



Delft University of Technology

Open Data Exposed

van Loenen, Bastiaan; Vancauwenberghe, Glenn; Cromptvoets, Joep; Dalla Corte, Lorenzo

DOI

[10.1007/978-94-6265-261-3_1](https://doi.org/10.1007/978-94-6265-261-3_1)

Publication date

2018

Document Version

Final published version

Published in

Open Data Exposed

Citation (APA)

van Loenen, B., Vancauwenberghe, G., Cromptvoets, J., & Dalla Corte, L. (2018). Open Data Exposed. In B. Van Loenen, G. Vancauwenberghe, & J. Cromptvoets (Eds.), *Open Data Exposed* (pp. 1-10). (Information Technology and Law Series; Vol. 30). TMC Asser Press. https://doi.org/10.1007/978-94-6265-261-3_1

Important note

To cite this publication, please use the final published version (if applicable). Please check the document version above.

Copyright

Other than for strictly personal use, it is not permitted to download, forward or distribute the text or part of it, without the consent of the author(s) and/or copyright holder(s), unless the work is under an open content license such as Creative Commons.

Takedown policy

Please contact us and provide details if you believe this document breaches copyrights. We will remove access to the work immediately and investigate your claim.

Green Open Access added to TU Delft Institutional Repository

'You share, we take care!' - Taverne project

<https://www.openaccess.nl/en/you-share-we-take-care>

Otherwise as indicated in the copyright section: the publisher is the copyright holder of this work and the author uses the Dutch legislation to make this work public.

Chapter 1

Open Data Exposed



**Bastiaan van Loenen, Glenn Vancauwenberghe, Joep Crompvoets
and Lorenzo Dalla Corte**

Contents

1.1 Introduction.....	1
1.2 Definition and Principles of Open Data.....	3
1.3 Open Data Ecosystem and Open Data Infrastructures	4
1.4 Outline of the Book.....	7
References	9

Keywords Open data · Open data infrastructure · Open data ecosystem

1.1 Introduction

This book is about open data, i.e. data that does not have any barriers in the (re)use. Open data aims to optimize access, sharing and using data from a technical, legal, financial, and intellectual perspective. Data increasingly determines the way people live their lives today. Nowadays, we cannot imagine a life without real-time traffic information about our route to work, information of the daily news or information

B. van Loenen (✉) · G. Vancauwenberghe · L. Dalla Corte
Faculty of Architecture and the Built Environment, Knowledge Centre Open Data,
Delft University of Technology, Delft, The Netherlands
e-mail: b.vanloenen@tudelft.nl

G. Vancauwenberghe
e-mail: g.vancauwenberghe@tudelft.nl

L. Dalla Corte
e-mail: l.dallacorte@tudelft.nl

J. Crompvoets
Public Governance Institute, KU Leuven, Leuven, Belgium
e-mail: joep.crompvoets@kuleuven.be

L. Dalla Corte
Tilburg University (TILT), Tilburg, The Netherlands

© T.M.C. ASSER PRESS and the authors 2018

B. van Loenen et al. (eds.), *Open Data Exposed*, Information Technology and Law
Series 30, https://doi.org/10.1007/978-94-6265-261-3_1

about the local weather. At the same time, citizens themselves now are constantly generating and sharing data and information via many different devices and social media systems. Especially for governments, collection, management, exchange, and use of data and information have always been key tasks, since data is both the primary input to and output of government activities. Also for businesses, non-profit organizations, researchers and various other actors, data and information are essential.

It is estimated that 90% of the world's data was just generated in the past two years.¹ Where in the past the entire data collection of the globe would fit a single memory stick of 8 Gb, in 2013 it was estimated that the world creates 2.5 quintillion bytes of data daily,² totalling a 2.7 Zettabytes³ of data existing in the digital universe.⁴ While in the past government data were regarded as being among the largest creators and collectors of data in many different domains,⁵ this is anno 2018 not the case anymore.⁶ The majority of the Zettabytes that are collected on a daily basis, often through citizens,⁷ are in the private domain.⁸

Since data is so critical for a well-functioning society,⁹ access to the data should be optimised. One way of arriving at such an ideal position is to open data. While the concept of making data freely available for the common good originally stems from the academic community¹⁰—many years before the creation of the internet—in recent years especially governments have been active in setting up open data initiatives and making their data available as open data on the web. Although there are also movements towards open commercial data, open research data and open science,¹¹ and open data provided by citizens, this book's focus is on open government data, which still makes up the majority of open data. Therefore, open data mainly translates into open government data in this book, unless otherwise indicated.

The main objective of this book on open data is to expose key aspects that have a relevance when dealing with open data and to provide appealing examples of how open data is implemented worldwide. This chapter first provides a definition of open data and discusses the values associated with open data. The chapter also introduces the reader to the central concepts of open data infrastructures and the open data ecosystem, and ends with the outline of the book.

¹ IBM 2016; SINTEF 2013.

² Jacobson 2013.

³ A Zettabyte equals 1 billion Terabytes. A Terabyte equals 1000 Gigabytes.

⁴ Karr 2012; see also DOMO 2017.

⁵ Janssen 2011.

⁶ Mulcahy 2017.

⁷ See Montargil and Santos 2017.

⁸ See Kelly 2012.

⁹ See also Castells and Himanen 2002.

¹⁰ See Chignard 2013: The term open data appeared for the first time in 1995, in a document from an American scientific agency (see National Research Council 1995).

¹¹ See for the Findable, Accessible, Interoperable and Reusable (FAIR) principles of open science: Wilkinson et al. 2016.

1.2 Definition and Principles of Open Data

Open data is data that can be accessed, shared, used and reused without any barrier for any type of (re)user. According to the Open Definition,¹² open data can be defined as *data that be freely used, modified, and shared by anyone for any purpose subject, at most, to measures that preserve provenance and openness*.¹³ Open data requires datasets to be either in the public domain, or distributed through an open license. The data must be provided as a whole, free of charge, and preferably downloadable via the Internet, including any additional information that might be necessary to comply with the open license's terms. Openness requires the data to be provided in a readily machine-readable form. The format must be open as well, meaning that it does not place any restriction upon its use, and that the files in that format can be processed with open-source software tools.

The Open Definition speaks broadly of open 'works', rather than of open data. Focusing on data *tout court*, one can move from the Open Government Data¹⁴ (OGD) principles. According to the OGD principles, which are arguably foundational in understanding the concept of open data, data must be: Complete;¹⁵ Primary;¹⁶ Timely;¹⁷ Accessible;¹⁸ Machine-processable;¹⁹ Non-discriminatory;²⁰

¹² 'Open Definition 2.1'. <http://opendefinition.org/>. Accessed May 2018.

¹³ 'Open Definition 2.1'. <http://opendefinition.org/>. Accessed May 2018. Please note that the attribution and sharealike requirements are possible limitations in the use, therefore not strictly adhering to the 'without any barrier' requirement of open data (see further Chap. 6 of this book).

¹⁴ As pointed out by the principles' authors, "(t)here are many definitions of "open" and this is but one. The 2007 working group's definition sits at the unique intersection of open government and open data and has United States sensibilities"—Dietrich et al. 2007.

¹⁵ Open data must be the default setting for governmental data releases, provided that said data is of a public nature, meaning that it must not be subject to valid privacy, security or other legitimate and legally sanctioned limitations. Moreover, while some resources are by now digital by default, some other artefacts are not: in the latter case, they should be made digitally available to the maximum extent possible.

¹⁶ I.e. collected at its very source, and as granular as possible; entities obtaining the original dataset, processing it, and publishing it in a modified (e.g. aggregated) form, should have the obligation to publish the original data set in its default format, thus contributing in preserving it for posterity.

¹⁷ Each piece of information has its own lifecycle, and the accuracy—and therefore the utility—of a dataset partly depends on the time lapsed from the dataset's creation. Timeliness, therefore, means that government data should be released as early as possible, to preserve the data's value.

¹⁸ Data must be accessible to the widest possible number of users for the widest possible array of purposes. Accessibility is deemed to be lacking if the data is not accessible through automated means, due to technological, policy, or other kinds of restrictions.

¹⁹ As following from the accessibility principle above, data must be machine-readable and processable, and thus in a widely used, normalized and sufficiently documented format.

²⁰ I.e. available to anyone, for any purpose, without access control, 'walled gardens', or other gatekeeping activities that might lead to differences in accessing information.

Non-proprietary,²¹ and License-free.²² Compliance with the OGD principles needs to be demonstrable, i.e. there need to be accountability measures in place to allow the review of the adherence to the principles above.

The concepts of Open Work and open data highlight how data needs to be both *legally, technically and financially* open,²³ so either in the public domain or covered by an open license, and kept in a machine-readable and non-proprietary format. Open data aims at making information available to everybody, for any purpose, in a machine-readable and interoperable format, based on open standards and digestible by *free/libre* open source software (FLOSS).²⁴ Also with respect to the financial accessibility open data is data available free of charge. Marginal costs of dissemination are accepted by some as a reasonable cost for users. However, open data is data that can be accessed and reused without any barrier for any type of reuse, and some user groups experience any price to be paid as a barrier.²⁵

1.3 Open Data Ecosystem and Open Data Infrastructures

In this book we consider open data as part of a bigger system that has been referred to as the open data ecosystem.²⁶ An ecosystem can be defined as “a system of people, practices, values, and technologies in a particular local environment”.²⁷ Ecosystems consist of interacting, relatively tightly connected components with substantial interdependencies. However, the specific components vary from ecosystem to ecosystem. Recently, the concept was also introduced in open data practice and research, and several scholars started to explore how the concept can be a valuable heuristic for understanding and approaching open data practices and initiatives.²⁸ It was Rufus Pollock who coined the concept of the open data ecosystem in 2011.²⁹ Pollock argued that we should transform our one way open data streets towards an ecosystem where data is cycled and recycled among producers and users with a prominent role for info-mediaries.³⁰ Such an ecosystem should thrive on collaboration, componentization

²¹ No entity should have exclusive control over the data format employed. As several proprietary formats are widely used, and conversely some open formats have a narrow user base, the decision of releasing a dataset in both widely used proprietary formats and in less used but open formats is compliant with the principle in discussion, as long as the *only* format used is not a proprietary one.

²² I.e. not subject to limitations deriving from IP rights, thus either in the public domain or disciplined by an open license.

²³ See Carrara et al. 2016.

²⁴ See Kulk and Van Loenen 2012; Van Loenen et al. 2016.

²⁵ See Welle Donker 2016.

²⁶ Pollock 2011; Harrison et al. 2012; Zuiderwijk et al. 2014; Jetzek 2017; Styin et al. 2017.

²⁷ Nardi and Day 1999.

²⁸ See e.g. Heimstädt et al. 2014; Zuiderwijk et al. 2014; Styin et al. 2017.

²⁹ Pollock 2011.

³⁰ See also Jetzek 2017: Stressing that the open data ecosystem should be circular in nature.

and open data.³¹ Since Pollock's approach, other approaches emerged,³² often within the context of open government data.³³ Some scoped the ecosystem purely technical by addressing the optimisation of the data provision to promote use.³⁴ Others argued that the ecosystem would comprise "an active network, facilitating interaction and communication amongst everybody interested and/or involved in open data and the re-use of information and data, internal, as well as external to the organisation".^{35,36} In Dawes approach, the open data ecosystem fulfils a communication or networking platform where stakeholders in the system can meet, greet and interact.³⁷ Further, the mutual interdependency of the different stakeholders in the ecosystem creates a common responsibility: only together can they make or break the system.³⁸

Although the concept of the open data ecosystem is not fully developed as of today, and its applicability to open data may be questioned, what is central "to the ecosystems metaphor is the recognition that users, technology innovators, and government leaders, data managers, and policy makers are mutually interdependent in developing this business efficiently, effectively, and in ways calculated to bring value to all participants".³⁹ An open data ecosystem can be considered as a cyclical, sustainable, demand-driven environment oriented around agents that are mutually interdependent in the creation and delivery of value from open data.⁴⁰ However, such an ecosystem cannot function properly without a foundation, the infrastructure that fulfils the basic requirements of the ecosystem. Whilst the ecosystem especially allows niche uses (specialised communities of use) to emerge,⁴¹ the infrastructure seeks to support the widest possible range of uses of the data.

In her work on open data infrastructures, Zuiderwijk defined this infrastructure as "a shared, (quasi-) public, evolving system, consisting of a collection of interconnected social elements (e.g. user operations) and technical elements (e.g. open data analysis tools and technologies, open data services) which jointly allow for OGD use".⁴² In this perspective the infrastructure is regarded "as a central place where researchers can find

³¹ Pollock 2011.

³² Ubaldi (2013) argues that the open data ecosystem consists of three interacting ecosystems: the data provider ecosystem, the data user ecosystem and the infomediary ecosystem.

³³ See, for example, Ubaldi 2013; Dawes et al. 2016; Harrison et al. 2012.

³⁴ Zuiderwijk et al. 2014.

³⁵ Share PSI 2.0 Best Practice: Establish an Open Data Ecosystem, 25 July 2016 [on line] available at: <https://www.w3.org/2013/share-psi/bp/eode/>. Accessed May 2018.

³⁶ See also Dawes et al. 2016; Ubaldi 2013; Harrison et al. 2012.

³⁷ Such ecosystem may exist at different levels of scale: within an organisation, a country, region or the worldwide open data ecosystem, in a specific domain (see Zuiderwijk 2015). Open data ecosystems may also involve multiple levels, namely a data producer and a data user level, with between the infomediaries level connecting the two (Ubaldi 2013; Jetzek 2017).

³⁸ Cf. Harrison et al. 2012.

³⁹ Harrison et al. 2012.

⁴⁰ Boley and Chang 2007; Harrison et al. 2012.

⁴¹ Davies 2010; cf. the concepts of infrastructures and business systems in Chan et al. 2001.

⁴² Zuiderwijk 2015.

and use the data published by OGD providers, where they can use integrated tools, and where they can interact with OGD providers and policy makers to discuss their findings from open data use.”⁴³ The function of this concept is rather that of an online platform than of an information infrastructure. A similar view is provided by Janssen et al. stating that open data publication requires “an infrastructure which is able to handle the data in an easy-to-use way to lower the user threshold. [...] Such an infrastructure should have facilities for the discovery, curation, provenance, analyzation, and visualization of data”.⁴⁴ Others defined an information infrastructure as “a technical framework of computing and communications technologies, information content, services, people, all of which interact in complex and often unpredictable ways”.⁴⁵ However, infrastructure encompasses much more than just the technical bit: it is people, it is laws, it is the education to be able to use systems, it is the policies, governance mechanisms and the funding structures.⁴⁶ In the context of physical infrastructures, Robert Pepper of the US Federal Communications Commission⁴⁷ explained that: “If you think about the highway system, we tend to think about bridges and interstates, but the infrastructure also includes the highway laws, drivers’ licenses, McDonalds along the roadside, gas stations, the people who cut the grass along the highways, and all of those support systems”.

In this book, we consider an open data infrastructure as the basic physical and organisational structure and facilities needed for the functioning of an open data ecosystem. As such we regard it as a social and technical construct.⁴⁸ In addition to the pure technical aspects of providing access through ftp, API, or otherwise to the datasets and their metadata, it also inhibits non-technical aspects such as the open data policies, and governance and funding structures. Like any infrastructure, the open data infrastructure has typical dimensions that are paramount to the success of open data ecosystems: users, providers, technical aspects (standards,⁴⁹ access networks),⁵⁰ legal/ policy framework dimensions,⁵¹ the funding dimension and the governance⁵² of the infrastructure connecting the users, user communities (like developers, universities, private sector) and providers of the open data.⁵³ The ecosystem builds on the infrastructure and is “made up of a series of interrelated tools and services that rely on one or more elements of the infrastructure either directly, or through intermediary tools and services, for their sustained operation”.⁵⁴ Davies argues that developing an

⁴³ Zuiderwijk 2015.

⁴⁴ Janssen et al. 2012.

⁴⁵ Borgman 2000, p. 30.

⁴⁶ Coleman and McLaughlin 1997.

⁴⁷ Coleman and McLaughlin 1997.

⁴⁸ Star and Ruhleder 1996, p. 113.

⁴⁹ Zuiderwijk et al. 2014.

⁵⁰ Zuiderwijk et al. 2014; Ubaldi 2013.

⁵¹ Ubaldi 2013; Harrison et al. 2012; World Bank 2015.

⁵² Harrison et al. 2012.

⁵³ See also World Bank 2015; Williamson et al. 2003.

⁵⁴ Davies 2010.

ecosystem around an open dataset might be taken up entirely by third parties (other than public organisations).⁵⁵ The European Commission sticks with different wording to the same concept: government should provide the infrastructure that should support business development.⁵⁶

1.4 Outline of the Book

The book is divided into four main parts. Together with this general introduction, the second chapter, in which the historical background of open data is discussed, forms a first introductory part of this book. In the second part of the book, which consists of Chaps. 3–8, various key components of open data infrastructures are addressed. The third part of the book, containing Chaps. 10–13, provides several cases studies on open data initiatives and infrastructures worldwide. The book ends with a final chapter in which current and future open data developments are critically discussed.

In this first introductory chapter of the book, we provided a definition of open data, discussed the main principles and values of open data, and introduced the reader into the central concepts of open data infrastructures and the open data ecosystem. The second chapter by Lorenzo Dalla Delta complements this first chapter, by providing a historical overview on open data. The concept of open data as we know it today is the result of several different initiatives, promoted by a wide range of actors, both of a legislative and non-legislative nature. Numerous regulatory antecedents meant to foster the concept of open data and to embed it in national and international policy agendas have been undertaken on both sides of the Atlantic, and also at a super-national level. He concludes that the striving towards openness can be characterised by different priorities and undertones, like public sector information reuse and economic growth in the EU, or transparency and accountability in the US, but its general principles are widely and internationally shared. Throughout Chaps. 3–9, different key components of open data initiatives and open data infrastructures are further discussed. In the first two chapters, the focus is on the main stakeholders involved in the implementation of these infrastructures, i.e. the user (Chap. 3) and the data provider (Chap. 4). Chapter 3 puts the user of open data central and explores the open data users, mentioned by many but considered by few. In this chapter, Bastiaan van Loenen argues that there no such thing as a single typical user making it very difficult to develop user oriented open data policies. Chapter 4 addresses open data developments from the perspective of the data providers, with a particular focus on the issue of funding open data. In this chapter the change process from cost recovery towards open data is explained and discussed by Frederika Welle Donker. She addresses the tension field between lost

⁵⁵ See also O'Reilly 2010: Arguing that greater government involvement could increase the vitality of an infrastructure. "But if the lesson is correctly learned, it should do so not by competing with the private sector to deliver [...] services, but by investing in infrastructure (and "rules of the road") that will lead to a more robust private sector ecosystem."

⁵⁶ European Commission DG CONNECT A European strategy on the data value chain.

revenue due to open data and maintain adequate data service quality in the context of a sustainable business model for open government data. Chapter 5 introduces and discusses the governance of open data initiatives as a key component in the implementation of open data. Building further on the public administration literature on coordination and governance in the public sector, Glenn Vancauwenberghe and Joep Crompvoets develop a framework for analysing the governance of open data initiatives, and use this framework to present examples of the use of various governance instruments for governing open data initiatives worldwide.

In the early years of open data, users were often confronted with unique complex restrictive licences in local languages which were not compatible with other licences. Although there has been significant work accomplished in the domain of harmonising licences, including open data licences, many countries still develop and use their own national version of an open licence. Users may wonder why countries and organisations do not use one single licencing framework across the globe. In Chap. 6, Alexandra Giannopoulou argues that it is, from a legal perspective, not as simple as it may look like due to internal and external legal interoperability issues. Open data interests also have to be balanced with other competing interest. Two of these competing interests are privacy and data protection. In Chap. 7, Lorenzo Dalla Corte identifies the relevance of distinguishing these two rights. He arrives at a complex mix of different types of information including private personal data, non-private personal data and non-private personal data that can be opened. The performance of open data and open data initiatives is addressed in Chap. 8, in which Glenn Vancauwenberghe discusses the different dimensions of open data assessments, and analyses the differences and similarities in existing open data assessments. The technological components of open data infrastructures are considered in Chap. 9. In this chapter, Stanislav Ronzhin, Erwin Folmer and Rob Lemmens use the five star model of Tim Berners Lee to explain the technological challenges of open data. They argue that linked (open) data provides the needed mechanisms and conventions for seamless integration of semantically heterogeneous datasets.

Although open data initiatives and infrastructures have been developed at different administrative levels, especially at the national level much effort is done to implement open data and coordinate the efforts and activities of different stakeholders. To give the reader better insight in past and ongoing open data initiatives, and the way the different components of open data discussed in this book are implemented, the book also highlights and investigates open data implementations in four different countries. In Chap. 10, Glenn Vancauwenberghe and Jamie Fawcett present the history of open data in the United Kingdom, starting from the very first steps towards open data in the 90s to the most recent developments. Chapter 11 by Bastiaan van Loenen focuses on the Netherlands, one of the frontrunners worldwide in opening spatial data. In Chap. 12, Xue Mei looks at open data developments in China, a country where especially at the local level many data have been opened by government. The fourth country explored in this book is Indonesia. In Chap. 13, Agung Indrajit explores how this emerging economy is embracing open data.

The final chapter of this book, Chap. 14, demonstrates that current developments towards open data, which can be referred to as the democratisation of data, is resulting in a very small number of data companies having access to a significant portion of data

available globally including open government data, without sharing this data with society. Hendrik Ploeger and Bastiaan van Loenen argue that this skewed balance in the information position of government, citizens and the (big) data companies may result in a data dictatorship dominating our information societies in the coming decades. Therefore they hold that the current open data system should be revolutionised from the democratisation of data available to the happy few into a data democracy for all.

References

- Boley H, Chang E (2007) *Digital Ecosystems: Principles and Semantics*. 2007 Inaugural IEEE International Conference on Digital Ecosystems and Technologies, Cairns, Australia, February
- Borgman CL (2000) *From Gutenberg to the Global Information Infrastructure; Access to Information in the Networked World*. The MIT Press, Cambridge, Massachusetts
- Carrara W, Oudkerk F, van Steenbergen E, Tinholt D (2016) *Open Data Goldbook for Data Managers and Data Holders*. <https://www.europeandataportal.eu/sites/default/files/goldbook.pdf>. Accessed May 2018
- Castells M, Himanen P (2002) *The Information Society and the Welfare State; The Finnish Model*. Oxford University Press, Oxford
- Chan TO, Feeney M-E, Rajabifard A, Williamson I (2001) The Dynamic Nature of Spatial Data Infrastructures: A Method of Descriptive Classification. *GEOMATICA* 55(1):65–72
- Chignard S (2013) A brief history of Open Data. *Paris Innovation Review*. <http://paris-innovationreview.com/articles-en/a-brief-history-of-open-data>. Accessed May 2018
- Coleman DJ, McLaughlin J (1997) Defining global geospatial data infrastructure (GGDI): Components, Stakeholders and Interfaces. *Global Spatial Data Infrastructure Conference*, Chapel Hill, North Carolina
- Davies T (2010) *Open Data: Infrastructures and ecosystems*. University of Southampton
- Dawes SS, Vidasova L, Parkhimovich O (2016) Planning and designing open government data programs: An ecosystem approach. *Government Information Quarterly* 33(1):15–27
- Dietrich D, Gray J, McNamara T, Poikola A, Pollock R, Tait J, Zijlstra T (2007) *The Open Data Handbook*. <http://opendatahandbook.org>. Accessed May 2018
- DOMO (2017) *Data Never Sleeps 5.0*. https://www.domo.com/learn/data-never-sleeps-5?aid=ogsm072517_1&sf100871281=1. Accessed May 2018
- European Commission (DG CONNECT) (2013) *A European strategy on the data value chain*
- Harrison TM, Pardo TA, Cook M (2012) Creating open government ecosystems: A research and development agenda. *Future Internet* 4(4):900–928
- Heimstädt M, Saunderson F, Heath T (2014) From Toddler to Teen: Growth of an Open Data Ecosystem. A Longitudinal Analysis of Open Data Developments in the UK. *JeDEM - Journal of eDemocracy & Open Government* 6(2):123–135
- IBM (2016) *10 Key Marketing Trends for 2017 and Ideas for Exceeding Customer Expectations*
- Jacobson R (2013) 2.5 quintillion bytes of data created every day. How does CPG & Retail manage it? <https://www.ibm.com/blogs/insights-on-business/consumer-products/2-5-quintillion-bytes-of-data-created-every-day-how-does-cpg-retail-manage-it/>. Accessed May 2018
- 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
- Janssen M, Charalabidis Y, Zuidewijk A (2012) Benefits, Adoption Barriers and Myths of Open Data and Open Government. *Information Systems Management* 29(4):258–268
- Jetzek T (2017) *Innovation in the Open Data Ecosystem: Exploring the Role of Real Options Thinking and Multi-sided Platforms for Sustainable Value Generation through Open Data*. Chapter in

- Analytics, Innovation, and Excellence-Driven Enterprise Sustainability. Part of the series Palgrave Studies in Democracy, Innovation, and Entrepreneurship for Growth, pp. 137–168
- Karr D (2012) Big Data Brings Marketing Big Numbers. <https://martech.zone/ibm-big-data-marketing/>. Accessed May 2018
- Kelly J (2012) Taming Big Data [A Big Data Infographic]. <http://wikibon.org/blog/taming-big-data/>. Accessed May 2018
- Kulk S, van Loenen B (2012) Brave New Open Data World? International Journal of Spatial Data Infrastructures Research 7:196–206
- Montargil F, Santos V (2017) Communication with Citizens in the First EU Citizen Observatories Experiences. Conference Proceedings European Conference on Digital Government, Lisbon
- Mulcahy M (2017) Big Data – Are You In Control? <https://www.waterfordtechnologies.com/big-data-interesting-facts/>. Accessed May 2018
- Nardi B, Day V (1999) Information Ecologies: Using Technology with Heart - Chapter Four: Information Ecologies. First Monday
- National Research Council (1995) On the Full and Open Exchange of Scientific Data. The National Academies Press, Washington DC
- O'Reilly T (2010) Government as a Platform. In: Lathrop D, Ruma L (eds) Open Government: Collaboration, Transparency, and Participation in Practice. O'Reilly Media, Sebastopol, pp. 11–39
- Pollock R (2011) Building the (Open) Data Ecosystem. <https://blog.okfn.org/2011/03/31/building-the-open-data-ecosystem>. Accessed May 2018
- Share PSI 2.0 Best Practice: Establish an Open Data Ecosystem. <https://www.w3.org/2013/share-psi/bp/eode/>. Accessed May 2018
- SINTEF (2013) Big Data, for better or worse. 90% of world's data generated over last two years. ScienceDaily, 22 May
- Star SL, Ruhleder K (1996) Steps Toward an Ecology of Infrastructure: Design and Access for Large Information Spaces. Information Systems Research 7(1):111–134
- Styrin E, Luna-Reyes L, Harrison TM (2017) Open data ecosystems: An international comparison. Transforming Government: People, Process and Policy 11(1):132–156. <https://doi.org/10.1108/TG-01-2017-0006>
- Ubaldi B (2013) Open Government Data: Towards Empirical Analysis of Open Government Data Initiatives. OECD Working Papers on Public Governance 22. OECD Publishing
- Van Loenen B, Kulk S, Ploeger H (2016) Data Protection Legislation: A Very Hungry Caterpillar: The Case of Mapping Data in the European Union. Government Information Quarterly 33(2):338–345
- Welle Donker FM (2016) From access to re-use: a user's perspective on public sector information availability. PhD thesis, Delft University of Technology
- Wilkinson MD et al. (2016) The FAIR Guiding Principles for scientific data management and stewardship. Sci Data, 2016 Mar 15;3:160018. <https://doi.org/10.1038/sdata.2016.18>
- Williamson I, Rajabifard A, Feeney M-EF (2003) Developing Spatial Data Infrastructures: From Concept to Reality. Taylor and Francis, London
- World Bank (2015) Open Data Readiness Assessment – Part B: Methodology
- Zuiderwijk A (2015) Open data infrastructures: The design of an infrastructure to enhance the coordination of open data use. Doctoral thesis
- Zuiderwijk A, Janssen M, Davis C (2014) Innovation with open data: Essential elements of open data ecosystems. Information Polity 19(1–2):17–33