local governments can use for disseminating information on sustainable development (**RQ 2.a**). Chapter 4 concentrated on information on official governmental websites. Thereon, several references to the SDGs are apparent in different contexts. The disclosure of information on the goals further varies strongly between different cities and could still be expanded. This finding supports previous works, which called for more postings on local governmental websites regarding sustainability reports (Navarro-Galera, Alcaraz-Quiles, & Ortiz-Rodríguez, 2016), as well as financial, social, and environmental information in general (Brusca, Manes Rossi, & Aversano, 2016; Tirado-Valencia, Rodero-Cosano, Ruiz-Lozano, & Rios-Berjillos, 2016). Chapter 5 showed that urban mobile applications are a further adequate way to disseminate information regarding sustainable development. Combined with features like games, maps, and user feeds, these applications may enhance the users' awareness concerning such information. In Chapter

8, another approach of sharing information on sustainable development, or more concrete, sustainable development strategies, was presented. Some cities use citizen participation formats for developing and implementing such a strategy at the local level. There are several possible participation formats with differing levels of decision-making power on the part of the participating citizens. Most approaches emphasize information sharing with interested citizens. However, in contrast to information websites and mobile applications, citizen participation formats are often designed for a smaller group of selected citizens. They thus are often less suitable for informing the broad public and achieving information access for everyone.

Chapter 3 unveiled libraries as the most prominent research object regarding sustainable development in current Information Science research. Chapter 9 illustrates the role of public libraries for information dissemination concerning sustainable development (**RQ 2.b**). Besides the lending of the apparent medium book, public libraries contribute to information dissemination by renting tools (e.g., energy meters) and by organizing information events. Librarians support the necessity of raising awareness for sustainable development in public libraries. However, they recognize that more can be done to draw attention to the topic further. Often, a lack of personnel or budget are challenges in this regard. Public libraries can address different target groups. Some libraries organize special exhibitions or information events for children and young people. Cooperation with schools and kindergartens further strengthens educational aspects regarding sustainable development. Similarly, other organizations are partnering with public libraries, e.g., by using the libraries' premises for disseminating information concerning sustainability events.

In sum, there are several ways, tools, and actors, for disseminating information regarding sustainable development at the local level and for contributing to good urban governance in this regard. In this thesis, I discussed the use of websites, mobile applications, and citizen participation formats by local governments, as well as the role of public libraries. Through different channels, a city can reach various target groups. For example, citizen participation formats can be in particular suitable for citizens already engaged with sustainable development, while the public library may offer learning spaces for children and young people. With today's significance of ICT, transparency and information access for everyone can be supported at the municipal level, which helps in achieving the SDGs.

The second notion of *Information for Sustainable Development* (Nolin, 2010), i.e., the adequate

gathering and structuring of indicators on sustainable development, is covered by **RQ 3.a** concerning open data. Opening datasets can further contribute to the development of citizen services regarding sustainable development, which is addressed by **RQ 3.b**.

RQ 3.a	To what extend can open urban data be applied for measuring progress on local sustainable development?
RQ 3.b	To what extend can open urban data be applied to fostering citizen services concerning sustainable development?

Today, numerous cities all over the world host an open data portal and thereby mainly display official statistics, but also data from sensor-based services concerning the corresponding municipality. Chapter 7 elaborates on the possibility of using open urban data for measuring progress on sustainable development, in particular the SDGs (**RQ 3.a**). There are some open data measurement tools which are providing different standards and data categories. Among these categories, some refer to sustainable development regarding one of the three dimensions. Some can further be mapped directly to a concrete SDG or embedded targets of the goals. Still, the concrete structuring of the open data categories differs between the various measurement tools and also between different open urban data portals. The amount of available datasets is another factor varying among different cities. As a result, further standardization is necessary to measure progress towards sustainable development adequately and to facilitate comparisons between different municipalities. The standardization should include data categories concerning sustainable development, metadata, and also aggregation levels for different indicators. The SDGs with its agreed-upon targets and indicators can serve as a template for opening datasets at the municipal level, whereby country-specific and local peculiarities have to be considered. There are already some open data portals at the national level, directly providing public datasets concerning the SDGs' targets. Further efforts like this at the local level would contribute to the adequate gathering and structuring of indicators on sustainable urban development and can increase transparency. Thereby, changes in the indicator set pose a challenge.

Freely available urban datasets can be useful for developing citizen services regarding sustainable development (**RQ 3.b**). Chapter 5 demonstrated the possibility of producing mobile applications based upon open urban government data. Numerous applications are available addressing urban issues such as mobility, health, and public safety. Combined with features like a map, these applications can act as valuable citizen services and transform the underlying datasets into

essential tools for improving living in a city. Features like a user feed often allow users to get in contact with the government, and real-time information provides immediate data directly after collecting it. Mobile applications can further contribute to problem identification and resolution, e.g., by reporting broken street lights. Chapter 6 dealt with challenges for opening urban datasets as well as data initiatives aiming at reusing open urban data collectively. The challenges range from legal issues (e.g., security, privacy, and copyright), issues related to human resources and IT infrastructure (e.g., lack of skilled personnel, lack of budget), to political challenges (e.g., politicians' fear to lose power). Thereby, political issues could be identified as being among the most significant challenges, strongly influencing the other problems identified. Despite the obstacles concerning opening datasets at the city level, open data can serve as an essential tool for measuring progress on sustainable development, but also for fostering citizen services in the form of mobile applications. Still, further efforts are necessary to standardize datasets adequately and to overcome political and legal challenges. Additional goals like transparency and participation can be an achievement of this process.

Enabling participation through various media and institutions is also the core of the third factor of *Information for Sustainable Development* (Nolin, 2010). The following research questions hence address the role of citizen participation for developing citizen services concerning sustainable development (**RQ 4.a**) and for contributing to sustainable urban development (**RQ 4.b**).

RQ 4.a	How can citizen participation be applied to developing citizen services concerning sustainable urban development?
RQ 4.b	In what ways does citizen participation contribute to fostering sustainable urban development?

Chapter 5 showed that not only governmental agencies produce citizen services, but also citizens themselves. By reusing public datasets on environmental, economic, or social topics, mobile applications can be a result of such efforts and can thereby foster sustainable urban development. However, most mobile applications are still being developed on behalf of a local government agency. Besides the challenges concerning opening datasets, Chapter 6 further discussed open government data initiatives aiming at working together with citizens to produce added value. Some cities host hackathons or app contests for this purpose. Topics that are prevalent in these events are often related to one of the dimensions of sustainable development, e.g., energy, waste,

transportation, or water efficiency. Usually, concrete problems are addressed, and solving these with newly developed applications can lead to improvements regarding sustainable development. However, a city has to ensure the distribution and ongoing support of these solutions to guarantee its success and thereby its added value to the city's sustainable development.

Citizen participation cannot only be a useful tool for solving concrete problems by developing applications in hackathons and app contests, but also for strategical considerations concerning sustainable urban development. In Chapter 8, the possibility of including citizen participation formats for developing sustainable development strategies is discussed. To systematically become more sustainable, cities can adopt a sustainable development strategy that serves as a political control instrument. Thereby, different stakeholders should be involved, including citizens. When speaking of citizen participation, different approaches have to be considered. Different methods encompass various levels of decision-making power of the included citizens and hence lead to varying effects on sustainable development. Similarly, various target groups can be at the focus of citizen participation formats. If the main goal is to foster sustainable development, experts in the respective fields have to be involved in the participation process. However, including laypersons can provide new perspectives and may enhance the acceptance of the developed solutions. The success of citizen participation formats for sustainable development is strongly dependent on the participating citizens and experts, but also organizational factors like the moderation of such an event, and the distribution of information related to the format itself as well as its outcomes.

The above components of urban governance for sustainable development, i.e., information dissemination, open data, and citizen participation, are deeply related to each other. For example, information dissemination is essential for hosting citizen participation events or promoting open data platforms. Withershins, open urban data often forms the basis for citizen services like mobile applications developed collaboratively. Similarly, public urban datasets can further assume the function of informing citizens on several topics concerning sustainable development. These dimensions of urban governance provide an excellent starting point for analyzing sustainable development at the local level. Thereby further applications of the threefold division of *Information for Sustainable Development* to other concepts of Information Science are conceivable.

The results of all chapters in this thesis highlighted the role of partnerships for sustainable development. Through research collaboration and government-citizen interactions, efforts towards

sustainable development can be strengthened. These attempts strongly support SDG 17, which emphasizes the importance of partnerships for achieving the goals. In summary, the following significances of partnerships concerning urban governance for sustainable development came to the fore in the previous chapters:

- Research collaboration: Researchers can support knowledge sharing regarding sustainable development by performing interdisciplinary and cross-national research.

- Government-government interactions: Through town-twinning, cities can support others with their efforts towards sustainable development. Learning processes in this regard can further be apparent between corresponding municipalities and districts.

- Government-citizen collaboration: Citizen participation formats can result in win-win solutions when transparency and credibility are enhanced on the parts of the citizens, and at the same time, citizens' contributions are leading to better-informed decisions on the part of a local government.

- Library-organization partnerships: Public libraries can collaborate with local actors, such as NGOs, schools, or kindergartens, to foster education on sustainable development and to disseminate information in this regard.

Of course, further partnerships are necessary to support sustainable development at the local level. For example, companies play a significant role in sustainable urban development and can also be involved in citizen participation events or local sustainable development strategies. The term 'governance' itself refers to enhanced cooperation between government and society, but also companies. Good urban governance requires transparent and participative approaches. From an Information Science perspective, further research can hence concentrate on the role of partnerships for sustainable development. As knowledge sharing and adequate ways of accessing information are at the core of the discipline, we can thereby contribute to supporting sustainable development, particularly SDG 17.

Information Science, as an interdisciplinary field, requires new perspectives on sustainability and sustainable development. This thesis paves the way for research on *Information Science for Sustainable Development*. The literature review in Chapter 3 is the first conceptual overview of

sustainable development from the LIS perspective. This facilitates the development of frameworks for future research on this issue and advances LIS research through establishing the topic in the discipline. By concentrating on urban governance for sustainable development, this thesis consolidates the main aspects and research topics concerning sustainable development to date discussed only marginally in Information Science research. These topics have hitherto been regarded mostly separate from each other. The three dimensions of urban governance for sustainable development, i.e., information dissemination, open data, and citizen participation, support the idea of Information on Sustainable Development and provide a connection of several essential aspects in this regard.

The results of the previous chapters have shown that the topics of information dissemination, open data, and citizen participation, are fast-moving. For example, in 2014, only a few open data portals were available at the local level. In contrast, in 2018, several cities host an open data portal and strive towards increasing transparency and participation. Similarly, channels and actors that are disseminating information regarding sustainable development will possibly experience profound changes.

The SDGs do not only act as a global action plan but have also proved to be a useful framework for researching sustainable development from a holistic view. The SDGs can act as a valuable source when attempting to explore the several dimensions of sustainable development instead of concentrating on one aspect. Future LIS research can hence further focus on the goals and the possible contribution to these from the Information Science community. Besides, the SDGs aim towards achieving progress in all countries, regardless of their development status and pledge to "leave no one behind". The interpretation of the goals and corresponding targets, as well as the relevance of indicators, differs immensely between countries, regions, and municipalities. In this thesis, urban governance for sustainable development has been investigated by focusing on the perspective of prosperous, developed states. In less-developed nations, urban areas face different challenges, which have to be explored in the future. The LIS community can contribute to sustainable development, e.g., by efforts towards bridging the digital divide. Thereby, information dissemination, open data, and citizen participation can be strengthened globally. "Citizens need information to see what is going on inside government and participation to voice their opinions about this" (Meijer, Curtin, Hillebrandt, & Curtin, 2012, p. 11). This vision holds for citizens from every municipality, region, and country around the world. In particular, the sustainable

development of one's surroundings and the government's efforts towards this development, in a social, environmental, and economic sense, is a crucial concern for everyone.

References

Brusca, I., Manes Rossi, F., & Aversano, N. (2016). Online Sustainability Information in Local Governments in an Austerity Context. *Online Information Review*, *40*(4), 497–514. doi: 10.1108/OIR-05-2015-0161

Chowdhury, G. (2013). Sustainability of Digital Information Services. *Journal of Documentation*, *69*(5), 602–622. doi: 10.1108/JD-08-2012-0104

Meijer, A. J., Curtin, D., Hillebrandt, M., & Curtin, D. (2012). Open Government: Connecting Vision and Voice. *International Review of Administrative Sciences*, *78*(1), 10–29. doi: 10.1177/0020852311429533

Navarro-Galera, A., Alcaraz-Quiles, F. J., & Ortiz-Rodríguez, D. (2016). Online Dissemination of Information on Sustainability in Regional Governments. Effects of Technological Factors. *Government Information Quarterly*, *33*(1), 53–66. doi: 10.1016/j.giq.2015.12.003

Nolin, J. (2010). Sustainable Information and Information Science. *Information Research - An International Electronic Journal*, *15*(2), paper 431. Retrieved from `http://informationr .net/ir/15-2/paper431.html`

Sachs, J. D. (2015). *The Age of Sustainable Development*. New York, NY; Chichester, UK: Columbia University Press.

Spink, A. (1995a). Digital Libraries and Sustainable Development? In *Proceedings of Digital Libraries, DL '95, Austin, TX, June 11-13, 1995* (pp. 1–7). College Station, TX: Tamu.

Spink, A. (1995b). Information and a Sustainable Future. *Libri*, *45*(3-4), 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), 1–9. Retrieved from `http://informationr.net/ir/5-1/ paper65.html`

Tirado-Valencia, P., Rodero-Cosano, M. L., Ruiz-Lozano, M., & Rios-Berjillos, A. (2016). Online Sustainability Information in European Local Governments. *Online Information Review*, *40*(3), 400–415. doi: 10.1108/OIR-05-2015-0155

A   Appendix

A.1   List of Examples on Websites

Title	Link	Accessed
Berlin		

film series #2030	`https://www.berlin.de/ba-charlottenburg`
	`-wilmersdorf/aktuelles/pressemitteilungen/2017/`
	`pressemitteilung.627011.php`
		9 July 2018

Hamburg		
SDGs Hamburg	`https://www.hamburg.de/agenda2030/`	9 July 2018
SDGs and education	`http://www.hamburg.de/nachhaltigkeitlernen/` `veranstaltungen/10172002/2-jahreskonferenz-wap/`	9 July 2018
My tree – my city	`https://www.hamburg.de/mein-baum-meine` `-stadt2017/8531452/mein-baum-meine-stadt2017/`	9 July 2018

Process and participation	`https://www.hamburg.de/contentblob/8163846/`
	`ea6f68b4df8b7ee4593f929a513c8003/data/`
	`d-dokumentation-prozess-und-partizipation`
	`-sustainable-development-goals-fuer-hamburg`
	`.pdf&9July2018`	

Hannover		

Nachhaltige Ge(o)heimnisse	`https://www.hannover.de/Leben-in-der-Region`
	`-Hannover/Umwelt-Nachhaltigkeit/Nachhaltigkeit/`
	`Agenda-21-Nachhaltigkeit/Aktiv-werden/`
	`Nachhaltige-Ge-o-heimnisse`
		16 July 2018

Düsseldorf		
Agenda 2030 information page	`https://www.duesseldorf.de/agenda21/` `weitere-informationen-im-netz.html`	12 July 2018
Essen		
Green Twinning	`https://www.essen.de/meldungen/` `pressemeldung_1097552.de.html`	13 July 2018
Energy and climate concept	`https://media.essen.de/media/wwwessende/aemter/` `59/klima/bilanzbericht_2016_riss.pdf`	13 July 2018
Dresden		

Future picture	`http://www.dresden.de/de/leben/gesellschaft/`
	`buergebeteiligung/zukunftsstadt/`
	`zukunftsbild.php`
		16 July 2018

Cologne		

Network "One-world city Cologne"	`https://www.stadt-koeln.de/`
	`politik-und-verwaltung/internationales/`
	`eine-welt-stadt/ziele-des-netzwerkes`
		10 July 2018

Frankfurt		
Request to sign the resolution	`https://www.frankfurt.de/sixcms/detail.php?id=` `2855&_ffmpar%5b_id_inhalt%5d=33458590`	11 July 2018

A.2   List of Analyzed Open Data Portals

City abbr.	City	Open Data Portal
(HH)	Hamburg	`http://transparenz.hamburg.de/open-data/`
(M)	Munich	`https://www.opengov-muenchen.de/`
(K)	Cologne	`https://offenedaten-koeln.de/`
(F)	Frankfurt	`http://offenedaten.frankfurt.de/home`
(D)	Düsseldorf	`https://opendata.duesseldorf.de/`
(L)	Leipzig	`https://opendata.leipzig.de/`
(BO)	Bochum	`https://www.bochum.de/opendata`
(W)	Wuppertal	`https://www.offenedaten-wuppertal.de/`
(BN)	Bonn	`https://opendata.bonn.de/`
(KA)	Karlsruhe	`https://transparenz.karlsruhe.de/`
(Ge)	Gelsenkirchen	`https://opendata.gelsenkirchen.de/`
(C)	Chemnitz	`http://portal-chemnitz.opendata.arcgis.com/`
(AC)	Aachen	`http://offenedaten.aachen.de/`
(HAL)	Halle (Saale)	`http&//www.halle.de/de/Verwaltung/` `Online-Angebote/Offene-Verwaltungsdaten/`
(KR)	Krefeld	`https://www.offenesdatenportal.de/` `organization/krefeld`
(FR)	Freiburg im Breisgau	`https://fritz.freiburg.de/` `Informationsportal/` `configurator?scenario=OpenData`
(HRO)	Rostock	`https://www.opendata-hro.de/`
(MH)	Mühlheim an der Ruhr	`https://geo.muelheim-ruhr.de/open-data/13819`
(P)	Potsdam	`https://opendata.potsdam.de/pages/home/`
(WAN)	Herne	`https://www.herne.de/Stadt-und-Leben/` `Stadtfakten/Open-Data/`
(UL)	Ulm	`http://daten.ulm.de/`
(J)	Jena	`https://opendata.jena.de/`
(MO)	Moers	`https://www.offenesdatenportal.de/` `organization/moers`

A.3 Interview Questions

Definition and thematic foci

1. What do you understand by a local sustainable development strategy?

2. What do you understand by a participative development of a local sustainable development strategy?

3. Who should be involved in participation processes?

Implementation in the corresponding municipality
(Flow of knowledge and added value)

1. How does your municipality plan and implement the sustainable development strategy?

   (a) How many persons are responsible for developing the strategy?

   (b) Are the responsible persons from public administration belonging to a specific department?

2. What actors are included in the process of developing the sustainable development strategy apart from public administration?

3. Is your municipality using citizen participation formats within the framework of the sustainable development strategy?

   (a) In which phases of implementing the sustainable development strategy do you use participative elements?

   (b) Who is invited to participate? Which criteria are used to select the participants?

   (c) What concrete channels and methods are used for citizen participation formats?

   (d) To what extend does the outcome of participation formats feed into the sustainable development strategy?

4. Where do you see potential for improvement in your current approach on citizen participation and the development of the sustainable development strategy?

Cooperation with other municipalities

1. Can other municipalities benefit from your approach?

   (a) How do you cooperate with other municipalities?

   (b) How do you share experience and outcomes?

Further suggestions

1. Do you have further topics or suggestions not covered by the above questions?

A.4 List of Public Libraries

Analyzed libraries ordered by the size of their print collection
(*) Libraries that participated in our questionnaire

Zentral- und Landesbibliothek Berlin
Bücherhallen Hamburg (*)
Münchner Stadtbibliothek
Stadtbibliothek Stuttgart
Stadtbibliothek Hannover (*)
Städtische Bibliotheken Dresden (*)
Stadtbüchereien Düsseldorf
Stadtbibliothek Duisburg (*)
Stadtbücherei Frankfurt am Main (*)
Stadtbibliothek Essen
Stadtbibliothek Köln (*)
Leipziger Städtische Bibliotheken (*)
Stadt- und Landesbibliothek Dortmund (*)
Stadtbibliothek Bremen (*)
Stadtbibliothek im Bildungscampus Nürnberg (*)
Stadtbibliothek Mitte. BZB Philipp-Schaeffer
Stadtbibliothek Mannheim (*)
Stadtbücherei Bochum (*)
Stadtbibliothek Ulm/Do
Bibliothek der Hansestadt Lübeck
Stadtbibliothek im Ständehaus Karlsruhe (*)
Stadtbibliothek Steglitz-Zehlendorf
Stadtbibliothek Friedrichshain-Kreuzberg (Berlin), Bezirkszentralbibliothek (*)
Stadtbibliothek Bielefeld
Stadtbibliothek Reinickendorf. Humboldt-Bibliothek
Stadtbibliothek Bonn (*)
Stadtbibliothek Spandau
Stadtbibliothek Tempelhof-Schöneberg, Bezirkszentralbibliothek (*)
Stadtbücherei Kiel
Stadtbibliotheken der Landeshauptstadt Wiesbaden
Stadtbibliothek Neukölln, Hauptbibliothek
Stadtbibliothek Ludwigshafen/Rh (*)
Stadt- und Landesbibliothek im Bildungsforum Potsdam (*)
Stadtbibliothek Chemnitz (*)
Stadtbücherei Münster (*)
Stadtbibliothek Charlottenburg-Wilmersdorf
Stadtbibliothek Freiburg/Br
Neue Stadtbücherei Augsburg (*)
Stadtbibliothek Aachen (*)
Stadtbibliothek Marzahn-Hellersdorf, Bezirkszentralbibliothek "Mark Twain" (*)
Stadtbibliothek Treptow-Köpenick (*)
Stadtbibliothek Mönchengladbach
Stadtbibliothek Wuppertal (*)
Stadtbibliothek Wolfsburg (*)
Stadtbibliothek Berlin-Lichtenberg, Hauptbibliothek 'Anna Seghers'

Stadtbücherei Regensburg
Stadtbibliothek Braunschweig (*)
Stadtbibliothek Reutlingen (*)
Städtische Volksbücherei Fürth
Stadtbibliothek Herne (*)
Stadtbibliothek Magdeburg (*)
Stadtbüchereien Hamm, Zentralbibliothek im Heinrich-von-Kleist-Forum
Stadtbücherei Heidelberg
Stadtbibliothek Pforzheim
Stadtbibliothek Oberhausen (*)
Stadtbibliothek Gelsenkirchen
Stadt- und Regionalbibliothek Erfurt (*)
Stadtbibliothek Mülheim an der Ruhr (*)
Stadtbibliothek Heilbronn (*)
Öffentliche Bücherei Mainz - Anna Seghers
Öffentliche Bibliothek des Kommunalen Bildungszentrums der Stadt Remscheid
Stadtbibliothek Oldenburg (*)
Stadtbibliothek Halle/S
Mediothek Krefeld (*)
Stadtbibliothek Koblenz
Stadtbibliothek Osnabrück
Stadtbibliothek Kassel (*)
Stadtbibliothek Darmstadt
Stadtbibliothek Göttingen (*)
Stadtbücherei Hagen (*)
Stadtbibliothek Neuss
Stadtbibliothek Erlangen
Stadtbücherei Ingolstadt (*)
Stadtbibliothek Rostock (*)
Stadtbibliothek Salzgitter (*)
Stadtbücherei Würzburg (*)
Jena Kultur Ernst-Abbe-Bücherei und Lesehalle (*)
Stadtbibliothek Bremerhaven (*)
Stadtbibliothek Paderborn (*)
Stadtbibliothek Saarbrücken (*)
Bibliothek Moers (*)
Stadtbibliothek Hildesheim
Stadtbibliothek Leverkusen, KulturStadtLev (*)
Lernzentrum Cottbus - Stadt- und Regionalbibliothek (*)
Stadtbibliothek Palais Walderdorff im Bildungs- und Medienzentrum Trier
Stadtbücherei / Medienzentrum Bergisch Gladbach (*)
Stadtbibliothek Offenbach/M (*)
Stadtbibliothek Solingen (*)
Stadtbibliothek Siegen (*)
Lebendige Bibliothek Bottrop
Stadtbücherei Recklinghausen

B   Author Contributions

This cumulative dissertation consists of eight articles, to which I contributed as described below.

Chapter 2:

Meschede, C. (2020). The Sustainable Development Goals in Scientific Literature: A Bibliometric Overview at the Meta-Level. *Sustainability, 12*(11), 1-14, `https://doi.org/10.3390/su12114461`.

Share: 100%

conceptualization, methodology, investigation, data curation, manuscript preparation, review and editing, visualization

Chapter 3:

Meschede, C., & Henkel, M. (2019). Library and Information Science and Sustainable Development: A Structured Literature Review. *Journal of Documentation, 75*(6), 1356-1369. `https://doi.org/10.1108/JD-02-2019-0021`

Share: 80%

conceptualization, methodology, investigation (partially), data curation, manuscript preparation, review and editing, visualization

Chapter 4:

Meschede, C. (2019). Information Dissemination Related to the Sustainable Development Goals on German Local Governmental Websites. *Aslib Journal of Information Management, 71*(3), 440-455. `https://doi.org/10.1108/AJIM-08-2018-0195`

Share: 100%

conceptualization, methodology, investigation, data curation, manuscript preparation, review

and editing, visualization

Chapter 5:

Mainka, A., Hartmann, S., Meschede, C., & Stock, W. G. (2015). Mobile Application Services Based Upon Open Urban Government Data. In *iConference 2015 Proceedings, Newport Beach, CA March 24-27, 2015* (pp. 1-15). Urbana, IL: IDEALS.

Share: 30%

investigation (partially), data curation (partially), manuscript preparation (5.4, 5.5.1, 5.5.2, 5.5.2), review and editing

Chapter 6:

Mainka, A., Hartmann, S., Meschede, C., & Stock, W. G. (2015). Open Government: Transforming Data into Value-added City Services. In M. Foth, M. Brynskov, & T. Ojala (Eds.), *Citizen's Right to the Digital City. Urban Interfaces, Activism, and Placemaking* (pp. 199-214). Singapore: Springer.

Share: 30%

investigation (partially), data curation (partially), manuscript preparation (6.3, 6.4.3), review and editing

Chapter 7:

Meschede, C., & Siebenlist, T. (2019). Open Urban Data and the Sustainable Development Goals. In *Proceedings of the 20th Annual International Conference on Digital Government Research, June 18-20, 2019, Dubai, UAE.* New York, NY: ACM.

Share: 80%

conceptualization, methodology (partially), investigation, data curation, manuscript preparation, review and editing, visualization

Chapter 8:

Meschede, C., & Mainka, A. (2020). Including Citizen Participation Formats for Drafting and Implementing Local Sustainable Development Strategies. *Journal of Urban Science, 4*(1), 1-19. `https://doi.org/10.3390/urbansci4010013`

Share: 90%

conceptualization, methodology, investigation (partially), data curation, manuscript preparation, review and editing, visualization

Chapter 9:

Beutelspacher, L., & Meschede, C. (2020). Libraries as Promoters of Environmental Sustainability. Collections, Tools and Events. *IFLA Journal* (online first). `https://doi.org/10.1177/0340035220912513`

Share: 50%

conceptualization (partially), methodology (partially), investigation (partially), data curation (partially), manuscript preparation (9.1, 9.2, 9.3, 9.4.1, 9.5, 9.6), review and editing, visualization (partially)

References

Abel, T. D., & Stephan, M. (2000). The Limits of Civic Environmentalism. *American Behavioral Scientist*, *44*(4), 614–628. doi: 10.1177/00027640021956413

Afacan, Y. (2017). Sustainable Library Buildings: Green Design Needs and Interior Architecture Students' Ideas for Special Collection Rooms. *Journal of Academic Librarianship*, *43*(5), 375–383. doi: 10.1016/j.acalib.2017.07.002

Aldrich, R. S., Benton, S., Schaper, L., & Scherer, J. A. (2013). Sustainable Thinking. Passageway to Better Buildings, Budgets and Beyond. In P. Hauke, K. Latimer, & K. U. Werner (Eds.), *The Green Library - Die grüne Bibliothek. IFLA Publications, Nr 161* (pp. 15–37). Berlin/Munich, Germany: De Gruyter, Saur.

Aloudat, A., Michael, K., Chen, X., & Al-Debei, M. M. (2014). Social Acceptance of Location-based Mobile Government Services for Emergency Management. *Telematics and Informatics*, *31*(1), 153–171. doi: 10.1016/j.tele.2013.02.002

Andersen, I. E., & Jaeger, B. (1999). Scenario Workshops and Consensus Conferences: Towards More Democratic Decision-making. *Science and Public Policy*, *26*(5), 331–340. doi: 10.3152/147154399781782301

AngelHack. (2011). *The AngelHack Story.* Retrieved November 28, 2014, from `https://angelhack.com/angelhackteam/`

Annan-Diab, F., & Molinari, C. (2017). Interdisciplinarity: Practical Approach to Advancing Education for Sustainability and for the Sustainable Development Goals. *International Journal of Management Education*, *15*(2), 73–83. doi: 10.1016/j.ijme.2017.03.006

Antonelli, M. (2008). The Green Library Movement: an Overview of Green Library Literature and Actions From 1979 to the Future of Green Libraries. *Electronic Green Journal*, *1*(27), 1–11. Retrieved from `https://escholarship.org/uc/item/39d3v236`

Apps for Amsterdam. (2012). *Second Apps for Amsterdam Contest: Smart Apps Awarded.* Retrieved November 28, 2014, from `http://www.appsforamsterdam.nl/`

Apps for Europe. (2013). *About Us.* Retrieved November 28, 2014, from `www.appsforeurope.eu/about-us`

Archambault, E., Vignola-Gagne, E., Côté, G., Larivière, V., & Gingras, Y. (2006). Benchmarking Scientific Output in the Social Sciences and Humanities: The Limits of Existing

Databases. *Scientometrics*, *68*, 329–342. doi: 10.1007/s11192-006-0115-z

Arnstein, S. R. (1969). A Ladder of Citizen Participation. *Journal of the American Institute of Planners*, *35*(4), 216–224. doi: 10.1080/01944366908977225

Asokhia, M. O. (2009). Emancipating Women Through Technological Empowerment: Aid to Sustainable Development. *Asian Journal of Information Technology*, *8*(3), 84–87. doi: ajit.2009.84.87

Aulisio, G. (2013). Green Libraries Are More Than Just Buildings. *Electronic Green Journal*, *1*(35), 1–10. Retrieved from `https://escholarship.org/uc/item/3x11862z`

Balch, O. (2013). *Can Open Data Power a Smart City Revolution?* Retrieved April 5, 2019, from `www.theguardian.com/sustainable-business/open-data-power-smart-city`

Baraniuk, C. (2013). The Civic Hackers Reshaping Your Government. *New Scientist*, *218*(2923), 36–39. doi: 10.1016/S0262-4079(13)61625-5

Barnes, L. L. (2012). Green Buildings as Sustainability Education Tools. *Library Hi Tech*, *30*(3), 397–407. doi: 10.1108/07378831211266546

Barth, J., Fietkiewicz, K. J., Mainka, A., Gremm, J., Meschede, C., Hartmann, S., & Stock, W. G. (2017). Informational Urbanism. A Conceptual Framework of Smart Cities. In *Proceedings of the 50th Hawaii International Conference on System Sciences, HICSS 2017, Waikoloa, HI, January 4-7, 2017* (pp. 2814–2823). Washington, DC: IEEE Computer Society.

Belanger, F., Carter, L. D., & Schaupp, L. C. (2006). U-Government: A Framework for the Evolution of E-Government. *Electronic Government: An International Journal*, *2*(4), 426–445. doi: 10.1504/eg.2005.008333

Bellone, C. J., & Goerl, G. F. (1992). Reconciling Public Entrepreneurship and Democracy. *Public Administration Review*, *52*(2), 130–134. doi: 10.2307/976466

Bettencourt, L. M. (2014). The Uses of Big Data in Cities. *Big Data*, *2*(1), 12–22. doi: 10.1089/big.2013.0042

Bibri, S. E., & Krogstie, J. (2017). Smart Sustainable Cities of the Future: An Extensive Interdisciplinary Literature Review. *Sustainable Cities and Society*, *31*, 183–212. doi: 10.1016/j.scs.2017.02.016

Bleischwitz, R. (2003). Governance of Sustainable Development. Towards Synergies between Corporate and Political Governance Strategies. *Wuppertal Papers*(132), 1–39. Retrieved

from `https://ideas.repec.org/p/zbw/wuppap/132.html`

Blum, M., Mclaughlin, E., & Hanley, N. (2019). Accounting for Sustainable Development over the Long-Run: Lessons from Germany. *German Economic Review*, *20*(4), 1–37. doi: 10.1111/geer.12148

Bond, S., & Thompson-Fawcett, M. (2007). Public Participation and New Urbanism: A Conflicting Agenda? *Planning Theory and Practice*, *8*(4), 449–472. doi: 10.1080/14649350701664689

Bornmann, L., Mutz, R., Neuhaus, C., & Daniel, H. D. (2008). Citation counts for research evaluation: Standards of good practice for analyzing bibliometric data and presenting and interpreting results. *Ethics in Science and Environmental Politics*, *8*, 93–102. doi: 10.3354/esep00084

Boyd, D., & Crawford, K. (2012). Critical Questions for Big Data: Provocations for a Cultural, Technological, and Scholarly Phenomenon. *Information Communication and Society*, *15*(5), 662–678. doi: 10.1080/1369118X.2012.678878

Brady, H. E., Fishkin, J. S., & Luskin, R. C. (2003). Informed Public Opinion about Foreign Policy: The Uses of Deliberative Polling. *The Brookings Review*, *21*(3), 16. doi: 10.2307/20081112

Brandusecu, A., & Lämmerhirt, D. (2018). *Open Data Charter Measurement Guide.* Retrieved August 1, 2018, from `https://open-data-charter.gitbook.io/odcmeasurement-guide/executive-summary`

Briscoe, G., & Mulligan, C. (2014). *Digital Innovation: The Hackathon Phenomenon.* London, UK: Creative Works London.

Brunkhorst, S., & Obenland, W. (2017). *SDGs für die Bundesländer.* Bonn, Germany: Global Policy Forum.

Brusca, I., Manes Rossi, F., & Aversano, N. (2016). Online Sustainability Information in Local Governments in an Austerity Context. *Online Information Review*, *40*(4), 497–514. doi: 10.1108/OIR-05-2015-0161

Bundesregierung. (2017). *Neue Deutsche Nachhaltigkeitsstrategie verabschiedet.* Retrieved August 8, 2018, from `http://www.bundesregierung.de/breg-de/aktuelles/neue-deutsche-nachhaltigkeitsstrategie-verabschiedet-748178`

Carroll, J. M., & Ganoe, C. H. (2009). Supporting Community with Location-sensitive Mobile

Applications. In M. Foth (Ed.), *Handbook of Research on Urban Informatics: The Practice and Promise of the Real-Time City* (pp. 339–352). Hershey, PA: IGI Global.

Castells, M. (1989). *The Informational City.* Oxford, UK, Cambridge, MA: B. Blackwell.

Chan, C. M. L. (2013). From Open Data to Open Innovation Strategies: Creating E-Services Using Open Government Data. In *Proceedings of the 46th Hawaii International Conference on System Sciences, Wailea, HI, January 7-10, 2013* (pp. 1890–1899). Washington, DC: IEEE Computer Society.

Charalabidis, Y., Loukis, E., & Alexopoulos, C. (2014). Evaluating Second Generation Open Government Data Infrastructures Using Value Models. In *Proceedings of the 47th Hawaii International Conference on System Sciences, HICSS 2014, Waikoloa, HI, January 6-9, 2014* (pp. 2114–2126). Washington, DC: IEEE Computer Society.

Chen, L. J., Ho, Y. H., Lee, H. C., Wu, H. C., Liu, H. M., Hsieh, H. H., . . . Lung, S. C. C. (2017). An Open Framework for Participatory PM2.5 Monitoring in Smart Cities. *IEEE Access*, *5*, 14441–14454. doi: 10.1109/ACCESS.2017.2723919

Chiesura, A. (2004). The Role of Urban Parks for the Sustainable City. *Landscape and Urban Planning*, *68*(1), 129–138. doi: 10.1016/j.landurbplan.2003.08.003

Cho, J.-s., & Chun, S. A. (2010). Ubiquitous Government: Mobile Portal for Seoul Metropolitan Government. In *Proceedings of the 11th Annual International Conference on Digital Government Research* (pp. 247–248). New York, NY: ACM.

Chourabi, H., Nam, T., Walker, S., Gil-Garcia, J. R., Mellouli, S., Nahon, K., . . . Scholl, H. J. (2012). Understanding Smart Cities: An Integrative Framework. In *Proceedings of the 45th Hawaii International Conference on System Sciences, HICSS 2012, Wailea, HI, January 7-10, 2012* (pp. 2289–2297). Washington, DC: IEEE Computer Society.

Chowdhury, G. (2010). Carbon Footprint of the Knowledge Sector: What's the Future? *Journal of Documentation*, *66*(6), 934–946. doi: 10.1108/00220411011087878

Chowdhury, G. (2012). An Agenda for Green Information Retrieval Research. *Information Processing and Management*, *48*(6), 1067–1077. doi: 10.1016/j.ipm.2012.02.003

Chowdhury, G. (2013). Sustainability of Digital Information Services. *Journal of Documentation*, *69*(5), 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), 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), 2379–2391. doi: 10.1002/asi.23599

Chowdhury, G., & 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), 2128–2138. doi: 10.1002/asi.23825

Circular Ecology. (2019). *Sustainability and Sustainable Development Guide.* Retrieved July 23, 2019, from `http://www.circularecology.com/sustainability-and-sustainable-development.html`

Cisco. (2011). *Cisco Collaborates With Barcelona to Support '2020 Vision' for Sustainable Urban Management and Economic Growth.* Retrieved from `newsroom.cisco.com/press-release-content;jsessionid=01230049AD3CA4E7D7A1C6438DD16818?type=webcontent&articleId=5918850`

Clarivate Analytics. (2018). *Research Areas (Categories / Classification).* Retrieved November 11, 2019, from `https://images.webofknowledge.com/images/help/WOS/hp_research_areas_easca.html`

Cleanweb Worldwide. (2012). *About.* Retrieved November 28, 2014, from `nyc.cleanweb.co/about/`

Conradie, P., & Choenni, S. (2014). On the Barriers for Local Government Releasing Open Data. *Government Information Quarterly*, *31*(Supplement 1), S10-S17. doi: 10.1016/j.giq.2014.01.003

Corbett, J., & Mellouli, S. (2017). Winning the SDG Battle in Cities: How an Integrated Information Ecosystem Can Contribute to the Achievement of the 2030 Sustainable Development Goals. *Information Systems Journal*, *27*(4), 427–461. doi: 10.1111/isj.12138

Creswell, J. W. (2012). *Qualitative Inquiry and Research Design: Choosing Among Five Approaches* (3rd ed.). Thousand Oaks, CA: Sage.

Cuadrado-Ballesteros, B., Frías-Aceituno, J., & Martínez-Ferrero, J. (2014). The Role of Media Pressure on the Disclosure of Sustainability Information by Local Governments. *Online Information Review*, *38*(1), 114–135. doi: 10.1108/OIR-12-2012-0232

Dawes, S. S., & Helbig, N. (2010). Information Strategies for Open Government: Challenges and

Prospects for Deriving Public Value from Government Transparency. In M. A. Wimmer, J.-L. Chappelet, M. Janssen, & H. J. Scholl (Eds.), *International Conference on Electronic Government, EGOC 2010, Lausanne, Switzerland, August 29 - September 2, 2010* (pp. 50–60). Berlin, Heidelberg, Germany: Springer LNCS, volume 6228.

de Camargo Fiorini, P., & 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*, *37*(4), 241–249. doi: 10.1016/j.ijinfomgt.2016.12.004

de Lange, M., & de Waal, M. (2013). Owning the City: New Media and Citizen Engagement in Urban Design. *First Monday*, *18*(11), 1–17. doi: 10.5210/fm.v18i11.4954

Dennerlein, S., Gutounig, R., Kraker, P., Kaiser, R., Rauter, R., & Ausserhofer, J. (2015). Knowledge Strategies in Organisations: A Case for the Barcamp Format. In *Proceedings of the European Conference on Knowledge Management, ECKM 2015, Udine, Italy, September 3-4, 2015* (pp. 222–230). Udine, Italy: University of Udine.

de Reuver, M., Stein, S., & Hampe, J. F. (2013). From E-Participation to Mobile Participation: Designing a Service Platform and Business Model for Mobile Participation. *Information Polity*, *18*(1), 57–73. doi: 10.3233/IP-2012-0276

Desouza, K. C., & Bhagwatwar, A. (2012). Citizen Apps to Solve Complex Urban Problems. *Journal of Urban Technology*, *19*(3), 107–136. doi: 10.1080/10630732.2012.673056

Deutscher Städtetag. (2015). *2030-Agenda für Nachhaltige Entwicklung: Nachhaltigkeit auf kommunaler Ebene gestalten.* Retrieved August 1, 2018, from `http://www.staedtetag` `.de/fachinformationen/staedtetag/075357/index.html`

Die Landesregierung Nordrhein-Westfalen. (2016). *Nachhaltigkeitsstrategie für Nordrhein-Westfalen.* Retrieved September 10, 2019, from `https://www` `.nachhaltigkeit.nrw.de/fileadmin/user_upload/Nachhaltigkeitsstrategie_PDFs/` `NRW_Nachhaltigkeitsstrategie_Broschuere_DE_Online_Version_22032017.pdf`

DiFranzo, D., Graves, A., Erickson, J. S., Ding, L., Michaelis, J., Lebo, T., & Hendler, J. (2011). The Web is My Back-end: Creating Mashups With Linked Open Government Data. In D. Wood (Ed.), *Linking Government Data* (pp. 205–219). New York, NY: Springer Science + Business Media.

Digitales Österreich. (2013). *apps4austria.* Retrieved November 28, 2014, from `https://www`

.digitales.oesterreich.gv.at/apps4austria

Ding, L., Peristeras, V., & Hausenblas, M. (2012). Linked Open Government Data. *IEEE Intelligent Systems*, *27*(3), 11–15. doi: 10.1109/MIS.2012.56

Drews, S., Antal, M., & Bergh, J. C. J. M. V. D. (2018). Challenges in Assessing Public Opinion on Economic Growth Versus Environment: Considering European and US Data. *Ecological Economics*, *146*, 265–272. doi: 10.1016/j.ecolecon.2017.11.006

Dudziak, E. A. (2007). Information Literacy and Lifelong Learning in Latin America: The Challenge to Build Social Sustainability. *Information Development*, *23*(1), 43–47. doi: 10.1177/0266666907075630

Eckerberg, K., & Mineur, E. (2003). The Use of Local Sustainability Indicators: Case Studies in Two Swedish Municipalities. *Local Environment*, *8*(6), 591–614. doi: 10.1080/1354983032000152716

Edwards, B. W. (2011). Sustainability as a Driving Force in Contemporary Library Design. *Library Trends*, *60*(1), 190–214. doi: 10.1353/lib.2011.0030

Elkington, J. (1997). *Cannibals with Forks: The Triple Bottom Line of 21st Century Business.* North Mankota, MN: Capstone.

Engagement Global. (2018). *Zeichnungskommunen der Agenda 2030 Resolution.* Retrieved July 30, 2018, from https://skew.engagement-global.de/zeichnungskommunen-agenda-2030.html

Engida, G. (2015). Foreword. In J. Singh, A. Grizzle, S. J. Yee, & S. H. Culver (Eds.), *Media and Information Literacy for the Sustainable Development Goals* (pp. 9–11). Göteburg, Sweden: Nordicom.

Estevez, E., & Janowski, T. (2013). Electronic Governance for Sustainable Development - Conceptual Framework and State of Research. *Government Information Quarterly*, *30*(Supplement 1), S94-S109. doi: 10.1016/j.giq.2012.11.001

Evangelista, P., & Durst, S. (2015). Knowledge Management in Environmental Sustainability Practices of Third-Party Logistics Service Providers. *Vine*, *45*(4), 509–529. doi: 10.1108/VINE-02-2015-0012

Fairtrade Deutschland. (2018). *Fair Trade Towns.* Retrieved November 16, 2018, from https://www.fairtrade-towns.de/no_cache/startseite/

Federal Ministry of Education and Research. (2017). *National Action Plan on Education for Sus-*

tainable Development. Retrieved November 10, 2018, from `https://www.bne-portal.de/sites/default/files/downloads/publikationen/BMBF_NAP_BNE_EN_Screen_2.pdf`

Fietkiewicz, K. J., Mainka, A., & Stock, W. G. (2017). Egovernment in Cities of the Knowledge Society. An Empirical Investigation of Smart Cities' Governmental Websites. *Government Information Quarterly*, *34*(1), 75–83. doi: 10.1016/j.giq.2016.08.003

Flick, U. (2009). *An Introduction to Qualitative Research*. Thousand Oaks, CA: Sage.

Florida, R. (2014). *11 Reasons the UN Should Make Cities the Focus of Its Forthcoming Sustainable Development Goals*. Retrieved April 4, 2020, from `https://www.citylab.com/life/2014/04/11-reasons-un-should-make-cities-focus-its-new-sustainable-development-goals/8896/`

Forsyth, E. (2005). Public Libraries and the Millennium Development Goals. *The IFLA Journal*, *31*(4), 315–323. doi: 10.1177/0340035205061389

Fox, O., & Stoett, P. (2016). Citizen Participation in UN Sustainable Development Goals. *Global Governance*, *22*(4), 555–574. doi: 10.1163/19426720-02204007

Franz, M. (2013). „... dass sich Menschen wohlfühlen". Energiesparende Konzepte aus dem Buchhandel übertragen auf Bibliotheken. In P. Hauke, K. Latimer, & K. U. Werner (Eds.), *The Green Library - Die grüne Bibliothek. IFLA Publications, Nr 161* (pp. 152–159). Berlin/Munich, Germany: De Gruyter, Saur.

Fuchs, C. (2010). Theoretical Foundations of Defining the Participatory, Co-operative, Sustainable Information Society. *Information Communication and Society*, *13*(1), 23–47. doi: 10.1080/13691180902801585

Gabriel, O. W., Ahlstih, K., Brettschneider, F., & Kunz, F. (2018). Transformations in Policy Preferences of Local Officials. In T. N. Clark & V. Hoffmann-Martinot (Eds.), *The New Political Culture* (p. 219 -234). New York, NY; Abingdon, UK: Taylor & Francis.

Garcia, A. C. B., Vivacqua, A. S., & Tavares, T. C. (2011). Enabling Crowd Participation in Governmental Decision-making. *Journal of Universal Computer Science*, *17*(14), 1931–1950. doi: 10.3217/jucs-017-14-1931

Gastil, J., & Dillard, J. P. (1999). Increasing Political Sophistication Through Public Deliberation. *Political Communication*, *16*(1), 3–23. doi: 10.1080/105846099198749

Gavel, Y., & Iselid, L. (2008). Web of Science and Scopus: A Journal Title Overlap Study. *Online Information Review*, *32*(1), 8–21. doi: 10.1108/14684520810865958

Gelderman, C. J., Semeijn, J., & Vluggen, R. (2017). Development of Sustainability in Public Sector Procurement. *Public Money and Management*, *37*(6), 435–442. doi: 10.1080/09540962.2017.1344027

German Federal Government. (2017). *German Sustainable Development Strategy (Summary)*. Retrieved September 9, 2019, from `https://www.bundesregierung.de/Content/EN/StatischeSeiten/Schwerpunkte/Nachhaltigkeit/Anlagen/2017-04-12-kurzpapier-n-en.pdf?__blob=publicationFile&v=7`

German Federal Statistical Office. (2018). *Städte (Alle Gemeinden mit Stadtrecht) nach Fläche, Bevölkerung und Bevölkerungsdichte am 31.12.2016.* Retrieved June 30, 2018, from `https://www.destatis.de/DE/ZahlenFakten/LaenderRegionen/Regionales/Gemeindeverzeichnis/Administrativ/Aktuell/05Staedte.html`

German National Library. (2019). *Nachhaltigkeit.* Retrieved June 30, 2018, from `http://d-nb.info/gnd/4326464-5`

Glänzel, W. (2001). National Characteristics in International Scientific Co-authorship Relations. *Scientometrics*, *51*, 69–115. doi: 10.1023/A:1010512628145

Goggin, G. (2011). Ubiquitous Apps: Politics of Openness in Global Mobile Cultures. *Digital Creativity*, *22*(3), 148–159. doi: 10.1080/14626268.2011.603733

Goodin, R. E., & Dryzek, J. S. (2006). Deliberative Impacts: The Macro-Political Uptake of Mini-Publics. *Politics and Society*, *34*(2), 219–244. doi: 10.1177/0032329206288152

Gorin, J., Manley, L., & Ariss, A. (n.d.). *Sustainable Development Goals and Open Data.* Retrieved June 30, 2018, from `http://blogs.worldbank.org/ic4d/sustainable-development-goals-and-open-data`

Granda, R., & Machin-Mastromatteo, J. D. (2016). From Caracas to Lyon: A Road Toward Sustainable Development? *Information Development*, *32*(2), 216–218. doi: 10.1177/0266666915626830

Gurstein, M. B. (2011). Open Data: Empowering the Empowered or Effective Data Use for Everyone? *First Monday*, *16*(2). doi: 10.5210/fm.v16i2.3316

Haider, J. (2014). How Library and Information Science Can Save the World and Why to Care. *LIBREAS. Library Ideas*, *25*, 80–91. doi: 10.18452/9065

Hák, T., Janoušková, S., & Moldan, B. (2016). Sustainable Development Goals: A Need for Relevant Indicators. *Ecological Indicators*, *60*, 565–573. doi: 10.1016/j.ecolind.2015.08.003

Halvorsen, T. (2017). The Sustainable Development Goals, Knowledge Production and the Global Struggle Over Values. In T. Halvorsen, H. Ibsen, H.-C. Evans, & S. Penderis (Eds.), *Knowledge for Justice. Critical Perspectives From Southern African-Nordic Research Partnerships* (pp. 13–36). Cape Town, Belville; South Africa: African Minds, SANORD.

Halvorsen, T., Ibsen, H., Evans, H.-C., & Penderis, S. (2017). Introduction. In T. Halvorsen, H. Ibsen, H.-C. Evans, & S. Penderis (Eds.), *Knowledge for Justice. Critical Perspectives From Southern African-Nordic Research Partnerships* (pp. 1–9). Cape Town, Belville; South Africa: African Minds, SANORD.

Hamari, J., Sjöklint, M., & Ukkonen, A. (2016). The Sharing Economy: Why People Participate in Collaborative Consumption. *Journal of the Association for Information Science and Technology*, *67*(9), 2047–2059. doi: 10.1002/asi.23552

Hassan, S. U., Haddawy, P., & Zhu, J. (2014). A Bibliometric Study of the World's Research Activity in Sustainable Development and Its Sub-areas Using Scientific Literature. *Scientometrics*, *99*, 549–579. doi: 10.1007/s11192-013-1193-3

Hauke, P. (2018). From Information Literacy to Green Literacy: Training Librarians as Trainers for Sustainability Literacy. In *IFLA World Library and Information Congress, IFLA WLC 2018, Kuala Lumpur, Malaysia, August 24-30, 2018* (pp. 1–10). Kuala Lumpur.

Hauke, P., & Werner, K. U. (2012). The Second Hand Library Building: Sustainable Thinking Through Recycling Old Buildings into New Libraries. *IFLA Journal*, *38*(1), 60–67. doi: 10.1177/0340035211435394

Hauke, P., & Werner, K. U. (2013). The Second-hand Library – A Way of Reducing the Ecological Footprint. In P. Hauke, K. Latimer, & K. U. Werner (Eds.), *The green library - die grüne bibliothek. ifla publications, nr 161* (pp. 175–193). Berlin/Munich, Germany: De Gruyter, Saur. doi: 10.1515/9783110309720.175

Hawkins, C. V., & Wang, X. H. (2012). Sustainable Development Governance: Citizen Participation and Support Networks in Local Sustainability Initiatives. *Public Works Management and Policy*, *17*(1), 7–29. doi: 10.1177/1087724X11429045

Headd, M. (2011). *Open Government Hackathons Matter*. Retrieved April 5, 2019, from `govfresh.com/2011/08/open-government-hackathons-matter/`

Heller, V., & Fansa, J. (2013). Nachhaltigkeit in drei Dimensionen. Ressourcenverantwortung im Fokus der Planung für die neue Zentral- und Landesbibliothek Berlin. In P. Hauke,

K. Latimer, & K. U. Werner (Eds.), *The Green Library - Die grüne Bibliothek. IFLA Publications, Nr 161* (pp. 333–344). Berlin/Munich, Germany: De Gruyter, Saur.

Henkel, M. (2015). Educators of the Information Society: Information Literacy Instruction in Canadian Informational Cities. *Journal of Systemics, Cybernetics and Informatics*, *13*(3), 22–27.

Henkel, M., & Stock, W. G. (2016). "We have big plans." - Information Literacy Instruction in Academic and Public Libraries in the United States of America. In *Proceedings of the 2nd International Conference on Library and Information Science, July 12-14, 2016, Kyoto, Japan* (p. 159-175). Taipeh, Taiwan: International Business Academics Consortium.

Hens, L., & Nath, B. (2005). *The World Summit on Sustainable Development. The Johannesburg Conference.* Dordrecht, Netherlands: Springer.

Herrington, N. (2006). Open Space Conferences: A New Way of Working. *Management in Education*, *20*(5), 13–14. doi: 10.1177/089202060602000503

Hollands, R. G. (2008). Will the Real Smart City Please Stand Up? *City*, *12*(3), 303–320. doi: 10.1080/13604810802479126

Howard, J., & Wheeler, J. (2015). What Community Development and Citizen Participation Should Contribute to the New Global Framework for Sustainable Development. *Community Development Journal*, *50*(4), 552–570. doi: 10.1093/cdj/bsv033

Huang, Z., & Benyoucef, M. (2014). Usability and Credibility of E-Government Websites. *Government Information Quarterly*, *31*(4), 584–595. doi: 10.1016/j.giq.2014.07.002

Huijboom, N., & Van Den Broek, T. (2011). Open Data: An International Comparison of Strategies. *European Journal of ePractice*(12), 4–16. Retrieved from https://joinup.ec.europa.eu/sites/default/files/document/2014-06/ePractice%20Journal-%20Vol.%2012-March_April%202011.pdf

Hung, S.-Y., Chang, C.-M., & Kuo, S.-R. (2013). User Acceptance of Mobile E-Government Services: An Empirical Study. *Government Information Quarterly*, *30*(1), 33–44. doi: 10.1016/j.giq.2012.07.008

Hunsberger, C. A., Gibson, R. B., & Wismer, S. K. (2005). Citizen Involvement in Sustainability-centred Environmental Assessment Follow-up. *Environmental Impact Assessment Review*, *25*(6), 609–627. doi: 10.1016/j.eiar.2004.12.003

Hunter, F. (2013). *The Civic Innovation Ecosystem Blooms in 2012. What's Next?* Retrieved

November 28, 2014, from `innovatesf.com/category/open-data/`

IBM. (2015). *IBM and Barcelona Supercomputing Center – Centro Nacional de Supercomputación Celebrate a Decade of Collaboration.* Retrieved from `https://www-03.ibm.com/press/us/en/pressrelease/46566.wss`

IFLA. (2002). *Statement on Libraries and Sustainable Development.* Retrieved July 23, 2019, from `https://www.ifla.org/publications/statement-on-libraries-and-sustainable-development`

Igbinovia, M. O. (2017). Librarians' Involvement in Cross-disciplinary Research and Its Implication for Sustainable Development Goals (SDGs). *Library Review*, *66*(4/5), 251–265. doi: 10.1108/LR-09-2016-0078

Immonen, A., Palviainen, M., & Ovaska, E. (2014). Requirements of an Open Data Based Business Ecosystem. *IEEE Access*, *2*, 88–103. doi: 10.1109/ACCESS.2014.2302872

Irving, R. A., & Stransbury, J. (2004). Citizen Participation in Decision Making: Is It Worth the Effort? *Public Administration Review*, *64*(1), 55–65. doi: 10.1007/s10694-015-0526-6

IUCN. (1980). *World Conservation Strategy - Living Resource Conservation for Sustainable Development.* Gland, Switzerland: IUCN.

Jankowska, M. A., & Marcum, J. W. (2010). Sustainability Challenge for Academic Libraries: Planning for the Future. *College & Research Libraries*, *71*(2), 160–170. doi: 10.5860/0710160

Jankowska, M. A., Smith, B. J., & Buehler, M. A. (2014). Engagement of Academic Libraries and Information Science Schools in Creating Curriculum for Sustainability: An Exploratory Study. *Journal of Academic Librarianship*, *40*(1), 45–54. doi: 10.1016/j.acalib.2013.10.013

Janowski, T. (2016). Implementing Sustainable Development Goals with Digital Government - Aspiration-Capacity Gap. *Government Information Quarterly*, *33*(4), 603–613. doi: 10.1016/j.giq.2016.12.001

Janssen, K. (2011). The Influence of the PSI Directive on Open Government Data: An Overview of Recent Developments. *Government Information Quarterly*, *28*(4), 446–456. doi: 10.1016/j.giq.2011.01.004

Jaokar, A. (2012). *Apps for Smart Cities.* Retrieved April 2, 2020, from `http://www.opengardensblog.futuretext.com/archives/2012/03/a-manifesto-apps-for-smart-cities.html`

Jenkin, T. A., Webster, J., & McShane, L. (2011). An Agenda for 'Green' Information Technology and Systems Research. *Information and Organization*, *21*(1), 17–40. doi: 10.1016/j.infoandorg.2010.09.003

Jetzek, T., Avital, M., & Bjørn-Andersen, N. (2013). Generating Value from Open Government Data. In *Proceedings of the 34th International Conference on Information Systems, ICIS 2013, Milan, Italy, December 15-18, 2013* (pp. 1–20). Milan, Italy: AISeL.

Johnson, P., & Robinson, P. (2014). Civic Hackathons: Innovation, Procurement, or Civic Engagement? *Review of Policy Research*, *4*(31), 349–357. doi: 10.1111/ropr.12074

Kates, R. W., Parris, T. M., & Leiserowitz, A. A. (2005). What is Sustainable Development? Goals, Indicators, Values, and Practice. *Environment*, *47*(3), 8–21. doi: 10.1080/00139157 .2005.10524444

Katz, M. L., & Shapiro, C. (1994). Systems Competition and Network Effects. *Journal of Economic Perspectives*, *8*(2), 93–115. doi: 10.1257/jep.8.2.93

Keite, U., & Banduch, R. (2013). Bücherhallen Hamburg im rechten Licht. Neue Beleuchtung in der Zentralbibliothek. In P. Hauke, K. Latimer, & K. U. Werner (Eds.), *The Green Library - Die grüne Bibliothek. IFLA Publications, Nr 161* (pp. 345–364). Berlin/Munich, Germany: De Gruyter Saur.

Kitchin, R. (2014). The Real-time City? Big Data and Smart Urbanism. *GeoJournal*, *79*(1), 1–14. doi: 10.1007/s10708-013-9516-8

Klopp, J. M., & Petretta, D. L. (2017). The Urban Sustainable Development Goal: Indicators, Complexity and the Politics of Measuring Cities. *Cities*, *63*, 92–97. doi: 10.1016/j.cities .2016.12.019

Kokol, P., & Blažun Vošner, H. (2018). Discrepancies Among Scopus, Web of Science, and Pubmed Coverage of Funding Information in Medical Journal Articles. *Journal of the Medical Library Association*, *106*(1), 81–86. doi: 10.5195/jmla.2018.181

Kondratieff, N. D. (1935). The Long Waves in Economic Life. *The Review of Economic Statistics*, *17*(6), 105–115. doi: 10.2307/1928486

Körfgen, A., Förster, K., Glatz, I., Maier, S., Becsi, B., Meyer, A., . . . Stötter, J. (2018). It's a Hit! Mapping Austrian Research Contributions to the Sustainable Development Goals. *Sustainability*, *10*(9), 1–13. doi: 10.3390/su10093295

Krippendorff, K. (2018). *Content Analysis. An Introduction to Its Methodology* (4th ed.). Thou-

sand Oaks, CA: SAGE.

Kuhn, K. (2011). Open Government Data and Public Transportation. *Journal of Public Transportation*, *14*(1), 83–97. doi: 10.5038/2375-0901.14.1.5

Kurbanoğlu, S., & Boustany, J. (2014). From Green Libraries to Green Information Literacy. In S. Kurbanoğlu, S. Špiranec, E. Grassian, D. Mizrachi, & R. Catts (Eds.), *Information Literacy. Lifelong Learning and Digital Citizenship in the 21st Century. Proceedings of the 2nd European Conference on Information Literacy, ECIL 2014, Dubrovnik, Croatia, October 20-23, 2014* (pp. 47–58). Basel, Switzerland: Springer Nature.

LAG 21 NRW, & SKEW. (2018). *Global Nachhaltige Kommune NRW. Gesamtdokumentation.* Dortmund/Bonn, Germany. Retrieved from `https://www.lag21.de/projekte/details/global-nachhaltige-kommune/`

Lanzarone, G. A., & Zanzi, A. (2010). Monitoring Gas and Water Consumption Through ICTs for Improved User Awareness. *Information, Communication & Society*, *13*(1), 121–135.

Lathrop, D., & Ruma, L. (2010). *Open Government: Collaboration, Transparency, and Participation in Practice.* Sebastopol, CA: O'Reilly Media.

Leal Filho, W., Azeiteiro, U., Alves, F., Pace, P., Mifsud, M., Brandli, L., . . . Disterheft, A. (2018). Reinvigorating the Sustainable Development Research Agenda: the Role of the Sustainable Development Goals (SDG). *International Journal of Sustainable Development and World Ecology*, *25*(2), 131–142. doi: 10.1080/13504509.2017.1342103

Lent, R. M., McCormick, M. T., & Pearce, D. S. (2005). Combining Future Search and Open Space to Address Special Situations. *The Journal of Applied Behavioral Science*, *41*(1), 61–69. doi: 10.1177/0021886304272607

Leydesdorff, L., Bornmann, L., & Wagner, C. S. (2019). The Relative Influences of Government Funding and International Collaboration on Citation Impact. *Journal of the Association for Information Science and Technology*, *70*(2), 198–201. doi: 10.1002/asi.24109

Leydesdorff, L., & Rafols, I. (2009). A Global Map of Science Based on the ISI Subject Categories. *Journal of the American Society for Information Science and Technology*, *60*(2), 348–362. doi: 10.1002/asi.20967

Li, X., & 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), 131–152. doi: 10.1080/136588100240886

Linders, D. (2013). Towards Open Development: Leveraging Open Data to Improve the Planning and Coordination of International Aid. *Government Information Quarterly*, *30*(4), 426–434. doi: 10.1016/j.giq.2013.04.001

Lior, N., Radovanović, M., & Filipović, S. (2018). Comparing Sustainable Development Measurement Based on Different Priorities: Sustainable Development Goals, Economics, and Human Well-being - Southeast Europe Case. *Sustainability Science*, *13*(4), 973–1000. doi: 10.1007/s11625-018-0557-2

Liu, W. (2019). The Data Source of This Study is Web of Science Core Collection? Not Enough. *Scientometrics*, *121*, 1815–1824. doi: 10.1007/s11192-019-03238-1

Liu, Y., Li, H., Kostakos, V., Goncalves, J., Hosio, S., & Hu, F. (2014). An Empirical Investigation of Mobile Government Adoption in Rural China: A Case Study in Zhejiang Province. *Government Information Quarterly*, *31*(3), 432–442. doi: 10.1016/j.giq.2014.02.008

López-de Ipiña, D., Vanhecke, S., Peña, O., De Nies, T., & Mannens, E. (2013). Citizen-Centric Linked Data Apps for Smart Cities. In *Ubiquitous Computing and Ambient Intelligence. Context-Awareness and Context-Driven Interaction. Proceedings of the 7th International Conference, UCAmI 2013, Carrillo, Costa Rica, December 2-6, 2013* (Vol. 8276, pp. 70–77). Berlin/Heidelberg, Germany: Springer LNCS, volume 8276.

Lukensmeyer, C. J., & Brigham, S. (2005). Taking Democracy to Scale: Large Scale Interventions - For Citizens. *Journal of Applied Behavioral Science*, *41*(1), 47–60. doi: 10.1177/0021886304272656

Lusa, D. A., Dos Santos Rabello, R., & Cervi, C. R. (2015). Open Smart City View - An Architecture for Open Government Data Manipulation and Presentation at City Level. In *Proceedings of the 14th International Conference on WWW/INTERNET 2015, Maynooth, Ireland, October 24-26, 2015* (pp. 119–126). Maynooth, Ireland: IADIS.

Mago, S. (2017). North–South Research Collaboration and the Sustainable Development Goals: Challenges and Opportunities for Academics. In T. Halvorsen, H. Ibsen, H.-C. Evans, & S. Penderis (Eds.), *Knowledge for Justice. Critical Perspectives From Southern African-Nordic Research Partnerships* (pp. 163–174). Cape Town/Belville, South Africa: African Minds, SANORD.

Mainka, A. (2018). *Smart World Cities in the 21st century.* Berlin/Boston: De Gruyter Saur.

Mainka, A., Fietkiewicz, K., Kosior, A., Pyka, S., & Stock, W. (2013). Maturity and Usability

of E-Government in Informational World Cities. In E. Ferrari & W. Castelnovo (Eds.), *Proceedings of the 13th European Conference on E-Government, ECEG 2013, Varese, Italy, June 13-14, 2013* (pp. 292–300). Sonning Common, UK: ACPI.

Mainka, A., Hartmann, S., Meschede, C., & Stock, W. (2015b). Open Government: Transforming Data into Value-added City Services. In M. Foth, M. Brynskov, & T. Ojala (Eds.), *Citizen's Right to the Digital City: Urban Interfaces, Activism, and Placemaking* (pp. 199–214). Singapore: Springer.

Mainka, A., Hartmann, S., Meschede, C., & Stock, W. G. (2015a). Mobile Application Services Based Upon Open Urban Government Data. In *iConference 2015 Proceedings, Newport Beach, CA, March 24-27, 2015* (pp. 1–15). Urbana, IL: IDEALS.

Mainka, A., Hartmann, S., Orszullok, L., Peters, I., Stallmann, A., & Stock, W. G. (2013). Public Libraries in the Knowledge Society. Core Services of Libraries in Informational World Cities. *Libri*, *63*(4), 295–319. doi: 10.1515/libri-2013-0024

Mainka, A., Hartmann, S., Stock, W. G., & Peters, I. (2014). Government and Social Media. A Case Study of 31 Informational World Cities. In *Proceedings of the 47th Hawaii International Conference on System Sciences, HICSS 2014, Waikoloa, HI, January 6-9, 2014* (pp. 1715–1724). Washington, DC: IEEE Computer Society.

Mainka, A., Hartmann, S., Stock, W. G., & Peters, I. (2015). Looking for Friends and Followers: A Global Investigation of Governmental Social Media Use. *Transforming Government: People, Process and Policy*, *9*(2), 237–254. doi: 10.1108/TG-09-2014-0041

Manning, E. W. (1990). Geographic Information Systems and Sustainable Development. *Government Information Quarterly*, *7*(3), 329–342. doi: 10.1016/0740-624X(90)90028-M

Marcum, J. W. (2009, 5). Design for Sustainability. *The Bottom Line*, *22*(1), 9–12. doi: 10.1108/08880450910955378

Marzouki, A., Mellouli, S., & Daniel, S. (2017). Towards a Context-based Citizen Participation Approach: A Literature Review of Citizen Participation Issues and a Conceptual Framework. In R. Baguma, R. De', & T. Janowski (Eds.), *Proceedings of the 10th International Conference on Theory and Practice of Electronic Governance, ICEGOV 2017, New Delhi, India, March 7-9, 2017* (pp. 204–213). New York, NY: Association for Computing Machinery.

Mayring, P. (2015). *Qualitative Inhaltsanalyse: Grundlagen und Techniken* (12th ed.). Wein-

heim/Basel, Switzerland: Beltz.

McDermott, P. (2010). Building Open Government. *Government Information Quarterly*, *27*(4), 401–413. doi: 10.1016/j.giq.2010.07.002

McMillan, S. J. (2000). The Microscope and the Moving Target: The Challenge of Applying Content Analysis to the World Wide Web. *Journalism and Mass Communication Quaterly*, *77*(1), 80–98. doi: 10.1177/107769900007700107

Meadowcroft, J. (2004). Participation and Sustainable Development: Modes of Citizen, Community and Organisational Involvement. In W. Lafferty (Ed.), *Governance for Sustainable Development: The Challenge of Adapting Form to Function* (pp. 162–190). Cheltenhan, UK; Northampton, MA: Edward Elgar.

Meadowcroft, J. (2007). National Sustainable Development Strategies: Features, Challenges and Reflexivity. *European Environment*, *17*(3), 152–163. doi: 10.1002/eet.450

Meijer, A. J., Curtin, D., Hillebrandt, M., & Curtin, D. (2012). Open Government: Connecting Vision and Voice. *International Review of Administrative Sciences*, *78*(1), 10–29. doi: 10.1177/0020852311429533

Mergel, I. (2013). Social Media Adoption and Resulting Tactics in the U.S. Federal Government. *Government Information Quarterly*, *30*(2), 123–130. doi: 10.1016/j.giq.2012.12.004

Meschede, C. (2019). Information Dissemination Related to the Sustainable Development Goals on German Local Governmental Websites. *Aslib Journal of Information Management*, *71*(3), 440–455. doi: 10.1108/AJIM-08-2018-0195

Meschede, C., & Henkel, M. (2019). Library and Information Science and Sustainable Development: A Structured Literature Review. *Journal of Documentation*, *75*(6), 1356–1369. doi: 10.1108/jd-02-2019-0021

Meyer-Emerick, N. (2012). Sustainable Cleveland 2019: Designing a Green Economic Future Using the Appreciative Inquiry Summit Process. *Public Works Management and Policy*, *17*(1), 52–67. doi: 10.1177/1087724X11429043

Microsoft. (2014). *Customer Stories.* Retrieved June 2, 2015, from `https://customers.microsoft.com/Pages/CustomerStory.aspx?recid=270`

Millard, J. (2010). Government 1.5: Is the Bottle Half Full or Half Empty? *European Journal of ePractice*(9), 35–48. Retrieved from `https://joinup.ec.europa.eu/sites/default/files/document/2014-06/ePracticeJournalVol.9-March2010.pdf`

Miller, K. (2010). *Public Libraries Going Green.* Chicago, IL: American Library Association.

Mitrea, O., Werner, M., & Greif, H. (2010). Sustainability ICT Visions and Their Embedding in Technology Construction. *Information, Communication & Society*, *13*(1), 48–67. doi: 10.1080/13691180903026372

Mkude, C. G., Pérez-Espés, C., & Wimmer, M. A. (2014). Participatory Budgeting: A Framework to Analyze the Value-add of Citizen Participation. In *Proceedings of the 47th Hawaii International Conference on System Sciences, HICSS 2014, Waikoloa, HI, January 6-9* (pp. 2054–2062). Washington, DC: IEEE Computer Society.

Mongeon, P., & Paul-Hus, A. (2016). The Journal Coverage of Web of Science and Scopus: A Comparative Analysis. *Scientometrics*, *106*, 213–228. doi: 10.1007/s11192-015-1765-5

Moon, M. (2002). The Evolution of E-Government Among Municipalities: Rhetoric or Reality? *Public Administration Review*, *62*(4), 424–433. doi: 10.1111/0033-3352.00196

Morillo, F. (2019). Collaboration and Impact of Research in Different Disciplines with International Funding (From the EU and Other Foreign Sources). *Scientometrics*, *120*, 807–823. doi: 10.1007/s11192-019-03150-8

Moro, G. (2005). Citizens' Evaluation of Public Participation. In OECD (Ed.), *Evaluating Public Participation in Policy Making* (pp. 109–125). Paris, France: OECD.

Müllert, N. R. (2009). Zukunftswerkstätten. Über Chancen demokratischer Zukunftsgestaltung. In *Zukunftsforschung und Zukunftsgestaltung* (pp. 269–276). Salzburg, Austria: Springer.

Nanz, P., & Fritsche, M. (2012). *Handbuch Bürgerbeteiligung. Verfahren und Akteure, Chancen und Grenzen.* Bonn, Germany: Bundeszentrale für politische Bildung. Retrieved from `http://www.bpb.de/shop/buecher/schriftenreihe/76038/handbuch-buergerbeteiligung`

Nathan, L. P. (2012). Sustainable Information Practice: An Ethnographic Investigation. *Journal of the Association for Information Science and Technology*, *63*(11), 2254–2268. doi: 10.1002/asi.22726

National Research Council. (1999). *Our Common Journey: A Transition Toward Sustainability.* Washington, DC: The National Academies Press.

Navarro-Galera, A., Alcaraz-Quiles, F. J., & Ortiz-Rodríguez, D. (2016). Online Dissemination of Information on Sustainability in Regional Governments. Effects of Technological Factors. *Government Information Quarterly*, *33*(1), 53–66. doi: 10.1016/j.giq.2015.12.003

Nefiodow, L., & Nefiodow, S. (2014). *The Sixth Kondratieff. The New Long Wave in Global Economy.* North Charleston, SC: CreateSpace Intependent Publishing.

Netzwerk Grüne Bibliothek. (2019). *Netzwerk Grüne Bibliothek.* Retrieved September 9, 2019, from `https://www.netzwerk-gruene-bibliothek.de/`

Neuendorf, K. A. (2002). *The Content Analysis Guidebook.* Thousand Oaks, CA: SAGE.

Nolin, J. (2010). Sustainable Information and Information Science. *Information Research - An International Electronic Journal*, *15*(2), paper 431. Retrieved from `http://informationr.net/ir/15-2/paper431.html`

Noon, P. (2008). The Lanchester Library - Building a Sustainable Library. *LIBER Quarterly*, *18*(2), 129–136. doi: 10.18352/lq.7916

Nugroho, Y. (2010). NGOs, the Internet and Sustainable Rural Development: The Case of Indonesia. *Information, Communication & Society*, *13*(1), 88–120. doi: 10.1080/13691180902992939

Obama, B. (2009). Memorandum for the Heads of Executive Departments and Agencies. Freedom of Information Act. *Presidential Studies Quarterly*, *39*(3), 429. doi: 10.1111/j.1741-5705.2009.03698.x

OECD. (2018). *Urban Population by City Size.* Retrieved August 10, 2018, from `https://data.oecd.org/popregion/urban-population-by-city-size.htm`

OECD/ITU. (2011). *M-Government: Mobile Technologies for Responsive Governments and Connected Societies.* Paris, France: OECD Publishing.

Oels, A. (2009). The Power of Visioning: The Contribution of Future Search Conferences to Decision-making in Local Agenda 21 Processes. In F. H. J. M. Coenen (Ed.), *Public Participation and Better Environmental Decisions: The Promise and Limits of Participatory Processes for the Quality of Environmentally Related Decision-making* (pp. 73–88). Dordrecht, Netherlands: Springer. doi: 10.1007/978-1-4020-9325-8_5

Ojo, A., Curry, E., & Zeleti, F. A. (2015). A Tale of Open Data Innovations in Five Smart Cities. In *Proceedings of the 48th Hawaii International Conference on System Sciences, HICSS 2015, Kauai, HI, January 5-8, 2015* (pp. 2326–2335). Washington, DC: IEEE Computer Society.

Olawumi, T. O., & Chan, D. W. (2018). A Scientometric Review of Global Research on Sustainability and Sustainable Development. *Journal of Cleaner Production*, *183*, 231–250. doi:

10.1016/j.clepro.2018.02.162

Open Data Watch. (2017a). *Open Data Inventory 2017. Country Profile Germany.* Retrieved October 1, 2018, from `http://odin.opendatawatch.com/ReportCreator/ExportCountryReport/DEU/2017`

Open Data Watch. (2017b). *Open Data Inventory 2017 Methodology Report.* Retrieved October 1, 2018, from `http://odin.opendatawatch.com/Downloads/otherFiles/ODIN-2016-Methodology.pdf`

Open Knowledge Forum Österreich. (2013). *OpenDataHackathon 2011.* Retrieved November 28, 2014, from `https://www.barcamp.at/OpenDataHackathon_2011`

Open Knowledge International. (n.d.-a). *Open Data Handbook.* Retrieved October 1, 2018, from `http://opendatahandbook.org/guide/en/`

Open Knowledge International. (n.d.-b). *The Open Definition.* Retrieved October 1, 2018, from `https://opendefinition.org/`

Open Knowledge International. (2017). *Global Open Data Index. Methodology.* Retrieved October 1, 2018, from `https://index.okfn.org/methodology/`

Paul-Hus, A., Desroches, N., & Costas, R. (2016). Characterization, Description, and Considerations for the Use of Funding Acknowledgement Data in Web of Science. *Scientometrics*, *108*, 167–182. doi: 10.1007/s11192-016-1953-y

Piotrowicz, W., & Cuthbertson, R. (2009). Sustainability – A New Dimension in Information Systems Evaluation. *Journal of Enterprise Information Management*, *22*(5), 492–503. doi: 10.1108/17410390910993509

Quental, N., & Lourenço, J. M. (2012). References, Authors, Journals and Scientific Disciplines Underlying the Sustainable Development Literature: A Citation Analysis. *Scientometrics*, *90*, 361–381. doi: 10.1007/s11192-011-0533-4

Quental, N., Lourenço, J. M., & Da Silva, F. N. (2011). Sustainable Development Policy: Goals, Targets and Political Cycles. *Sustainable Development*, *19*(1), 15–29. doi: 10.1002/sd.416

Rabidas, S. (2016). Green Library Buildings: A Sustainable Process. *International Journal of Advance Research and Innovative Ideas in Education*, *2*(6), 342–346. doi: 16.0415/IJARIIE-3327

Reddick, C. G. (2014). Citizens and Mobile Government Adoption: A Comparison of Activities and Uses. *International Journal of Civic Engagement and Social Change*, *1*(1), 13–26. doi:

10.4018/ijcesc.2014010102

Ribeiro, L. C., Rapini, M. S., Silva, L. A., & Albuquerque, E. M. (2018). Growth Patterns of the Network of International Collaboration in Science. *Scientometrics*, *114*, 159–179. doi: 10.1007/s11192-017-2573-x

Ross, A. (2010). It's Time to Get Serious - Why Legislation is Needed to Make Sustainable Development a Reality in the UK. *Sustainability*, *2*(4), 1101–1127. doi: 10.3390/su2041101

Sachs, J. D. (2012). From Millennium Development Goals to Sustainable Development Goals. *The Lancet*, *379*(9832), 2206–2211. doi: 10.1016/S0140-6736(12)60685-0

Sachs, J. D. (2015). *The Age of Sustainable Development*. New York, NY; Chichester, UK: Columbia University Press.

Salvia, A. L., Leal Filho, W., Brandli, L. L., & Griebeler, J. S. (2019). Assessing Research Trends Related to Sustainable Development Goals: Local and Global Issues. *Journal of Cleaner Production*, *208*, 841–849. doi: 10.1016/j.jclepro.2018.09.242

Sandoval-Almazán, R., Gil-Garcia, J. R., Luna-Reyes, L. F., Luna, D. E., & Rojas-Romero, Y. (2012). Open Government 2.0: Citizen Empowerment Through Open Data, Web and Mobile Apps. In *Proceedings of the 6th International Conference on Theory and Practice of Electronic Governance, ICEGOV 2012, Albany, NY, October 22-25, 2012* (pp. 30–33). New York, NY: ACM.

Schaupp, L. C., & Carter, L. (2005). E-voting: From Apathy to Adoption. *Journal of Enterprise Information Management*, *18*(5), 586–601. doi: 10.1108/17410390510624025

Scholl, H. J. (2012). Five Trends that Matter: Challenges to 21st Century Electronic Government. *Information Polity*, *17*(3-4), 317–327. doi: 10.3233/IP-2012-0280

Scholl, H. J., & Scholl, M. C. (2014). Smart Governance: A Roadmap for Research and Practice. In *iConference 2014 Proceedings, Berlin, Germany, March 4-7, 2014* (pp. 163–176). Urbana, IL: IDEALS.

SCImago. (2007). *SCImago, SJR — SCImago Journal & Country Rank*. Retrieved February 1, 2018, from `http://www.scimagojr.com`

SDG National Reporting Initiative. (2018). *Facilitating Information-sharing on SDG Reporting*. Retrieved October 1, 2018, from `https://www.sdgreporting.org/`

Shadbolt, N., & O'Hara, K. (2013). Linked Data in Government. *IEEE Internet Computing*, *17*(4), 72–77. doi: 0.1109/MIC.2013.72

Shapiro, J. M. (2006). Smart Cities: Quality of Life, Productivity, and the Growth Effects of Human Capital. *Review of Economics and Statistics*, *88*(2), 324–335. doi: 10.1162/rest.88.2.324

Shepherd, E. (2015). Freedom of Information, Right to Access Information, Open Data: Who is at the Table? *The Round Table. The Commonwealth Journal of International Affairs*, *104*(6), 715–726. doi: 10.1080/00358533.2015.1112101

Singh, P., & Mishra, R. (2019). Environmental Sustainability in Libraries Through Green Practices / Services. *Library Philosophy and Practice (e-journal)*, article 2312. Retrieved from `https://digitalcommons.unl.edu/libphilprac/2312`

Spink, A. (1995a). Digital Libraries and Sustainable Development? In *Proceedings of Digital Libraries, DL '95, Austin, TX, June 11-13, 1995* (pp. 1–7). College Station, TX: Tamu.

Spink, A. (1995b). Information and a Sustainable Future. *Libri*, *45*(3-4), 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), 1–9. Retrieved from `http://informationr.net/ir/5-1/paper65.html`

Sriskandarajah, D. (2018). A People's Agenda: Citizen Participation and the SDGs. In R. Desai, H. Kato, H. Kharas, & J. McArthur (Eds.), *From Summits to Solutions: Innovations in Implementing the Sustainable Development Goals* (pp. 302–317). Washington, DC: Brookings Institution Press.

Stock, W. G. (2011). Informational Cities: Analysis and Construction of Cities in the Knowledge Society. *Journal of the American Society for Information Science and Technology*, *62*(5), 963–986. doi: 10.1002/asi.21506

Studentcompetitions. (2012). *Open Stockholm Award Winners Bring Stockholm Closer Towards Vision 2030*. Retrieved November 28, 2014, from `studentcompetitions.com/posts/open-stockholm-award-winners-bring-stockholm-closer-towards-vision-2030`

Sunlight Foundation. (2017). *Ten Principles for Opening Up Government Information.* Retrieved October 1, 2018, from `https://sunlightfoundation.com/policy/documents/ten-open-data-principles/`

Tan, S., & Brown, J. (2005). The World Café in Singapore: Creating a Learning Culture Through Dialogue. *Journal of Applied Behavioral Science*, *41*(1), 83–90. doi: 10.1177/

0021886304272851

Thongmak, M. (2013). A Systematic Framework for Sustainable ICTs in Developing Countries. *International Journal of Information Technologies and Systems Approach*, *6*(1), 1–19. doi: 10.4018/jitsa.2013010101

Tilson, D., Sorensen, C., & Lyytinen, K. (2012). Change and Control Paradoxes in Mobile Infrastructure Innovation: The Android and iOS Mobile Operating Systems Cases. In *Proceedings of the 45th Hawaii International Conference on System Sciences, HICSS 2013, Wailea, HI, January 7-10* (pp. 1324–1333). Washington, DC: IEEE Computer Society.

Tirado-Valencia, P., Rodero-Cosano, M. L., Ruiz-Lozano, M., & Rios-Berjillos, A. (2016). Online Sustainability Information in European Local Governments. *Online Information Review*, *40*(3), 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), 21–23. doi: 10.1108/LHTN-07-2014-0059

Trimi, S., & Sheng, H. (2008). Emerging Trends in M-Government. *Communications of the ACM*, *51*(5), 53–58. doi: 10.1145/1342327.1342338

Uhegbu, A. N., & 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), 35–44. doi: 10.1108/00242530610641772

Umweltbibliothek Chemnitz. (2019). *Umweltbibliothek und Dritte-Welt-Archiv Chemnitz.* Retrieved August 6, 2019, from `https://umweltbibliothek-chemnitz.de/bibliothek-und-dwa.html`

UNESCO. (2017). *Education for Sustainable Development Goals: Learning Objectives.* Retrieved August 15, 2018, from `https://unesdoc.unesco.org/ark:/48223/pf0000247444`

United Nations. (2015a). *Goal 16: Promote Just, Peaceful and Inclusive Societies.* Retrieved October 13, 2019, from `https://www.un.org/sustainabledevelopment/peace-justice/`

United Nations. (2015b). *Millennium Development Goals.* Retrieved April 4, 2020, from `https://www.un.org/millenniumgoals/`

United Nations. (2015c). *Sustainable Development Goals.* Retrieved January 5, 2018, from `http://www.un.org/sustainabledevelopment/sustainable-development-goals/`

United Nations. (2015d). *Transforming Our World: The 2030 Agenda for Sustainable Development.* Retrieved January 8, 2019, from `https://sustainabledevelopment.un.org/`

content/documents/21252030AgendaforSustainableDevelopmentweb.pdf

United Nations. (2016a). *The New Urban Agenda.* Retrieved March 3, 2020, from `http://habitat3.org/the-new-urban-agenda`

United Nations. (2016b). *The Sustainable Development Agenda.* Retrieved October 13, 2019, from `http://www.un.org/sustainabledevelopment/development-agenda/`

United Nations. (2018). *Sustainable Development Goal 17.* Retrieved April 3, 2019, from `https://sustainabledevelopment.un.org/sdg17`

United Nations. (2019). *World Urbanization Prospects: The 2018 Revision.* New York, NY: United Nations. Retrieved August 1, 2018, from `https://population.un.org/wup/Publications/Files/WUP2018-Report.pdf`

United Nations Statistics Division. (2017). *IAEG-SDGs. Inter-Agency Expert Group on SDG Indicators.* Retrieved October 1, 2018, from `https://unstats.un.org/sdgs/iaeg-sdgs/`

van der Waal, S., Węcel, K., Ermilov, I., Janev, V., Milošević, U., & Wainwright, M. (2014). Lifting Open Data Portals to the Data Web. In S. Auer, V. Bryl, & S. Tramp (Eds.), *Linked Open Data — Creating Knowledge out of Interlinked Data* (pp. 175–195). Berlin, Germany: Springer.

van Eck, N. J., & Waltman, L. (2010). Software Survey: VOSviewer, a Computer Program for Bibliometric Mapping. *Scientometrics*, *84*, 523–538. doi: 10.1007/s11192-009-0146-3

Venkatesh, V., Sykes, T. A., & Venkatraman, S. (2014). Understanding e-Government portal use in rural India: Role of demographic and personality characteristics. *Information Systems Journal*, *24*(3), 249–269.

Vera-Baceta, M. A., Thelwall, M., & Kousha, K. (2019). Web of Science and Scopus Language Coverage. *Scientometrics*, *121*, 1803–1813. doi: 10.1007/s11192-019-03264-z

Vetter, A. (2009). Citizens Versus Parties: Explaining Institutional Change in German Local Government, 1989-2008. *Local Government Studies*, *35*(1), 125–142. doi: 10.1080/03003930802574524

Wagner, C. S., Whetsell, T. A., & Leydesdorff, L. (2017). Growth of International Collaboration in Science: Revisiting Six Specialties. *Scientometrics*, *110*, 1633–1652. doi: 10.1007/s11192-016-2230-9

Watson, R. T., Boudreau, M.-C., & Chen, A. J. (2010). Information Systems and Environmentally Sustainable Development: Energy Informatics and New Directions for the IS

Community. *MIS Quarterly*, *34*(1), 23–38. doi: 10.2307/20721413

WCED. (1987). *Report on the World Commission on Environment and Development. Our Common Future.* Oxford, UK: Oxford University Press. Retrieved August 5, 2018, from `http://www.un-documents.net/our-common-future.pdf`

Weisbord, M. R., & Janoff, S. (1996). Future Search: Finding Common Ground in Organizations and Communities. *Systems Practice*, *9*(1), 71–84. doi: 10.1007/BF02173419

Werner, K. U. (2013). Sustainable Buildings, Equipment, and Management. A Checklist. In P. Hauke, K. Latimer, & K. U. Werner (Eds.), *The Green Library - Die grüne Bibliothek. IFLA Publications, Nr 161* (pp. 395–404). Berlin/Munich, Germany: De Gruyter, Saur.

Wiersum, K. F. (1995). 200 Years of Sustainability in Forestry: Lessons from History. *Environmental Management*, *19*(3), 321–329. doi: 10.1007/BF02471975

World Bank Data Team. (2018). *The 2018 Atlas of Sustainable Development Goals: An All-new Visual Guide to Data and Development.* Retrieved October 1, 2018, from `http://blogs.worldbank.org/opendata/2018-atlas-sustainable-development-goals-all-new-visual-guide-data-and-development`

World Wide Web Foundation. (2015). *Open Data Barometer. ODB Methodology.* Retrieved October 1, 2018, from `https://opendatabarometer.org/2ndEdition/about/method.html`

Yeh, A. G.-O., & Li, X. (1998). Sustainable Land Development Model for Rapid Growth Areas Using GIS. *International Journal of Geographical Information Science*, *12*(2), 169–189. doi: 10.1080/136588198241941

Zhang, J., Liu, H., Sayogo, D. S., Picazo-Vela, S., & Luna-Reyes, L. (2016). Strengthening Institutional-based Trust for Sustainable Consumption: Lessons for Smart Disclosure. *Government Information Quarterly*, *33*(3), 552–561. doi: 10.1016/j.giq.2016.01.009

Zhu, J., & Hua, W. (2017). Visualizing the Knowledge Domain of Sustainable Development Research Between 1987 and 2015: A Bibliometric Analysis. *Scientometrics*, *110*, 893–914. doi: 10.1007/s11192-016-2187-8