Experiences about opening data in private sector: a systematic literature review

Antti Herala, Erno Vanhala, Jari Porras and Timo Kärri
Lappeenranta University of Technology
Skinnarilankatu 34
53850 Lappeenranta, Finland
Email: {antti.herala; erno.vanhala; jari.porras; timo.karri}@lut.fi

***Abstract*—Open data has been described to, for example, reduce bureaucracy, remove corruption and lower the cost of a product. The discussion has mainly been over the data that has been provided by public organizations: governments, states, and municipalities. In this systematic literature review the aim is to see why private organizations would want to participate to open data initiative and how it would impact their operations. This study presents observed benefits and challenges as well as assumed implications. It was found out that the studied research is mainly speculative and observed results are shallow compared to the assumed and speculated benefits and problems.**

***Keywords*—Open data; Private organizations; Business change; Business impacts**

I. Introduction

Open data is gaining popularity as an initiative, especially in governmental organizations [1]. According to Masip-Bruin, open data is "*an approach to managing data so that it enables the structured free flow of non-sensitive information to those who have a need or interest in using it, both within and across government agencies and to the public. It allows different types of users to access, organize and use data in ways that make sense to them*" [2, p. 331]. With open data and open movement developing, there resides potential for changes in the ecosystems on how the data is processed, shared, and used [3]. In their study Geiger and von Lucke present three major changes of data handling [4, p. 186-187]:

- "*Everything is secret, if is not explicitly marked as public.*" –> "*Everything is public, if it's not explicitly marked as secret.*"
- "*Range and time of publication are determined by public authority. Often, inspection of files is on application, based on the Freedom of Information Act.*" –> "*All data not determined by qualified data privacy protection or data security are fully published, proactive and contemporary.*"
- "*Published data are permitted to be inspected for private use. Further usage is reserved and can be allowed on demand.*" –> "*Published data are usable by everybody for everything including commercial usage without any restrictions exempt from charges. This contains the possibility of editing and distributing of the public data.*"

While the public bodies hold vast amount of data, open data is required from private organizations in order to realize the full benefits [5]. For example in Earth observations open data is a de facto standard to use, since most of the data is applied by and for the public [6]. While the major discussion about open data is currently concentrated on governmental level [7], the private companies also need to have strategies and policies to harness the advantages of disclosure [5]. This phenomenon is partially explained by Jetzek when talking about open government data (OGD): "*When governments become open, the mechanisms that affect value generation and appropriation move beyond the traditional buyer-seller relationships; thus connections between the public and the private, as well as the social and the economic dimensions begin to emerge*" [3, p. 3]. The main objective of this study is to survey the existing literature on how the companies have benefited from open data and what negative effects they have suffered. The impacting segments are separated into two groups based on the perspective: assumptions and observations. The main focus are the observed impacts and assumptions are used to support and explain the nuances of the observations. This study found six beneficial and four detrimental impacts to companies from opening their data.

After the introduction, in the second section the research process is presented, followed by the research questions and the setting of the study in section three. The fourth section outlines the search: used databases, search terms, and the yield of the search. In the fifth section the findings are presented by starting from positive impacts and followed by negative impacts. Lastly the findings are discussed and the limitations of the study are outlined in the sixth section. The study is concluded in the seventh section.

II. Research process

This study follows the systematic mapping study guidelines introduced by Kitchenham and Charters [8]. This method was selected in order to gather and present a phenomenon in a thorough manner, especially since the topic has been a target of a biased conversation [7]. The systematic mapping research process has been illustrated by Petersen et al. [9] and presented in Figure 1.

The first step in the process of a systematic mapping study is to define and outline the topic. From the clear topic, a review scope can be created that will be used to conduct the research and categorize the search, which yields all the articles. The papers are then screened against the criteria set at the beginning of the research and only the relevant studies are included for the next step. When all the non-relevant articles are excluded

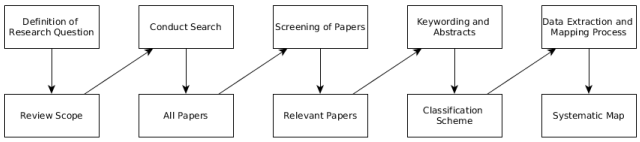

Fig. 1. Systematic mapping research process [9]

from the search, the remaining papers are keyworded from abstracts. Finally, after the classification scheme is placed, the selected studies are read carefully, the data concerning the research problem is extracted, and the systematic map can be constructed with the results in a suitable format.

III. Research questions

The landscape of open data currently requires scientific evidence about the benefits and negative effects for companies and their businesses to increase the understanding and participation in open data initiative [10]. The discussion about the topic has been biased between company representatives and open data experts, with little scientific evidence [11]. This mapping concentrates on two research questions:

- *What are the effects of opening their data to private sector?*
- *What are the open data perspectives of private sector in scientific literature?*

For the both technological and management goals of this study, the following databases were used: ACM Digital Library, IEEE Xplore Digital Library, Science Direct, ProQuest, EBSCO, and additionally Google Scholar. The aim is to find as many articles as possible from all the scientific areas, where open data has been published or is being considered for publishing. These databases offer articles from both governmental and private open data, focusing on the effects that open data can bring and has brought already.

In addition, to the organizational effects the papers were selected with additional requirements: 1) the article has to cover observed or assumed effects of open data instead of a list of possible barriers, 2) the article has to be peer-reviewed, 3) the language of the article has to be English and 4) full-text articles are required.

Two initial searches were conducted from February 2015 to March 2015 and an additional search was done in April 2015.

IV. Search

The search was done in three individual stages. Round 1 (R1) focused on the term *"open data" AND "private sector" AND ("impact" OR "effects")* from all search fields. In round 2 (R2) the search focused on the title-abstracts with more limited search term *("private sector" OR "effects") AND "open data")* in order to limit the search results. In addition to these two search rounds, the selected articles were collected and their references were mapped for additional information. The additional, reference-based search was conducted by extracting data from articles and if the data was referenced from a non-analyzed article, that paper was selected for further analysis. Those articles were searched from the predefined databases and additionally from Google Scholar, presented as Other in Table I. The additional search was used in order to cover as much previous research as possible. The results of the three stages of the search can be found on Table Search. Total of 347 articles were searched and it yielded 74 papers having few duplicates. The results are presented in Table I.

TABLE I. R1: *"open data" AND "private sector" AND ("impact" OR "effects")* FROM ALL FIELDS, R2: *("private sector" OR "effects") AND "open data"* FROM TITLE-ABSTRACT, ADDITIONAL SEARCH FROM PREVIOUS REFERENCES. NUMBERS ARE PRESENTED AS ACCEPTED / FOUND.

	ACM DL	IEEE Xplore	Science Direct	ProQuest	EBSCO	Other	
(R1)	17/29	0/0	12/122	6/83	1/2	0/0	36/236
(R2)	3/37	6/8	4/11	5/11	4/10	0/0	22/77
Ref. search	0/2	0/0	1/7	7/11	0/0	8/14	16/34
	20/68	6/8	17/140	18/105	5/12	8/14	74/347

The 347 title-abstracts of the papers were read in the search and 74 were accepted for further studying. Five duplicates were found in R2, after R1 was completed. The duplicates were dropped from the total count, leaving the final count to 69 individual articles. Out of the 69 articles, 21 were discarded after reading the full article. The major reason for the exclusion was the focus on technological aspects, such as implementations and effective delivery, instead of the effects of open data to the organization. In these papers the authors either analyzed or constructed systems to utilize open data from the technological point of view. Another reason was the focus on single governmental unit that constructed strategies for opening the data. This shows only possibilities for a singular entity without any concrete studies, evidence-based hypotheses, or necessary insights. In the end, out of 347 articles, 48 papers were fully read and selected for data extraction. The findings are presented in the next section.

V. Findings

The articles qualified for this study rely heavily onto the assumed propositions, while the studies showing concrete implications were considerably fewer. This is evident from Figure 2, where the papers are categorized by the number of impacts per article and the emphasis on the nature of the impacts: assumed or observed and positive or negative. In Figure 2 the assumed impacts are on the left side of y-axis and the observed impacts on the right side while the positive impacts are over the x-axis and the negative impacts below it. The position for x-axis was calculated by subtracting the number of assumed impacts from observed impacts, leaving the mainly assuming papers on the negative side of the axis and the mainly observing articles on the positive side. The position for y-axis was calculated by subtracting the number of negative impacts from positive impacts. The size of the bubble correlates the total number of mentioned impacts in the article.

The Figure 2 shows the current bias about open data: most of the papers are concentrating on the assumptions. Only a handful of studies present cases, where opening the data has brought any concrete impacts to the industry. Such examples are the cases of Nike and Levi-Strauss [12] and the industrial revolution in British isles [13]. Most of the

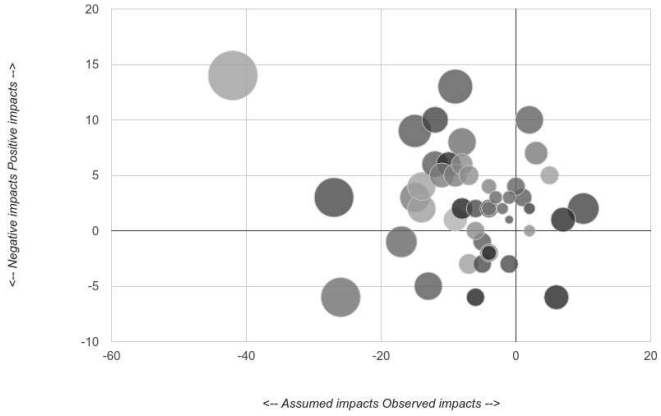

Fig. 2. Emphasis on positive and negative impacts (different levels of gray are for clarification).

positive impacts are assumed by various actors without actual references or research on how the use open data improves business. The negative impacts rely to assumptions as well by showing even fewer observed cases about the negative impacts of open data. Most of those papers suggest and warn about the negative effects hypothetically without experience, for example concerns about privacy infringements.

In Figure 3, the articles are presented individually to show the different emphasis they had. The figure confirms that the number of assumed impacts is higher than observed and some of the papers concentrate purely on assumptions. Some researchers, such as Nuvolari [13] and Tjoa [14] present only few observed impacts while for example, Janssen [7] present only assumptions as well as the largest number of impacts in an individual article in this study.

The collected impacts were analyzed in order to extract compact information from the initial data. The process that was used is as follows:

1) Impacts are divided into four categories: observed positive/negative, assumed positive/negative.
2) Positive and negative impacts are separated and the following steps are applied to both sets separately.
3) All of the impacts are clustered based on their attributes and the clusters are named with an abstracted topic that explains them with few words.
4) The clusters of assumed impacts are then clustered based on the clustered observed impacts and the result is presented in Table II (positive) and Table IX (negative).
5) The clustered observed impacts are illustrated with the articles and the clustered assumed impacts are abstracted into tables.

In Table II the clustered observed impacts are presented in the first row and in the parenthesis the corresponding table, where the assumptions are explained. Beneath the observed impacts in the columns are the clustered assumed impacts and after the assumed impacts in the parenthesis, the number of references in the articles. In some articles the collected individual impacts were categorized similarly and thus, the total number of impacts here and the number of all impacts in

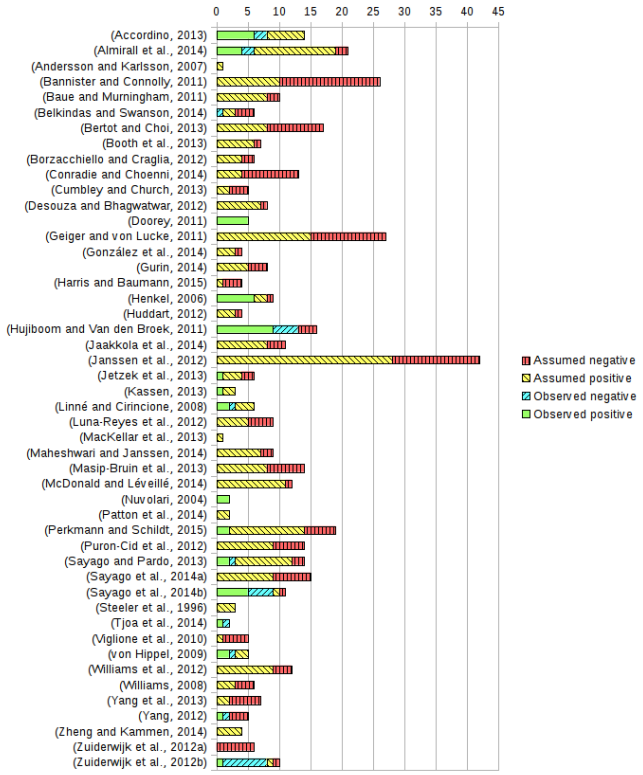

Fig. 3. Impact categories in mapped papers

Discussion differ. In the next section, the positive impacts are presented and negative impacts follow afterwards.

A. Findings providing positive impacts

1) Collaborative actions: As an example about opening data to collaboration, from the first industrial revolution Nuvolari [13] presents a case of Cornish pumping engines from 19th century. The study speaks about collaborative actions by mine managers, who released the information about their mining engines: technical characteristics, operating procedures and performance. The motivation for the publication was the current monopoly of one engine provider, who was able to block other steam technology development with a patent. After the patent expired, the market opened for other developers, which caused the current engines to be discarded and new versions developed by individual engineers. By providing data and information to engineers, the amount of trial-and-error development decreased, which helped the efficiency of the engines in use to improve steadily.

Since the first industrial revolution, the technology for data and information sharing has become more effective. Through Internet, sharing, collaborating, and participation are made easier continuously and the standing problem is how to harness the available technologies [15]. For example, major cities in different countries are using technologies to share the data they have collected from their functions to enhance civic open innovation to accelerate the development of tools for citizens [16]. The strategy is to use external resources and collective actions to increase the added value to citizens [17],

TABLE II. POSITIVE ASSUMED IMPACTS CATEGORIZED WITH OBSERVED IMPACTS.

Collaborative actions (Table III.)	Innovation and development (Table VI.)	Competitiveness (Table IV.)	Ecosystem-wide engagement and communication (Table V.)	Internal change (Table VII.)	Public image (Table VIII.)
Participative actions (12)	Data development (5)	Business development (14)	Community actions (5)	Governance development (3)	Public image (11)
Feedback (11)	Impact to innovation (14)	Change in business environment (10)	Crowdsourcing (10)	Decision-making support (7)	
Research activities (9)	Service development (10)	Change in revenue generation (10)	Ecosystem change (20)	Internal change (21)	
			External expert utilization (9)	Working environment (8)	

for example through combination of data in a new way [14]. According to Geiger and von Lucke [4], added value is created when unconnected datasets are combined and new conclusions achieved. After the data is published, the publisher should be actively searching the knowledge that has emerged from the data [7]. The cities also use open data initiative to engage the citizens to the policymaking through collectivity [15], making the dialog and participation possible between policymakers and citizens [3].

Private organizations are also a part of opening the data. In 2005 Nike and Levi-Strauss disclosed their factory data after multiple inquiries from student unions [12]. While the companies had initial fears about the disclosure, the long-term benefit was enhanced industry collaboration and information sharing. In addition, the private companies can benefit from the increased dialog and participation also from its customers: Sayogo et al. [5] report smart disclosure by companies, who open their data to the consumers about their production and supply chain. The goal is to increase public understanding about the sustainability of the products and empower the consumers to take actions the companies provide. The smart disclosure by companies can decrease consumer confusion in complex market, empower consumers by informing them about their decision and increase data-driven products and services and thus improve economy [5].

TABLE III. ASSUMED IMPACTS THAT REFER TO COLLABORATIVE ACTIONS.

Term	Description
Participative actions	**Collaboration and participation** [18], [19], [7], [4], [20], [2], [15], [21] **in topics of interest** [22] **and in application development** [23], [4] **increases interoperability** [24] **with academia and other companies** [25], [21], [10], [2], [20], [26], [4], [22]**.**
Feedback	**Contribution through effective feedback** [20], [15], [27], [24] **channels** [7], [11] **from data consumers to improve processes, policies** [28]**, products, services** [7] **and data quality** [29] **increases company's understanding about customers** [30], [27], [31] **and generates external input** [32]**.**
Research activities	**Acceleration** [33], [34], [35], [10] **and focus** [36] **to transparent research process** [37] **allows multiple goals** [22] **in efficient research** [38], [10], [16] **with academia** [36] **and reduces the high failure rates** [22]**.**

2) Competitiveness : The increase in competitiveness influences both the data providers and the enablers, who enable the opening and use of data [1], [39]. An example of enabler business is the targeted advertisement, where the social media data is used [15]. The study of Huijboom and Van den Broek [1] found that by gaining access to more data, the ICT companies can create new programs and enhance old applications by adding new features and functionalities that uses data from multiple sources. In addition, to the increased actions of ICT companies, the applications produced from the published data can increase the awareness about the provider. Open data leaves the aspect of ownership and focuses on the developers and companies, who provide products and services tailored to larger audiences for greater financial gains [16]. The companies can transform to become more transparent about their actions and processes, increasing publicity and consumer trust. According to the interviews done by Sayogo et al. [5], becoming transparent and open about the company's activities allows smaller enterprises to compete with larger players, who have the advantages in scale, resources, visibility and brand, and consumer base.

While the opening of data can provide benefits, the companies have to strictly limit the amount and quality of published data. In a case by Yang [17], the releasing organization showed less concern of losing valuable assets, since the data was updated daily; it "went bad" fast. Henkel [23] presents a case about embedded Linux, where the actors in the development share their code to public use through open source software. The report found that companies do share their code with strict rules: either generic code or highly specialized code designed only for their hardware. The study also reports that some companies reveal their code, because of its importance to the competitive position and differentiation. From the answers a conclusion is drawn that for some companies the revealing may even support their competitive advantage. The major reason for this stand comes from the fact that by revealing their code they gather technical benefits, such as external development and reduce their maintenance support. The study concludes that the companies can collect benefits by creating a right balance between protecting and sharing their products. The enhancement to competitiveness through revealing may come from shaping collaborative behavior of others or discouraging direct competition. [22].

While the companies lack cases in the literature Borzacchiello and Craglia [40] found that in governmental sector the benefits have been found to outweigh costs in most of the cases. A case from the literature shows that the initial costs were recovered in six months due to increased efficiency [41]. Another study found that by opening data, the average saving of costs and time decreased 11% and 17% respectively [42].

3) Ecosystem-wide engagement and communication: The roles in business ecosystems vary from direct to indirect roles, including the value chain and also other roles, such as outsourcing companies and regulatory agencies [47]. Since opening the data is meant to affect mostly on the public, it can affect every actor in business ecosystem; open data ties together governments, businesses, and citizens [25]. Henkel's [23] study about selective revealing in a case of embedded Linux shows that companies are having extended dialog through revealed artifact. Doorey [12] also reports similar

TABLE IV. ASSUMPTIONS THAT AFFECT COMPETITIVENESS OF THE COMPANY.

Term	Description
Business development	**Developing new, more effective business models and processes** [43], [44], [34], [32], [27], [39] **with collaborative and competitive strategies** [16] **and operational efficiency** [45] **with new information, methods, and business intelligence** [21] **about trends, issues, and challenges** [15]**. Support to economic, knowledge** [7], [32] **and business development** [23], [32] **and sustainable production** [5] **by understanding possibilities of economic growth in every point of the information-driven supply chain** [46], [5]**.**
Change in business environment	**Achieving and maximizing new economic opportunities** [32], [16] **by stimulating competitiveness** [25], [5], [7], [2] **and enhancing the competitive position and advantage** [22], [32], [25] **by efficiency gains from combined and trusted data** [31], [39] **and increased client commitment** [39] **by releasing social and commercial value** [18]**.**
Change in revenue generation	**Increased revenue** [6], [16] **and lowered transactions costs** [19] **through credible and sustainable commerce** [31] **and added value through augmentation** [27]**, reuse** [4] **and combination** [7] **of data. Boosted economic development** [35] **leads to profitability** [45]**, widening the company portfolio** [16] **and discouraging competition** [22]**.**

activities in the case of Nike and Levi-Strauss, where increased transparency and factory disclosure added the informal dialog as well as information sharing and collaboration in monitoring, training, and remediation between competitors. Companies have also been able to harness the knowledge of private actors and communities [15], [12].

Openness in ecosystems is a complicated matter, since it requires clear data ownership and clear policies about the disclosure; one company opening the data can easily affect the whole ecosystem [5]. However, the ownership of the data is increasingly moving back to the consumer, who can use the data as they see fit. This would suggest that the customers themselves decide, based on their own data, which advertisements they want to see and what services they want to use [25]. The value of data should be calculated from the financial viewpoint as well as the amount of reuse when compared to the effort needed to publish it [19].

TABLE V. ASSUMPTIONS RELATED TO THE POSITIVE CHANGE IN ECOSYSTEM.

Term	Description
Community actions	**Expand the community** [31] **and increase communal activities around the company and their technologies** [28]**, allowing easier access to possible customers** [31] **for comparison** [24] **and scrutinization of data** [7]**. Users can also submit their own data sources and analyzes through the communities** [24]**.**
Crowdsourcing	**Accessibility to crowdsourcing** [20], [35], [21], [10], [16], [22] **encourages crowd-based benchmarking** [24] **and involvement in data collection, analysis, and application** [2]**. Crowdsourcing and public engagement** [7] **increases awareness of problems and solutions** [48]**.**
Ecosystem change	**Transparency** [40], [49], [32], [7], [4], [3], [20], [2], [21], [5], [24], [18] **in ecosystem allows accountability** [50], [29], [20], [21], [25] **and accessibility to investors and companies** [48], [7], [16]**, making the two-way communication between stakeholders and companies faster and more reliable** [19], [28], [15], [4]**. The data can be engaged and validated through external resources** [28], [16], [7] **with transparent process that allows tracking and makes explanations possible** [29] **in the ecosystem. Through the external engagement, the publisher remains ready for constructive influences, discourses, and exchanges** [7]**.**
External expert utilization	**Enhancing performance** [28] **through increased communications with third parties** [51]**, allowing the use of collective intelligence** [4], [7] **and involving third parties to data processing** [7] **and validation** [22]**. Third parties include global expert community** [10] **that can be accessed** [20], [16] **through the Internet** [34]**.**

4) Innovation and development: In the era of information-driven development, where even one user can innovate and create their own products, the free and public open data makes a powerful business resource [35]. Von Hippel [51] presents a study about user-based innovation, an innovative action by the users instead of the product manufacturers. In the paper he underlines the importance of user-based innovation in software business that requires extensive amount of data from users over time. Acquiring and applying this data becomes possible through open data, as have been seen from the example of cities and public bodies [30]. Accordino [15] presents an example of innovative software that is connected to open data: the Futurium Platform, a software created solely on decision-making. The data is collected from open data providers, social media APIs and from stakeholders and policymakers. All this data is pooled together and Futurium is capable of using this data to derive knowledge for future use when making decisions. Gurin [35] proposes a demand-driven data disclosure; the opening process is driven by the needs of users by involving the stakeholders.

Linné and Cirincione [36] studied the effects of open data in real estate, appraisal, and mortgage banking. This is only one example of developing industries, who have embraced open data, renewing the real estate analytics. According to the study, the benefit of open data primarily comes from cost savings and increased efficiency in the real estate industry, since the data can be typed only once. Also opening the data records to commercial vendors, academics, and practitioners the business analytics and metrics are required to change in order to analyze millions of aggregated data points [36]. Through open data the market's movements and patterns are now visible and exploitable, enhancing the quality of services and products available for consumers [5].

TABLE VI. ASSUMPTIONS ABOUT THE ENHANCEMENT OF INNOVATION AND DEVELOPMENT.

Term	Description
Data development	**The mix of public and private data** [7] **adds cross-data interactions and aggregations** [2] **that are made possible with easier data movement** [22] **and sustainable data** [7]**. The technologically independent access** [2] **provides new challenges to third party data mining** [29] **and unearths underlying data quality issues** [43]**.**
Impact to innovation	**Enhanced** [21], [10]**, accelerated** [33]**, promoted** [49]**, increased** [26], [44], [25], [22], [39], [19]**, improved** [50] **and stimulated** [7] **cumulative** [22] **and collective** [4] **innovation** [3]**.**
Service development	**New** [7]**, improved** [16], [7] **and enhanced** [32] **services with improved service provision** [24]**. The performance** [10] **and efficiency** [48] **of the services can be increased through better standards** [50] **and seamless integration** [2]**, increasing the quality** [39], [45] **and outreach** [32] **of the services.**

5) Internal change: The reported benefits from internal change emerging from open data is rather scarce in the literature. Huijboom and Van den Broek [1] report budget cuts as a driver to open data in United Kingdom. The government wanted to create savings through publishing data about the public expenditures and they involved citizens in the process of cutting, asking where the cuts should be made. Doorey [12] reports that open data is thought to provide better performance through publicity, when corporations open the data that reflects poorly on their requirements and it encourages managers to improve the performance of the processes where the data is gathered. The decisions of Nike and Levi-Strauss that lead to the disclosure of their supplier factories pressured the suppliers

TABLE VII. ASSUMPTIONS ABOUT THE CHANGES IN INTERNAL PROCESSES.

Term	Description
Governance development	**The culture of administration changes to welcome opposing views and inputs** [7] **and the process of administration is optimized** [7] **and modernized through openness** [4]**. Administration can receive supportive data from multiple sources to leverage investments** [48] **and development does not necessary need to be tied to administration** [4]**.**
Decision-making support	**Legitimate decisions** [15] **and policies can be based on** [40], [29] **and improved with** [7] **a rich set of analyzes and opinions** [33]**, making the process** [7] **transparent** [52] **and the consequences visible, comprehensible and discussable** [4]**.**
Internal change	**Creating cost efficiency, decreasing costs** [16], [22], [20], [30], [25], [36], [33], [39] **and boosting productivity** [3], [32], [5], [40], [27] **by countering unnecessary duplication of data and work** [10], [7], [39]**. By illuminating problems in the processes** [29] **the information asymmetry is reduced** [49]**, support is given to the creation of new insights, knowledge, and technologies** [48], [28], [7] **in agile and adaptable environment** [16], [15] **and the information and data can be easily maintained and extended** [52]**.**
Working environment	**Internal criticism** [29] **and corruption** [35] **can be reduced through easier monitoring** [28], [29] **and transparent guidance** [5]**, when openness becomes a standard procedure** [21] **and employees are empowered** [20] **to change their own working conditions and future within the company. By opening the data, employees can be moved to more interesting jobs** [40] **and the stress and workload can be reduced on individual level** [48]**.**

to increase the transparency on their working environment and processes [12].

6) Public image: Companies are increasingly being inquired about their actions by the governments and the information about the sustainability of companies products and practices is being increasingly demanded by the customers [49]. This drives them to change their working methods towards transparent actions [12]. According to Doorey [12] Nike and Levi-Strauss disclosed their supplier factories because of the public demand; they deemed the potential benefits of being the first to market with transparency to be more beneficial than the associated risks. The companies can also provide their data directly to the public, but can use data intermediaries to validate and publish the data to the public [49]. While the companies use third party certifiers to calm the public about the sustainability and ethicality of their products, social pressure and government enactment are guiding the companies from certifications to transparent actions, where each individual consumer can monitor the product throughout the supply chain [5]. Even charities have found that donors are actually expecting accountable and transparent actions instead of assurances [50].

TABLE VIII. ASSUMED ENHANCEMENT OF PUBLIC IMAGE.

Term	Description
Public image	**Brand, reputation** [31], [25], [4], [7] **and public profile** [10] **is improved through positive publicity, visibility, and transparent actions that broadens understanding** [7], [28]**, adds trust towards the publisher** [35], [29], [32], [25], [5], [39], [7] **and conveys competence and integrity** [5]**.**

B. Findings providing negative impacts

The negative impacts in Table IX are presented similarly to the positive impacts in the previous section. The first row of the table presents the topic (observed impact) and in the parenthesis the table, where the assumed impacts are explained after the description. In the parenthesis after the assumed impact is a number that indicates how many articles mentioned the said impact.

TABLE IX. NEGATIVE ASSUMED IMPACTS CLUSTERED WITH OBSERVED IMPACTS.

Decrease in efficiency (Table X.)	Increased costs (Table XI.)	Public data increases problems (Table XII.)	Required changes (Table XIII.)
Economic hindrance (20)	Investments (17)	Illegal activities (21)	Business change (5)
Efficiency decrease (18)		Public image (9)	Internal change (7)
Hindered collaboration (9)			

1) Decrease in efficiency: Yang [17] found in a case study about the Taiwanese e-government that when an organization is striving towards openness, the usually forgotten fact is that setting up openness and creating new processes parallel to the old ones increase the workload on existing, limited resources. Even if the open processes are used to substitute the old ones, the preparations and modification take up substantial amount of time and new resources are needed to maintain the systems. While the preparations and management could be handled, Tjoa [14] found a challenge that the technical experience of the publisher and especially users are usually lacking. In other words, even if the data is published, the ones who would want to use the data lack the skill to access it. This would require significant investments into the user interfaces, which would conflict with the target of the publisher.

In addition, Huijboom and Van den Broek [1] found that the scattered strategies of the organization are a major hindrance, if the organizations cannot decide which processes they should use, thus dividing the available resources. They also found that national laws and ethics can be a significant factor in opening the data, since in some countries the publishing of the same datasets are illegal, even if they would be legal in others. Such datasets that hold any data that can be classified as private will have multiple problems from legislative regulations. Almirall [16] also found that existing conflicts between different organizations can prevent opening the data. While the study by Doorey [12] discredited the necessity to hide the data from competitors, some companies still refuse to collaborate with each others business, limiting the amount of data to be released.

2) Increased costs: According to Accordino [15], the first costs about the data comes from the collection. The instantaneous data collection technology and the use of information and communication technology (ICT) is largely untapped, demanding technological investments to simply gather data. Accordino continues that after the data has been successfully collected, the next problem is that the data has to be rendered useful to stakeholders and policymakers through visualization, which requires more tools. In order to make the use of technology effective, the users of the new systems also require training to the systems, which increases the technology related costs [1].

If the company has existing technologies and systems they use, then changing to openness may require more investments into the systems. The interviews done by Sayogo [5] point that there exists multiple costs, when striving towards openness.

TABLE X. ASSUMPTIONS ABOUT THE DECREASING EFFICIENCY.

Term	Description
Economic hindrance	**The income can be reduced** [11], [49], [17], [34] **because of the uncertain economic shift** [34]**, impact** [1]**, outcomes** [19], [7] **and costs** [31], [19] **or because of regulations** [44], [22]**, lack of intellectual rights** [23] **or the lack of use of the data** [7], [2], [3], [5], [37], [20]**. The company can also lose market share** [22] **and commercial confidentiality** [32], [5], [29], [4], [21], [44], [22] **by accidentally publishing critical data.**
Efficiency decrease	**The efficiency can be decreased due to legal restrictions (licensing and copyright** [43], [11], [7], [4], [10], [39], [6] **and opaque data ownership** [19])**, technical issues (information asymmetry** [26], [4]**, lack of standardization** [4], [26] **and poor data quality** [35], [50])**, human reasons (lack of technical expertise** [39], [20], [21]**, misinterpretations** [24] **and the lack of users** [37], [48], [21]) **and the lack of collaborative actions and interoperability** [22], [21]**. Opening the data may cause the processes to be obfuscated** [29] **to the point where the effectiveness suffers.**
Hindered collaboration	**The collaborative companies have mismatched technologies** [31] **or business models** [16], [4]**, lacking the interoperability between systems** [37], [2], [26], [10] **and the created technologies will be unused due to the lack of technological expertise** [7], [37], [11] **and linguistic problems** [31]**.**

First, ensuring openness throughout the supply chain requires significant investments due to the possibility of suppliers being unable to use the latest technology. Usually the suppliers use remote technological resources, which requires additional staff. To publish the data online, if not completely automated, also requires more time and dedication from the existing staff, a time they could use to complete their original jobs. Opening process data might also require extensive explanations and background material available [29]. The data maintenance, such as records and documentations, is also a significant cost to data producers because of the collection, accuracy, and credibility of the data, especially when the data is published to the public who scrutinize the data [29].

TABLE XI. ASSUMED AIMS FOR NEW INVESTMENTS THAT ARE REQUIRED TO REALIZE OPENNESS.

Term	Description
Investments	**Significant financial** [27] **and technological costs** [26]**, because of tying management** [21] **and time** [43], [29] **during the opening process. The technological tasks are unclear** [19] **until the whole system has been implemented, requiring resource, budget, and time** [2] **as well as technological investments** [7], [4], [37], [10], [20], [2], [21], [25], [39], [6], [18], [35], [19], [43]**. After the new systems have been implemented, the management requires new mechanisms, capabilities, and processes for governance** [7]**.**

3) Public data increases problems: The study of Zuiderwijk [53] concentrates on the case of the Research and Documentation Centre (WODC) located in Netherlands. The WODC collects, stores, enhances, and provides information to the Dutch Ministry of Security and Justice. The data the WODC processes is partially sensitive and private information; the study creates guidance for organizations with sensitive data on how and what to publish. When mapping 45 datasets, the most commonly recognized issues by Zuiderwijk [53] were privacy-sensitivity and anonymization, a lack of metadata, and a lack of data quality. The privacy-sensitive data can be misused and misunderstood and it can be used to trigger spurious findings that may affect the provider's publicity. For example, inadvertent release of confidential data may lead to privacy infringements by de-anonymizing data, identifying groups and individuals [29]. According to Zuiderwijk [53], the lack of metadata and data quality makes the dataset more difficult to search through and the usability of data is lowered by confusing the users about the source and function of the data.

TABLE XII. ASSUMED PROBLEMS THAT OPENING THE DATA MAY BRING.

Term	Description
Illegal activities	**The opened data is exposed to misuses and misinterpretations** [40], [4], [28], [21], [5], [19], [11], [24], [29]**, it can cause potential threats** [29] **to the company** [1] **and to individuals** [37], [1], [29], [4], [7], [31], [26], [2], [21], [44], [25], [6], [19] **and can be available for malpractices** [20]**, such as data fraud** [49]**, hacking and data manipulation** [29]**.**
Public image	**By opening the data, publisher may receive negative publicity** [4] **which can lead to loss of trust** [49] **and brand** [21]**, including other socially undesirable outcomes** [29] **such as critique towards individuals** [28] **instead the company. By opening the datasets, company may face legal actions** [29]**, critical and unwanted questions** [7] **or increased discussion and confusion about the data** [7]**, especially if the data lacks validity, completeness, or exhaustiveness** [3], [2], [4], [7]**.**

4) Required changes: Open data and openness brings changes into organizations, ecosystems, and cultures. According to Zuiderwijk [53], the organizations face changes in the form of new focus and policies, such as funding and reward systems, and time consumption structures. The interviews conducted by Sayogo [5] indicate that the decision of one company opening their data affects the supply chain directly. The suppliers are required to provide exact and complete data to their customers, who want to publish the data, requiring changes in the ecosystem and both organizations. The closed cultures of organizations are also required to change, when the data is published outside the company. Huijboom and Van den Broek [1] report that the closed culture of an organization is a major hurdle for opening the data, requiring changes in policies and processes but as well in the employees and their mentality. According to Bannister and Connolly [29], transparency should be used in constructive climate and a culture of quality improvement, or it may lead to cover-ups and blame assignment.

Aside from the changes in the organizations, the old business models and sources of value can become ineffective. Belkindas and Swanson [43] point out that especially to companies who make revenue by selling data, launching open data requires more financial resources to cover the expanded offerings, while the revenue from data has disappeared.

VI. DISCUSSION

In the beginning of this article, two research questions were outlined: RQ1 – *What are the effects of opening their data to private sector?* and RQ2 – *What are the open data perspectives of private sector in scientific literature?*.

TABLE XIII. ASSUMPTIONS ABOUT THE NEGATIVE IMPACTS THAT THE REQUIRED CHANGES BRING TO ORGANIZATIONS.

Term	Description
Business change	**The control over the data of the publisher cannot be predefined but only guided** [7], [22]**, causing changes in existing culture** [7], [5], [22]**, business models** [34] **and operational models** [26]**.**
Internal change	**Cultural shift in administration** [4]**, organization** [20], [16], [19] **and processes** [19], [4] **may lead to biased overview** [7] **and into new culture, where excessive caution and conformity, non-recording, informal procedures, and self-censorship increase** [29] **due to destruction of jobs** [40]**. Such environment does not support radical thinking, honesty, and openness** [29]**.**

This study outlines multiple impacts that affect organizations, both positive and negative. The positive impacts comprise from increasing collaborative actions and competitiveness, addition to ecosystem-wide engagement and communication, enhanced innovation and development, internal change within the company processes and methods, and positive public image. The negative impacts consist of decrease in efficiency, increasing costs, problems caused by public access to data and the changes that are required from the organizations.

In the search, 48 articles were included into the reading process and 466 impacts were collected from the papers. The number of impacts and the ratio of positive and negative impacts in a cluster are presented in Table XIV. The majority of the papers are making assumptions but still both clusters, observed and assumed, have more positive impacts than negative. The ratio of positive impacts over negative impacts in the observed cluster was 2.0 and in the assumptions cluster it was 1.64. The articles had 50 positive observed impacts and only 25 negative impacts. The positive assumed impacts was counted to be 243 in the articles, while the number of negative assumptions was 148. Both observed and assumed impacts would suggest that the opening of data has more positive than negative impacts to businesses but the number of assumptions show that openness is still seen as a disadvantage. This finding suggests that open data is perceived as a threat in current businesses, while the empirical experience suggests otherwise.

TABLE XIV. THE DIVISION OF IMPACTS FOUND FROM THE SELECTED ARTICLES.

	Observed	Assumed
Positive	50	243
Negative	25	148
Ratio [positive/negative]	2.0	1.64
Sum	75	391

A. Limitations

A major limitation is the search through selected databases that does not guarantee that every article about the topic is presented. The lack in the search functionalities of the databases were partially covered with the reference-based search. The databases were selected to cover the viewpoint of both engineering and management to get as wide a sampling as possible. In the search, the selection also excluded books and non-peer-reviewed articles by focusing on peer-reviewed publications. The research is partially covered in non-scientific publications and reports, especially since this study concentrates on the organizations, who usually do their own research. The main concentration was also the articles that were written in English, while the open data initiative covers multiple countries and governments and the research is written in multiple languages. This has possibly ruled out reports, where the effects of open data are being discussed.

Open data is also currently being published by public organizations. While they are fundamentally different from private organizations, they share similar attributes. The possible effects that are influencing changes in the public organizations can also remain true for private organizations as well. By excluding the governmental open data from the search can have left out valuable impacts that can affect an organization.

B. Future work

The data gathered from the 48 articles indicate that the private organization have not opened their data storages with the same speed and interest as the state owned organizations. It shows a clear need for more research about the lack of eagerness to open the data on private organizations. The next step in the research is to study the actual private organizations and their reasons to open their data and keep their data closed.

VII. CONCLUSION

Open data is a rising ideology that can change the current business landscape through sharing the data. Multiple governments have already started releasing their data systematically and only few companies are yet following the trend.

This study highlights reasons, what could happen to private organizations if they opened their data. The impacts were found by mapping existing literature systematically from scientific databases. The search was made using five databases and 48 articles were selected for further analysis. The impacts from the articles were clustered as observed and assumed as well as positive and negative impacts.

The impacts lean heavily on assumptions; 391 of 466 of the found impacts were assumed. However, the literature also suggests that the impacts are mostly positive to the organizations, as long as the opening is done systematically and carefully. The observed impacts also show a higher ratio of positive impacts per negative impacts, totaling a ratio of 2.0 while the assumed impacts total only 1.64 ratio. This would suggest that when the data is opened, the results are beneficial but for some reasons private organizations have not opened their data; they may see it as a loss of business advantage.

While the scientific literature shows that opening the data brings benefits to the provider, the practice does not follow the examples. While the governments are opening their data, private organizations are waiting to see, how the new ideology can enhance the existing markets and businesses. Based on what has been found in this paper, the organizations have multiple opportunities to benefit from openness.

ACKNOWLEGMENT

We'd like to thank Fimecc and S4Fleet-project for funding this study.

REFERENCES

[1] N. Huijboom and T. Van den Broek, "Open data: an international comparison of strategies," *European journal of ePractice*, vol. 12, no. 1, pp. 4–16, 2011.

[2] X. Masip-Bruin, G.-J. Ren, R. Serral-Gracia, and M. Yannuzzi, "Unlocking the Value of Open Data with a Process-Based Information Platform," in *2013 IEEE 15th Conference on Business Informatics (CBI)*, Jul. 2013, pp. 331–337.

[3] T. Jetzek, M. Avital, and N. Bjørn-Andersen, "Generating Value from Open Government Data," in *Proceedings of the 34th International Conference on Information Systems. ICIS 2013*. Atlanta, GA: Association for Information Systems. AIS Electronic Library (AISeL), 2013.

[4] C. P. Geiger and J. von Lucke, "Open Government Data," in *Conference for E-Democracy and Open Government*, 2011, pp. 183–194.

[5] D. S. Sayogo, J. Zhang, T. A. Pardo, G. K. Tayi, J. Hrdinova, D. F. Andersen, and L. F. Luna-Reyes, "Going Beyond Open Data: Challenges and Motivations for Smart Disclosure in Ethical Consumption," *Journal of Theoretical and Applied Electronic Commerce Research*, vol. 9, no. 2, pp. 1–16, 2014.

[6] R. Harris and I. Baumann, "Open data policies and satellite Earth observation," *Space Policy*, vol. 32, pp. 44–53, 2015.

[7] M. Janssen, Y. Charalabidis, and A. Zuiderwijk, "Benefits, Adoption Barriers and Myths of Open Data and Open Government," *Information Systems Management*, vol. 29, no. 4, pp. 258–268, Sep. 2012.

[8] B. Kitchenham and S. Charters, "Guidelines for performing systematic literature reviews in software engineering," Technical report, EBSE Technical Report EBSE-2007-01, Tech. Rep., 2007.

[9] K. Petersen, R. Feldt, S. Mujtaba, and M. Mattsson, "Systematic Mapping Studies in Software engineering," in *Proceedings of the 12th International Conference on Evaluation and Assessment in Software Engineering*. Italy: British Computer Society, 2008.

[10] A. J. Williams, L. Harland, P. Groth, S. Pettifer, C. Chichester, E. L. Willighagen, C. T. Evelo, N. Blomberg, G. Ecker, C. Goble, and B. Mons, "Open PHACTS: semantic interoperability for drug discovery," *Drug Discovery Today*, vol. 17, no. 21–22, pp. 1188–1198, Nov. 2012.

[11] A. Viglione, M. Borga, P. Balabanis, and G. Blöschl, "Barriers to the exchange of hydrometeorological data in Europe: Results from a survey and implications for data policy," *Journal of Hydrology*, vol. 394, no. 1–2, pp. 63–77, Nov. 2010.

[12] D. J. Doorey, "The transparent supply chain: From resistance to implementation at Nike and Levi-Strauss," *Journal of Business Ethics*, vol. 103, no. 4, pp. 587–603, 2011.

[13] A. Nuvolari, "Collective invention during the British Industrial Revolution: the case of the Cornish pumping engine," *Cambridge Journal of Economics*, vol. 28, no. 3, pp. 347–363, 2004.

[14] A. M. Tjoa, B.-L. Do, A. Anjomshoaa, T.-D. Trinh, P. Wetz, and E. Kiesling, "Exploring Linked Statistical Data Using Linked Widgets," in *Proceedings of the Fifth Symposium on Information and Communication Technology*, ser. SoICT '14. New York, NY, USA: ACM, 2014, pp. 1–3.

[15] F. Accordino, "The Futurium–a Foresight Platform for Evidence-Based and Participatory Policymaking," *Philosophy & Technology*, vol. 26, no. 3, pp. 321–332, Sep. 2013.

[16] E. Almirall, M. Lee, and A. Majchrzak, "Open innovation requires integrated competition-community ecosystems: Lessons learned from civic open innovation," *Business Horizons*, vol. 57, no. 3, pp. 391–400, May 2014.

[17] T.-M. Yang, "The Complexity of Cross-boundary Information Sharing: An Organizational Perspective on Taiwan e-Government," in *Proceedings of the 6th International Conference on Theory and Practice of Electronic Governance*, ser. ICEGOV '12. New York, NY, USA: ACM, 2012, pp. 143–145.

[18] J. C. González, J. Garcia, F. Cortés, and D. Carpy, "Government 2.0: A Conceptual Framework and a Case Study Using Mexican Data for Assessing the Evolution Towards Open Governments," in *Proceedings of the 15th Annual International Conference on Digital Government Research*, ser. dg.o '14. New York, NY, USA: ACM, 2014, pp. 124–136.

[19] P. Conradie and S. Choenni, "On the barriers for local government releasing open data," *Government Information Quarterly*, vol. 31, Supplement 1, pp. S10–S17, Jun. 2014.

[20] G. Puron-Cid, J. R. Gil-Garcia, and L. F. Luna-Reyes, "IT-enabled Policy Analysis: New Technologies, Sophisticated Analysis and Open Data for Better Government Decisions," in *Proceedings of the 13th Annual International Conference on Digital Government Research*, ser. dg.o '12. New York, NY, USA: ACM, 2012, pp. 97–106.

[21] J. C. Bertot and H. Choi, "Big Data and e-Government: Issues, Policies, and Recommendations," in *Proceedings of the 14th Annual International Conference on Digital Government Research*, ser. dg.o '13. New York, NY, USA: ACM, 2013, pp. 1–10.

[22] M. Perkmann and H. Schildt, "Open data partnerships between firms and universities: The role of boundary organizations," *Research Policy*, vol. 44, no. 5, pp. 1133–1143, Jun. 2015.

[23] J. Henkel, "Selective revealing in open innovation processes: The case of embedded Linux," *Research Policy*, vol. 35, no. 7, pp. 953–969, Sep. 2006.

[24] D. Maheshwari and M. Janssen, "Reconceptualizing measuring, benchmarking for improving interoperability in smart ecosystems: The effect of ubiquitous data and crowdsourcing," *Government Information Quarterly*, vol. 31, no. 1, pp. S84–S92, Jun. 2014.

[25] D. S. Sayogo and T. A. Pardo, "Understanding Smart Data Disclosure Policy Success: The Case of Green Button," in *Proceedings of the 14th Annual International Conference on Digital Government Research*, ser. dg.o '13. New York, NY, USA: ACM, 2013, pp. 72–81.

[26] T.-M. Yang, J. Lo, H.-J. Wang, and J. Shiang, "Open Data Development and Value-added Government Information: Case Studies of Taiwan e-Government," in *Proceedings of the 7th International Conference on Theory and Practice of Electronic Governance*, ser. ICEGOV '13. New York, NY, USA: ACM, 2013, pp. 238–241.

[27] P. Booth, P. Gaskell, and C. Hughes, "The Economics of Data: Quality, Value & Exchange in Web Observatories," in *Proceedings of the 22nd International Conference on World Wide Web Companion*, ser. WWW '13 Companion. Republic and Canton of Geneva, Switzerland: International World Wide Web Conferences Steering Committee, 2013, pp. 1309–1316.

[28] B. Baue and M. Murninghan, "The accountability web: Weaving corporate accountability and interactive technology," *Journal of Corporate Citizenship*, vol. 41, no. 2, pp. 27–49, 2011.

[29] F. Bannister and R. Connolly, "The Trouble with Transparency: A Critical Review of Openness in e-Government," *Policy & Internet*, vol. 3, no. 1, pp. 1–30, 2011.

[30] M. Kassen, "A promising phenomenon of open data: A case study of the Chicago open data project," *Government Information Quarterly*, vol. 30, no. 4, pp. 508–513, Oct. 2013.

[31] L. F. Luna-Reyes, D. F. Andersen, D. L. Andersen, D. Derrick, and H. Jarman, "Full information product pricing regimes: Policy implications for US-Mexico sustainable commerce," in *Puentes Symposium, Houston, TX*. Citeseer, 2012.

[32] J. McDonald and V. Léveillé, "Whither the retention schedule in the era of big data and open data?" *Records Management Journal*, vol. 24, no. 2, pp. 121–99, 2014.

[33] C. Zheng and D. M. Kammen, "An innovation-focused roadmap for a sustainable global photovoltaic industry," *Energy Policy*, vol. 67, pp. 159–169, Apr. 2014.

[34] A. J. Williams, "A perspective of publicly accessible/open-access chemistry databases," *Drug Discovery Today*, vol. 13, no. 11–12, pp. 495–501, Jun. 2008.

[35] J. Gurin, "Open Governments, Open Data: A New Lever for Transparency, Citizen Engagement, and Economic Growth," *The SAIS Review of International Affairs*, vol. 34, no. 1, pp. 71–82, 2014.

[36] M. R. Linné and J. Cirincione, "Creating Open Data Standards for Real Estate, Appraisal, and Mortgage Banking," *Journal of Real Estate Literature*, vol. 16, no. 1, pp. 75–81, 2008.

[37] A. Zuiderwijk, M. Janssen, S. Choenni, R. Meijer, and R. S. Alibaks, "Socio-technical Impediments of Open Data," *Electronic Journal of E-Government*, vol. 10, no. 2, pp. 156–172, 2012.

[38] B. MacKellar, C. Schweikert, and S. A. Chun, "Patient-oriented clinical trials search through semantic integration of Linked Open Data," in *2013 12th IEEE International Conference on Cognitive Informatics Cognitive Computing (ICCI*CC)*, Jul. 2013, pp. 218–225.

[39] H. Jaakkola, T. Mäkinen, and A. Eteläaho, "Open Data: Opportunities and Challenges," in *Proceedings of the 15th International Conference on Computer Systems and Technologies*, ser. CompSysTech '14. New York, NY, USA: ACM, 2014, pp. 25–39.

[40] M. T. Borzacchiello and M. Craglia, "The impact on innovation of open access to spatial environmental information: a research strategy," *International Journal of Technology Management*, vol. 60, no. 1/2, pp. 114–129, Sep. 2012.

[41] P. G. Almirall, P. Q. Ros, M. Craglia, and M. Moix, *The Socio-economic Impact of Spatial Data Infrastructure of Catalonia*. Office for Official Publications of the European Communities, 2008.

[42] M. Craglia and M. Campagna, "Advanced regional SDIs in Europe: Comparative cost-benefit evaluation and impact assessment perspec-

tives," *International Journal of Spatial Data Infrastructures Research*, vol. 5, pp. 145–167, 2010.

[43] M. V. Belkindas and E. V. Swanson, "International support for data openness and transparency," *Statistical Journal of the IAOS*, vol. 30, no. 2, pp. 109–112, Jun. 2014.

[44] R. Cumbley and P. Church, "Is "Big Data" creepy?" *Computer Law & Security Review*, vol. 29, no. 5, pp. 601–609, Oct. 2013.

[45] L. A. Streeter, R. E. Kraut, H. C. Lucas, and L. Caby, "How open data networks influence business performance and market structure," *Association for Computing Machinery. Communications of the ACM*, vol. 39, no. 7, p. 62, Jul. 1996.

[46] M. Andersson and C. Karlsson, "Knowledge in Regional Economic Growth—The Role of Knowledge Accessibility," *Industry & Innovation*, vol. 14, no. 2, pp. 129–149, May 2007.

[47] M. F. Baghbadorani and A. Harandi, "A Conceptual Model for Business Ecosystem and Implications for Future Research," *DOI*, vol. 10, pp. 82–86, 2012.

[48] K. C. Desouza and A. Bhagwatwar, "Citizen Apps to Solve Complex Urban Problems," *Journal of Urban Technology*, vol. 19, no. 3, pp. 107–136, Jul. 2012.

[49] D. S. Sayogo, J. Zhang, H. Liu, S. Picazo-Vela, and L. Luna-Reyes, "Examining Trust As Key Drivers in Smart Disclosure for Sustainable Consumption: The Case of I-choose," in *Proceedings of the 15th Annual International Conference on Digital Government Research*, ser. dg.o '14. New York, NY, USA: ACM, 2014, pp. 137–146.

[50] S. Huddart, "Renewing the Future: Social Innovation Systems, Sector Shift, and Innoweave," *Technology Innovation Management Review*, vol. 2, no. 7, pp. 5–9, Jul. 2012.

[51] E. von Hippel, "Democratizing Innovation: The Evolving Phenomenon of User Innovation," *International Journal of Innovation Science*, vol. 1, no. 1, pp. 29–40, Mar. 2009.

[52] E. W. Patton, P. Seyed, P. Wang, L. Fu, F. J. Dein, R. S. Bristol, and D. L. McGuinness, "SemantEco: A semantically powered modular architecture for integrating distributed environmental and ecological data," *Future Generation Computer Systems*, vol. 36, pp. 430–440, Jul. 2014.

[53] A. Zuiderwijk, M. Janssen, R. Meijer, S. Choenni, Y. Charalabidis, and K. Jeffery, "Issues and Guiding Principles for Opening Governmental Judicial Research Data," in *Electronic Government*, D. Hutchison, T. Kanade, J. Kittler, J. M. Kleinberg, F. Mattern, J. C. Mitchell, M. Naor, O. Nierstrasz, C. Pandu Rangan, B. Steffen, M. Sudan, D. Terzopoulos, D. Tygar, M. Y. Vardi, G. Weikum, H. J. Scholl, M. Janssen, M. A. Wimmer, C. E. Moe, and L. S. Flak, Eds., vol. 7443. Berlin, Heidelberg: Springer Berlin Heidelberg, 2012, pp. 90–101.