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Utilization of open government data: A systematic literature review of types, conditions, effects and users

Igbal Safarov*, Albert Meijer and Stephan Grimmelikhuijsen
Utrecht School of Governance, Utrecht University, 3511 ZC Utrecht, The Netherlands

Abstract. This paper presents a comprehensive overview of the literature on the types, effects, conditions and user of Open Government Data (OGD). The review analyses 101 academic studies about OGD which discuss at least one of the four factors of OGD utilization: the different types of utilization, the effects of utilization, the key conditions, and the different users. Our analysis shows that the majority of studies focus on the OGD provisions while assuming, but not empirically testing, various forms of utilization. The paper synthesizes the hypothesized relations in a multi-dimensional framework of OGD utilization. Based on the framework we suggest four future directions for research: 1) investigate the link between type of utilization and type of users (e.g. journalists, citizens) 2) investigate the link between type of user and type of effect (e.g. societal, economic and good governance benefits) 3) investigate the conditions that moderate OGD effects (e.g. policy, data quality) and 4) establishing a causal link between utilization and OGD outcomes.

Keywords: Open data, open government data, utilization, effects, users, conditions

1. Introduction

Open government data has attracted much attention in recent years, becoming part of the everyday lexicon of transparency activists, NGOs, and public officials. An increasing number of academic studies focus on Open Government Data (OGD) initiatives and policy-making in order to explain differences in OGD provisions among various government organizations [1–3]. Indeed, there has been considerable scholarly attention devoted to OGD and its provision by governments [4].

However, numerous OGD studies highlighted that a key problem of OGD lies not so much in its disclosure, but in its usage, and – more precisely – the lack of OGD use [5–9]. In recent years, many scholars have therefore sought to understand what determines OGD usage and what conditions are necessary [3,10,11]. As a result of this surge in academic attention on OGD usage, a systematic and comprehensive overview of what we know about OGD utilization is lacking.

There have been two recent systematic literature reviews on OGD. Attard, Orlandi et al. [4] aim to assess OGD initiatives and describe the life-cycle of OGD. Attard et al. [4] focus predominantly on the provision of public data, thus focusing on the supply side of OGD. Hossain et al. [12] conducted a comprehensive systematic review about the insights from extant studies and provide a research agenda for

*Corresponding author: Igbal Safarov, Utrecht University, Utrecht School of Governance, Bijlhouwerstraat 6, 3511 ZC Utrecht, The Netherlands. Tel.: +31 684708713; E-mail: i.safarov@uu.nl.

future studies. This study presents the classification of context, perspectives, research methods, benefits and barriers of open data and information about publications.

Both literature reviews provide important insights about the current state-of-the-art in OGD research. However, these studies have a broad aim and do not specifically focus on the utilization of OGD. As we noted, the latter is particularly important because in practice OGD is barely used and a better understanding is needed to improve this.

Another study, while it is not a pure systematic review, is targeted to provide a taxonomy of OGD research areas [13]. This study provides 35 research areas of OGD including the summary of research literature and research objectives. Charalabidis et al. [13] highlight the importance and relevance of OGD usage and value as a research area which is very supportive for our study. Comparing the mentioned reviews, our study focuses only the papers about the public open data specifically utilization of OGD.

We will discuss the literature in four broad categories: the types of OGD utilization, the subsequent effects, the contextual conditions moderating these effects, and the user groups of OGD.[1] These four categories were chosen because it aligns with an often made distinction in technology acceptance models, which have been widely used and tested (e.g. [14,15]). Although these categories are predetermined, the content of these categories is not and will emerge from the literature itself. Thus the objective of this paper is to present a comprehensive overview of what the academic literature has found on 1) the types of OGD utilization 2) effects of OGD usage 3) condition that moderate these effects and 4) who are identified as users.

The *type of utilization* covers the various ways in which practitioners employ OGD. For instance, open data can be utilized as a research tool [16], in hackathons [17,18], or in data analytics [8,19]. It is important to analyze these types according to how they influence the effects of OGD. The *effects* constitute the second part of our review. OGD has the potential to contribute to an array of (positive) outcomes, for example, transparency [20], accountability [21], or as a source of innovation [22–24]. The third topic in the review is the *moderating conditions*. For instance, research has indicated that the potential impact of OGD usage may be moderated by various conditions, such as low data quality [25,26] or legal barriers [27,28]. The fourth and final factor that we take into account is the *users*. Many studies have highlighted users' roles and participation in the OGD value-extraction process, defining different user groups, such as developers [28], citizens [29–31], activists, and NGOs [32,33].

The contribution of this systematic literature review is twofold. First, it provides an overview of the current OGD research focusing on the utilisation of OGD. Second, our objective is to synthesize the current body of knowledge by developing a multi-dimensional framework of OGD utilization and use this framework as basis to present suggestions for future research.

This article presents a systematic analysis of both tested and hypothesized relations in order to develop a multi-dimensional framework of OGD utilization. This framework opens up the black box of OGD utilization by identifying various patterns of usage, user groups, contextual conditions, and effects. The article begins by outlining our review methodology, after which we present the descriptive results of the review in the descriptive analysis section. Descriptive analysis presents year of publications and its dynamics, the countries that the articles dedicated, diversity of methodologies and other descriptive aspects of selected studies. Next, we discuss thematic analysis in which each factor of OGD utilization is handled and elements of factors are discussed. The review continues by synthesizing findings into an OGD utilization framework and discussing avenues for further OGD utilization research in

[1]This also means the systematic literature review will not include *all* literature on OGD, only the literature that discusses various factors of OGD utilization.

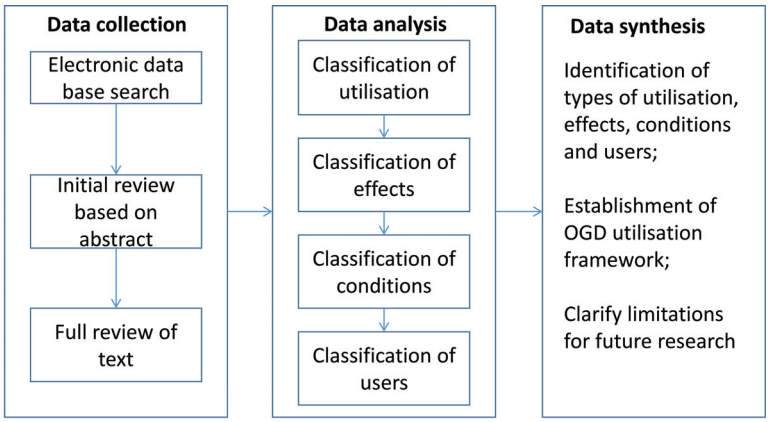

Fig. 1. General research design.

the "Synthesis and discussion" section. Finally, we discuss conclusion and research limitations at the end of the review.

2. Methodology

In order to analyze the existing knowledge, we conducted a systematic literature review based on the established procedures [34–36]. The design of the literature review consisted of a systematic collection of articles for the review, a systematic analysis of these articles and a systematic synthesis of these findings (see Fig. 1).

Data collection. To explore the heterogeneous literature in the field of OGD, the following bibliographic databases were searched:

- www.scopus.com – Scopus database;
- apps.webofknowledge.com – Web of Science database maintained by Thomson Reuters;
- dl.acm.org – Association for Computing Machinery database;
- www.sciencedirect.com – ScienceDirect database maintained by Elsevier.[2]

The searching of the studies was conducted from 1st December, 2015 to 21st January, 2016. Since the same article can be reached through various scientific databases, the majority of selected studies ($n = 65$) was retrieved from the first used database (Scopus). The terms "open government data" and "open data" were used as keywords to search each database in the title, abstract and keywords of articles. However, "open data" has not been used as a separate search keyword to keep the search results in the frame of public or government based open data.

Selection criteria. We attempted to reduce the risk of bias because of data (study) collection by implementing clear exclusion and inclusion criteria. the following inclusion criteria were used in our review.

1. We only considered the peer-reviewed articles that were written in English language.
2. Only open government data studies were included in the review thus we excluded studies regarding open science data, open data from NGOs and international organizations.

[2]We carried out an additional search on Google Scholar to search for articles containing the keywords "open government data". The search results on "Google Scholar" were very similar to our primary search results or did not meet the requirements of inclusion.

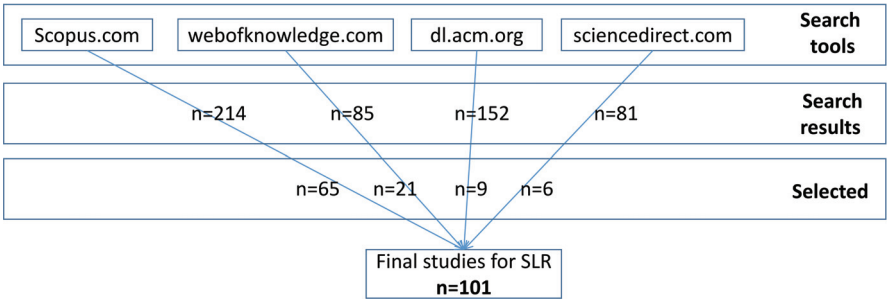

Fig. 2. Selected primary studies.

3. We included studies that regarded one or more dimensions of utilization: types, effects, conditions and users. Studies that regarded open government data in general, without mentioning these dimensions were excluded.

The types of utilization refer to the use and re-use of OGD for a particular purpose, typically as a field of study or practice. *Effects* refer to the potential results and outcomes of OGD utilization from social, economic or good governance perspectives. *Conditions* refer to the environmental features or aspects of overall OGD utilization functioning as technical, social or political paradigms of public data usability. The fourth factor of OGD utilization is *users,* which describe individuals or groups that use public data for achieving the targeted effects and gaining value mostly in the form of product, advantage or practice. Each selected study was added a data extraction form in Excel to summarize information about publication, research method, research question, abstract and results, utilization, effects, conditions, users, research domain and research country.

Data synthesis. Based on the data extraction form, main trends and elements were determined for each factor of OGD utilization. All elements were grouped and classified regarding their most common characteristics to understand better the overall picture of OGD utilization. In the final stage, the factors, elements and their classification were depicted on the unified OGD utilization framework including connections between factors.

3. Descriptive analysis

This study analyzes 101 academic articles about Open Government Data (OGD) in order to identify what is known about different types of utilization, the effects of utilization, the key conditions, and the different user groups. For the purposes of a systematic literature review, we categorized studies based on the country where the study was conducted. The collected literature shows that OGD-related studies are primarily conducted in developed countries. Only a couple of studies are devoted to developing countries, such as Brazil, India, Chile, Mexico, Russia, and Romania, and regions, such as the Middle East and Latin America. The most researched countries are the Netherlands [12], the United States [11], and the United Kingdom [6], which indicates that scholars from these countries contribute significantly to the field of study. Several studies investigate and compare two or more countries, such as Sweden and the Netherlands [22]; the European Union [1,37–39]; the Netherlands and Brazil [40]; the Netherlands and Greece [41]; and, Australia, Canada, France, New Zealand, Singapore, the UK, and the US [2].

Figure 3 shows that there is a predominant focus on the USA and the Netherlands. This means that findings on OGD utilization are mainly found in two countries with strongly developed economies and

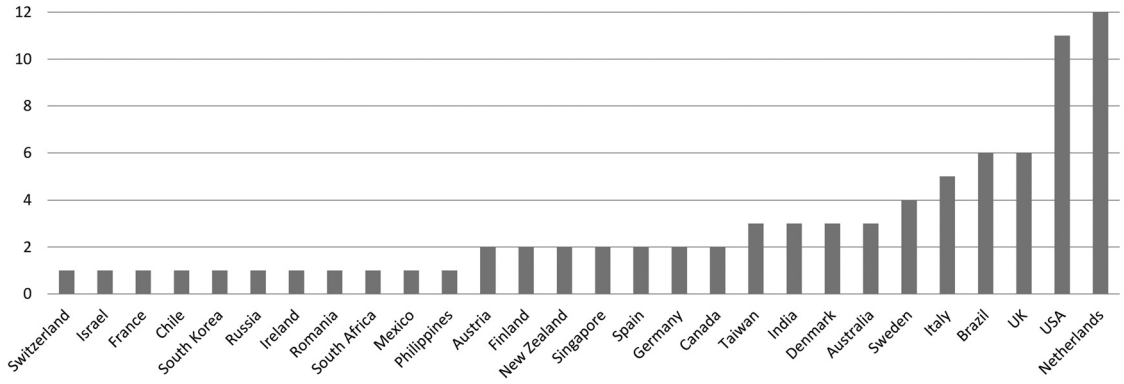

Fig. 3. Number of articles by country.

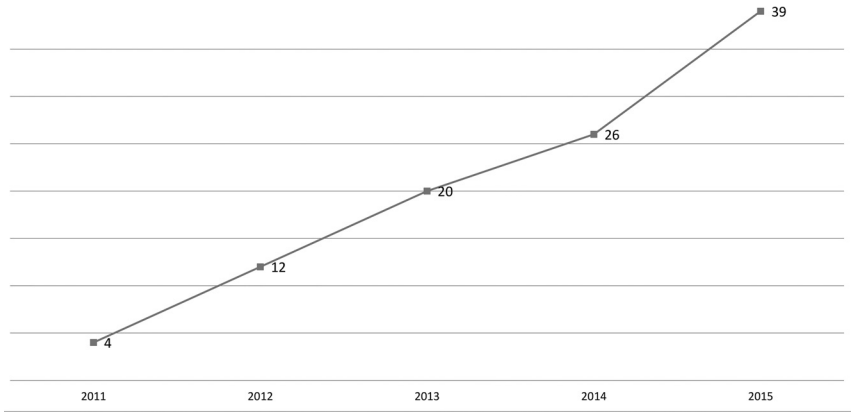

Fig. 4. Number of selected studies by year.

longstanding democratic tradition. More research from a more diverse set of countries is needed to see if current insights about OGD hold in different institutional contexts.

Next, we analyzed the publication trends of open data over time. Figure 4 illustrates the rapid increase of academic publications about OGD in the last five years. Remarkably, more than one-third of selected studies were published in 2015 (39 articles), whereas no articles were found from before 2010. This finding is in line with OGD's rising popularity in public policy following the declaration of OGD principles by advocates in 2008 [42] and the publication of the first Open Government National Action Plan of the United States in 2011. As governments began investing increasingly in open data infrastructure, funds to study those investments seem to have followed. This dramatic increase also indicates the need for a more systematic overview and research agenda.

Further evidence for the growing popularity of OGD is the distribution of studies published in journals and presented at conferences. A breakdown of the relevant studies is provided in Table 1. This table shows that OGD research is mainly published in journals related with e-government and information science in general. Interestingly, a great deal of papers was published in official conference proceedings and not in journals. This may be due to the youngness of the field; it takes a relatively long time to get article published in journals. Furthermore, we also found many thematic journals that published articles about OGD, such as Journal of Public Transportation and Journal of Public Health Management and Practice, etc., that publish OGD-related studies (Table 1). This implies that OGD research is quite

Table 1
Sources of studies

Name of journal	Number
Lecture notes in computer science (LNCS) – Springer	14
Government information quarterly	11
International conference on theory and practice of electronic governance	7
Information polity	7
Journal of theoretical and applied electronic commerce research	5
Social science computer review	5
Hawaii international conference on system science	4
International conference on digital government research	3

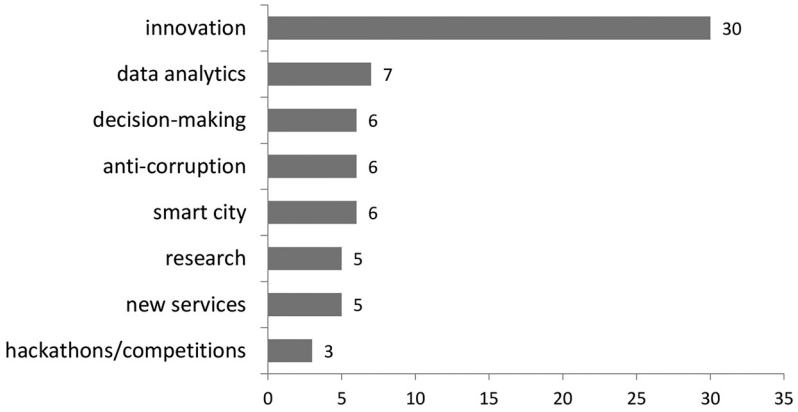

Fig. 5. Number of articles on the types of utilization.

dispersed over various disciplines, such as public administration and information science and that it is a nascent field with many publications in conference proceedings.

The variety of publication outlets also resonates with the diversity of methodologies used to study the topic. The majority of the studies are qualitative [76], while only 25 out of 101 are quantitative. Four studies combined both qualitative and quantitative methods. Taking into account that the studies used a broad range of methodologies, those were coded and generalized in order to clarify and group standard methods. Thus, we found that the selected studies mostly adopted case studies [54], desk research, which was primarily used to investigate OGD portals [14], literature reviews [13], document analysis [12], surveys [12], and interviews [7] to investigate the targeted areas. The imbalance between qualitative and quantitative studies indicates that there may be room for more quantitative studies on OGD.

4. Thematic analysis

4.1. The types of utilization

We found 70 articles that discussed one or more types of OGD utilization. The reviewed literature revealed that there are many types of utilization. Some types of utilization were very broad, such as innovation and decision-making, while others were very specific, such as creating new stories from data, informal settlement analysis, or climate change research. Figure 5 lists the types of utilization that were mentioned in at least three different studies.

Innovation. Figure 5 highlights innovation as the most prominent type of OGD utilization in the selected studies. The literature mentions various types of innovation, such as business-driven innovation for the purposes of generating economic value [24] and innovation spurred by citizens to co-produce public services [21]. In addition, according to the literature, a lack of public data sharing significantly decreases innovativeness, hinders entrepreneurial incentives, and prevents the execution of many new business and Internet start-up plans [43]. In this paper, we included "innovation" as a type of utilization rather than as an effect of utilization. We acknowledge that, in some cases, innovation can be an outcome or effect of OGD utilization, in this paper, innovation is seen as an intermediary variable that generates a broader effect, such as economic gain or societal value. Therefore, we consider using OGD for innovation as a type of utilization itself (using it for innovative purposes) and not an effect, as we conceptualize effects more broadly.

Data analytics. Data analytics allow users to utilize released public data more productively – for instance, to create visualizations that are important for discovering and understanding complex datasets [44]. According to the literature, the development of big data analytics in the public sector may offer opportunities for predictions and forecasting by combining and analyzing government data [19,28]. Furthermore, several studies investigate data analytics as a tool for different fields of study, including utilizing transportation data for public transportation services [8], conducting environmental impact analysis [45], and studying early childhood development [46].

Decision-making. Quality of decision-making partly depends on available data, which is rapidly transforming with the implementation of digital tools, such as big data and machine learning. Power et al. [47] argue that decision-making possibilities have been improved through the wide variety of OGD available to key decision makers, experts, and non-experts, including members of local communities. OGD can contribute to decision-making processes in very diverse ways. It can improve participatory decision-making [48] real-time transparency of decision-making [9] and enable data-driven decision-making in the planning process [49].

Anti-corruption. Promoting anti-corruption and the effective use of public resources are seen as dominant reasons for releasing public data. A lack of information can lead to corruption, and OGD can be a powerful tool to increase awareness while reducing the misuse and waste of economic resources due to corruption [11,50]. However, most of the released public datasets on the OGD portals seem less relevant in terms of utilizing them for anti-corruption purposes, which decreases opportunities to achieve OGD's anti-corruption possibilities [41,51].

Smart city. Smart use of technologies is key for enabling urban populations and stakeholders to participate in and collaborate on urban management to become a 'smart city' [37]. Bakici et al. [52] argue that OGD is a main component of smart cities, which also include smart districts, living labs, initiatives, electronic services, and additional infrastructure that enable the dynamic generation of new ideas through the utilization of released public data. Spatial open data infrastructure, which is a core type of open data for smart cities, may improve urban management [53]. Furthermore Chakraborty et al. [49] suggest that a lack of reliable open urban data can negatively impact urban planning and implementation.

New services. Service creation over OGD is mostly associated with innovations and smart city. However, some new services cannot be considered innovative while those services are new as an approach or a location. OGD also can be utilized to extend existing services, increase number of functionalities and quality of services. Geographic information and postcode data can be a resource for improving existing classic services [43]. Service creation based on OGD is in the early stages of its development which Chan [54] notes that competitions and increasing awareness are the important factors to extend the participation of users.

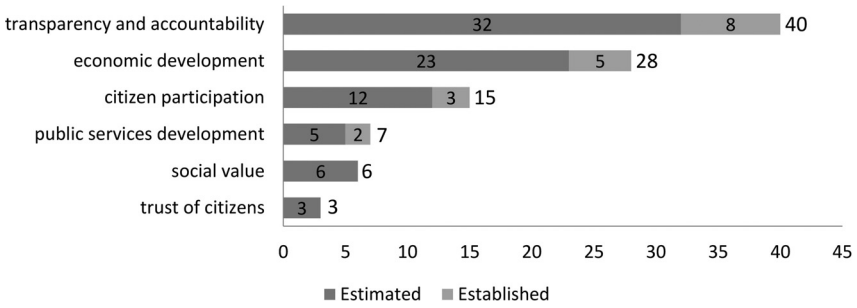

Fig. 6. Number of articles on effects.

Research. Planning and predicting the potential directions of OGD utilization, particularly in the research areas are very difficult. OGD allows a researcher to combine his/her internally collected data and public data in order to test and confirm new hypotheses [25]. OGD can be utilized for various academic studies such as unemployment research combining UK election data and non-government open data [25] for ecological research combining data on the number of trees (OGD) and open street maps (non-government open data) [55] and many other fields of research. Martin et al. [16] consider the researchers as a part of the open data ecosystem and argue that there is less awareness of open data among researchers.

Hackathons/competitions. Hackathons and competitions are considered a type of utilization to create value from released public data. Hackathons are events which focus on developers and mostly other information technology related stakeholders to work in partnership on a specific domain or project. Matheus et al. [17] emphasize the importance of contests and hackathons to develop applications for social control, transparency and improvement of public policies in healthcare, transportation, education and etc. Hackathons are also suggested as a significant component of open innovation strategy to spur citizen engagement, to seek new ideas and improve awareness for utilization of OGD [54]. While civic hackathons have a positive impact on citizen participation, limited adoption of the results may decrease their effect, thus pursuing and maintaining the outcomes are important [18].

4.2. Effects of OGD utilization

We found 83 articles that considered one or more effects of OGD. According to the literature, OGD utilization has diverse effects, mostly related to generating social and economic value and achieving good governance. Thematic analysis of selected studies revealed six prominent effects, which were determined to be so due their occurrence in at least three studies:

Figure 6 highlights the important difference between ‘estimated’ and ‘established’ effects. Not all studies that discuss effects employ empirically verified approaches. In addition, some articles are not intended to confirm or cannot empirically confirm a solid connection between OGD utilization and the discussed effects. In this regard, the effects can be classified either as established effects or estimated effects. If the study empirically proved the effect of OGD, it is considered an ‘established effect’, while hypothetical consideration and assumed effects are considered ‘estimated effects’. Among 83 articles that discuss one or more effects of OGD utilization, 19 studies’ approaches to the effects were classified as established, while 64 out of 83 studies were classified as estimated.

According to this distinction, only one-fifth of the selected articles indicated one or more established effects of OGD utilization. Nevertheless, the majority of studies either do not discuss OGD utilization

effects at all, or they estimate the potential effects of OGD utilization. As is clear from the reviewed literature, while OGD has gained extensive popularity with the recent establishment of many public data portals, Empirical studies have yet to fully validate the potential effects of OGD utilization. A total of 40 studies considered transparency and accountability as effects of the release and the utilization of OGD. Economic development and citizen participation are the next most mentioned effects of OGD utilization.

Transparency and accountability. Transparency and accountability are the core expected effects of all OGD initiatives, regardless of the scope, government organization, and type of data. OGD can be considered an important component of so-called computer-mediated transparency [56]. Releasing public data decreases information asymmetry and thus increases transparency and accountability [57]. Moreover, the creation of modern tools based on OGD [58] promotes the utilization of public data by civil society, which increases transparency, accountability, and government efficiency by enabling citizens to collaborate with the government to tackle threats against public interests [59]. However, increasing transparency and accountability is not an immediate result of releasing public data. These outcomes require the fulfillment of many preconditions. For instance, the data that is released must be relevant, and data analytics skills and awareness must be increased. Murillo [51] argues that although a moderate number of datasets relevant to achieving transparency have been released, thus their contribution to openness is limited regarding to provide relevant data.

Economic development. Generally, economic development is perceived as quality and prosperity improvements realized by innovation, diminishing transaction costs and the utilization of proficiencies toward realization of new goods and services which positions the economy on a rising growth trend [60, p. 12]. A main driver for national governments' to release datasets is economic development [61]. Availability of public data creates opportunity for citizens to conduct social control, suggest developments of public services thus achieve local economic development [33]. The contribution of OGD to the economic development is mostly related to the establishment of new business [23], and using OGD for anti-corruption purposes to reduce the economic loss, hence lead to social and economic development [50]. Moreover, OGD may contribute to information markets, which consequently enhance economic growth and efficiency [43]. However, several studies highlight that open data utilization by private sector is in the initial stage of its development and does not necessarily effect on the creation of economic value, thus economic outcome is uncertain [22,61].

Citizen participation. According to the UN World Public Sector Report 2008, the notion of citizen participation, which strongly correlates with good governance, is the participation of citizens in policymaking, including levels of service, budget, and adjusting government programs toward community needs and building public support [62]. Openness is considered a strong determinant for participation by citizens and other stakeholders which is fundamental subject in the studies of public administration [63]. OGD initiatives and utilization of public data can decrease the citizen participation barrier and encourage political participation by providing indirect channels into government activities [27]. Janssen et al. [64] discuss citizen participation and self-empowerment as one of the political and social benefits of open public data. Achieving better results with citizen participation will essentially be determined by the prerequisites, like specific abilities and skills of the citizens [37] which is discussed more broadly as an utilization condition in the next section.

Public service development. New public services based on OGD either appears as an innovation building new services or functional improvement of existing services. The important contribution of OGD to the public services as regulations, procedures and standards is a common subject in the literature, emphasizing its capability to foster the quality of services. By means of information openness, government bodies are expected to deliver more cohesive, precise and innovative services to the citizens [65]. To

improve the public administration and the outcomes, OGD can be utilized for public service development creating synergy with citizen participation on policy and service creation [66]. New public services based on OGD created by citizens increase cooperation between government and community with real social innovation [52]. Public service development is discussed as an estimated effect of OGD utilization in the literature with strong expectations by scholars for improving quality and effectiveness of public services. However, public bodies less willingly support OGD initiatives with assumption that released data might be utilized to establish better service applications than existing tools that the government provides [65].

Social value. Although the reviewed literature predominantly discusses social value as an estimated effect of OGD utilization, there are enormous expectations on OGD for obtaining more social value with effective utilization of public data. Consequently, social value is one of the primary driving factors of OGD initiatives by governments and utilization by society members [22]. Broad aspects of social value generation are discussed in the literature as an effect of OGD utilization such as social control for efficiency of public services [17], social innovation for innovative solutions of social problems in cities [52], increase citizen interaction with government for solving local problems [28] or social value from better transportation, health care, education and etc. However, getting better results are strongly depended on the elimination of disabling conditions of OGD utilization regarding institutional issues, user participation, legislation and technical issues [64].

Trust of citizens. Social and political trust of citizens in government is considered an important potential effect of increased government openness [67]. While trust is widely studied subject in political science and public administration, only three OGD related studies discuss trust of citizens as a social and political benefits of OGD. There is insufficient empirical verification for utilization - effect relationship between OGD and trust of citizens, thus trust is an estimated effect of OGD utilization. The trust of citizens effect can only be achieved under severe circumstances associated with quality of released data, including the completeness of datasets, accuracy and reliability of OGD that has been collected in a reliable record management conditions [68]. Depending on complexity and preconditions, OGD might not create trust in government, even cause negative consequences and bad experiences [64]. Consequently, transparency and data openness can be considered supportive effect for improvement of citizen trust [69].

4.3. Conditions of OGD utilization

With respect to the types of utilization and the effects, conditions are a central phenomenon of OGD utilization. They not only impact the enhancement of effects, but they also increase the possibilities of utilization. Not surprisingly, the most discussed condition for the use and re-use of OGD resources is the quality of data, which is followed by legislation/policy, skills, and infrastructure.

The relationships between the utilization of OGD and the acquired effects are not a simply “drag and drop”. Instead, they require many technological and social pre/post-conditions to be accomplished that may either enable or disable the utilization process. According to our observations, 77 studies discussed at least one or several conditions that impact the utilization of released public data. Some conditions cover very broad aspects of OGD and are discussed in only one study. These include open innovation strategies [54], information policy [1], open data ecosystems [16], organizational culture and leadership [31], or organizational support [45]. The conditions that directly influence OGD utilization and are discussed in three or more studies are listed below.

Quality of data. Nearly 36 studies mention one or several parameters of data quality that have impact on use and re-use of public data. In this regard, there are strong theoretical arguments that quality of data

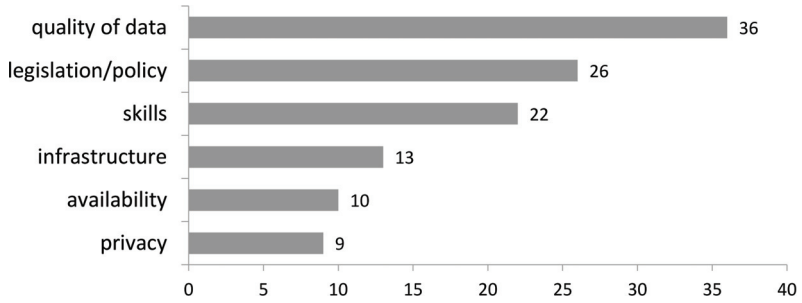

Fig. 7. Number of articles on conditions.

is prerequisite for obtaining better effects from OGD initiatives and utilization. Potential users and user groups cannot anticipate the expected benefits that can be achieved, thus users may be unwilling to utilize OGD if data quality is low [70]. Data quality is a complex and multidimensional concept. The literature generally identifies timeliness [4], availability of metadata [71], accuracy [72] and usefulness [2] as key components of data quality. In this regard, quality assurance might be a useful mechanism to increase effects of utilization and hamper problems regarding OGD utilization [2].

Legislation/policy. Legislation and policy is the most often mentioned condition alongside data quality [65]. Like all other conditions, legislation and policy can either spur or hamper both the types of utilization and effects of OGD utilization. Freedom of Information (FOI) legislation is an important legal backbone and fundamental to enable and enhance OGD implementation and can reduce resistance of public bodies to opening up government data [20,39]. Development of a legal framework is considered one of the main requirements for further development of OGD initiatives, along with political data publication, data standards and targeting stakeholders' interests [27]. However, legislation and policies are not always supportive for opening up government data. Rather frequently, it is considered as a barrier for building more resilient OGD initiatives. Particularly, legislative barriers and shortcomings regarding data protection and funding models need to be solved for opening up more public data and utilize them without any impediment [31]. Consequently, a clear and harmonized legal framework is needed to regulate the relationship and eliminate ambiguities between copyright, privacy, personal data and data openness to achieve the full potential of OGD [39].

Skills. To be able to use OGD, technical skills and knowledge about data is needed, such as knowledge about statistics or programming. ICT literacy is considered to be a more significant conditions than financial and other resources in order to establish an innovation by utilizing OGD [22]. Graves and Hendler [44] argue that whether important group of users, such as journalists and activists – want to obtain benefits from public data, lack of fundamental skills and expertise regarding data management, data visualization and data operations hamper getting value and creating positive effects by utilizing OGD. Open data focused research centers, think tanks and innovation incubators (e.g. Open Data Institute, Open Knowledge Foundation) have a significant role in development of required skills and expertise and supporting innovations creation processes and businesses using OGD [22].

Infrastructure. The increasing data generation requires infrastructure that facilitate data exchange between government bodies and users, such as software for data analytics and discovery and web-based platforms [24]. OGD infrastructure has specific requirements and capabilities to address the challenges regarding public data sharing and utilization. For instance, OGD infrastructures need to integrate various technologies, analysis techniques and information architectures to support user requirements by using generic or specialized open data platforms [72,73]. Particularly, feedback mechanisms between supplier

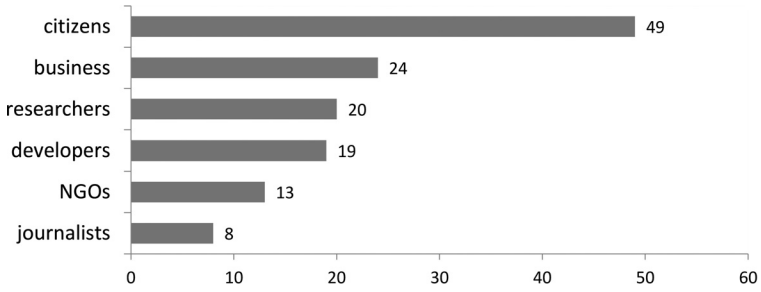

Fig. 8. Number of articles on users.

and users [9,74] and data processing capabilities [75] are the vital features of OGD infrastructure which have strong impact on the utilization of OGD.

Availability. Availability of public data is essential element or pre-condition for the value chain of data-driven innovation and OGD utilization [22]. A variety of available public data helps users to combine and link diverse datasets for processing and answering questions that were not possible with a single source and dataset [76]. Availability is considered one of the strongest enabling factors for data-driven innovation which is believed to be the cause the social and economic value generation [24]. Availability of OGD is considered to be a necessary, yet not a sufficient condition for OGD utilization, because this requires the fulfillment of many other conditions, like skills and technical knowledge, public awareness and quality of data, to achieve or increase the expected effects of OGD utilization.

Privacy. Elimination of private-sensitive data and other attributes may cause privacy breaches is the first phase of data preparation for publicly releasing [69]. Complying the data protection legislation appears to be concerned over how public data be anonymized and which parts of data be released [28]. Privacy and confidentiality, copyright and misuse of data are considered foremost possible threats for government decision-makers to freely release public data [10]. As a result, data policies regarding OGD should address privacy issues upfront, including not publishing national security related data and to ensure the compliance of confidentiality and privacy guidelines [72].

4.4. Users of OGD

A systematic approach to understanding the OGD utilization process by investigating users is particularly important because of their purpose on data usage and because they are consumers of utilization effects. Generally, 82 studies noted one or many user groups that utilize OGD. Since the goal of this review is to investigate direct (directly utilizing OGD) and indirect (consuming effects of OGD utilization) users, eight type of users and user groups were extracted. Each of these was discussed in three or more studies. Generally, the users can be divided into two broad groups: revenue-driven service developers and companies; and public-value-oriented users encompassing journalists, researchers and citizens in general [30].

Nearly half of the selected articles mention citizens as users of OGD. This is primarily because citizens comprise a very broad user group and the studies are less empirically focused on a particular user group. Moreover, the reviewed literature shows that users of OGD are relatively less researched as subjects and authors. Instead, most literature merely makes estimates about users. Several articles studied users and user groups as stakeholders in an OGD ecosystem [74] or as part of the study domain [49,77]. The next most discussed user group after citizens is the business community. In general, 6 user categories or groups were determined, with each user category having been discussed in at least 3 articles.

Citizens. Releasing government data is considered to be a key mechanism for reducing the asymmetry of information among citizens and governments bodies [51,58]. One study identifies citizens as primary stakeholders (along with businesses, researchers, and journalists) that are the major beneficiaries of utilization due to increased participation, which enables citizens to obtain more insight into government activities [27]. OGD allows citizens to evaluate the activities of government bodies and to take a more active part in government decision-making [78]. The most effective way to deliver public value and address a wide range of community challenges that still need to be improved is through the creation of mobile applications developed by citizens and built to utilize public data (which the author calls "citizen apps") [79]. However, Mainka et al. [80] argue that although there are limited examples of mobile applications developed by citizens, released government data does not necessarily result in the rapid spread of application development. Data analysis skills, the presentation of open data, and data exploration are critical factors for determining citizens' ability to achieve accountability, and these require affordable tools for citizens to analyze and share public data [23]. Therefore intermediary tools that demonstrate to citizens how they can use open data in familiar ways are necessary [81].

Business. As stated, users are perceived as revenue-driven and public-value driven regarding their aims to utilize public data in order that businesses and entrepreneurs are forming an important part of the first category. Susha et al. [22] emphasis that the drivers and motives behind the establishment of social innovation projects that targeted to solve social problems are different from those directing to marketable products using public data for commercial profit. Despite the practical difficulty in observing OGD utilization by business bodies (either because it is not one of the core activity of business or it is hidden under trade secrets), the rapid development of data technologies, such as data mining and data analysis, has created promising chances for research of business as a user of OGD. Very few studies focus purely on businesses as a user of OGD, yet there are exceptions. For instance, some authors discuss the development of commercial products over OGD [23], driving factors of OGD utilization by business [22], diverse business models using open data [77], OGD as a foundation for entrepreneurial innovations and start-ups [43], utilizing specific datasets for business decisions [38]. It is believed that accurate and reliable data can support businesses to utilize those public data for better decision-making [25,82], although this effect is not yet empirically validated.

Researchers. Researchers are mostly mentioned in combination of other users like journalists, NGOs and citizens. Graves and Hendler [44] assume that researchers and journalists may utilize OGD to investigate public policies, education system, healthcare and etc. activities of governments. Taking into account the availability of advanced data analytics tools and high professional competencies of researchers, awareness of data availability, openness and limited engagement with OGD projects are primary obstacles for utilization of data by researchers [16]. In addition, to interpret OGD, it is necessary to have precise knowledge about the context of the data. Therefore, researchers need contextual qualitative data along with OGD in order to utilize public data effectively for academic purposes [83]. Although the role of OGD in scientific studies have been less investigated, the increasing number of studies that handle specific open dataset for research purposes, can be considered decent foundation for exploring researchers as a user group of OGD utilization.

Developers. Open data developers perform significant role to encourage the adoption of OGD policies and revealing more and more datasets [28]. OGD initiatives allow developers to establish professional networks of developers to support development of universal tools and encouraging the standardization of the utilization processes of OGD [84]. According to Desouza and Bhagwatwar [79], the majority of the OGD based projects are established by developers as start-ups. Accompanied by the availability of data resources, a complementary additions, such as APIs (application program interface – containing

protocols and tools for application development) are considered an essential added value for developers to establish services based on "live" public data [54]. Finally, taking into account the primary role of developers in the utilization process, research on cultural and regional features is needed to get a more comprehensive picture of the role of developers [80] and motivation of developers [85] in OGD.

NGOs. Building resilient OGD ecosystem strongly requires the involvement of NGOs such as Open Knowledge Foundation, World Wide Web Consortium (W3C), Transparency Hacker Groups or Transparency International, which are very active on constructing guidelines, promoting discussions, pressing national governments for releasing more data and organizing events [17]. Although NGOs are estimated less primary user group comparing to business, media and citizens (particularly for open spending data), they have a professional interest and expertise for releasing and utilizing public data [86]. Additionally, collaboration and partnership mechanisms between NGOs and governments by means of contests, financial and technical supports and grants, offer more effective results [84]. Along with active role of NGOs on OGD movement as defenders, utilization of specific public data may add significant input towards realizing their activities which OGD's potential, in this regard, essentially remains unexplored [87]. Consequently, the literature has mostly discussed the promoter and campaigner role of NGOs in OGD utilization rather than as an end user of OGD.

Journalists. Journalists are a user group that are highly involved in utilization of OGD for their daily activities to conduct studies and write newspaper articles, including a visualization of public data [44]. Journalists, for instance, may integrate several datasets for bringing new insights that individuals may not be able or eager to conduct such research [7]. Moreover, along with opening up relevant public data, government policy should effort to increase motivation of data journalists and their community implementing grant programs, supports of NGOs and targeted funds to solve social problems, particularly corruption and misusing public resources [88]. The studies mostly handle the journalists as a user group along with other potential user groups without specific attention thus, some studies discuss journalists with NGOs and business [86] or journalists with other citizens [59,81].

Finally, the summary of thematic analysis and classification are presented in the Table 2.

5. Synthesis and discussion

5.1. Synthesizing our findings: The OGD utilization framework

The systematic literature review has resulted in a more comprehensive understanding of the types of OGD utilization, effects, contextual conditions, users and the relations between these factors. Most importantly we find that most relations between utilization factors are assumed or hypothesized and not tested empirically. Based on the four categories we introduced at the start of this article (types, effects, users, conditions), we can now 'fill' these categories with insights from the literature in a conceptual framework (Fig. 9).

In the proposed OGD utilization framework, two types of utilization can be distinguished based on the literature: analytic utilization and synthetic utilization. Moodysson et al. [89] distinguish between analytic and synthetic utilization according to types of knowledge creation as follows: analytic denotes the understanding and explaining of characteristics of the world and its features, while synthetic contributes to the design or establishment of something to reach functional objectives. In this regard, analytic utilization refers to OGD utilization that explains specific features or solves particular problems, such as public, business, or government problems by implementing a specific set of algorithms to analyze specific public data sets. On the other hand, synthetic utilization refers to the utilization of OGD to develop tools and appliances that solve functional problems, such as delivering better services.

Table 2
Summary of thematic classification

Factors and brief description	Num. of articles	Categories	References
TYPES the use and re-use of OGD for a particular purpose, typically as a field of study or practice	30	Innovation	[9,18,21–24,28,33,37,38,40,44,48,52–55,58,61,74,79–81,84,88,90,100,105,112,115].
	7	Data analytics	[8,19,25,28,44,46,48]
	6	Decision-making	[25,47–49,79,96]
	6	Anti-corruption	[11,50,51,88,103,106]
	6	Smart city	[37,40,49,52,53,80]
	5	Research	[6,16,25,55,83]
	5	New services	[40,48,100]
	3	Hackathons/ competitions	[17,18,54]
EFFECTS the potential results and outcomes of OGD utilization from social, economic or good governance perspectives	40	Transparency and accountability	[2,4,6,7,10,17,20,21,28,29,31,38,39,44,51,57–59,64,66,68,69,71,79,82–84,86–88,91,95,97,101–103,105–107,109]
	28	Economic development	[8,17,18,22–24,27–30,32,33,41,45,46,48–50,52,54,55,61,64,77,90,100,112,115]
	15	Citizen participation	[9–11,27,37,48,54,57,64,66,68,86,97,101,103];
	7	Public services development	[8,17,33,47,52,79,85]
	6	Social value	[17,22,24,28,30,64]
	3	Trust of citizens	[64,68,69]
CONDITIONS the environmental features or aspects of overall OGD utilization functioning as technical, social or political paradigms of public data usability	36	Quality of data	[2,5,6,16,22,23,25,26,41,45,49,51,55,57,61,64,66,68,70–74,79–81,83,87,94,95,97,102–104,108,113]
	26	Legislation/policy	[1,9,10,20,22,27,28,31,39,51,61,64,65,68,71,74,78,90,91,96,97,99,103,110,114,115]
	22	Skills	[7,10,16,22,24,37,39,41,44,46,47,59,64,74,77,82,83,91,96,98,106,116]
	13	Infrastructure	[5,9,10,24,70,73–75,85,91,95,96,104]
	10	Availability	[16,22,24,25,40,41,45,66,71,97]
	9	Privacy	[10,28,29,39,50,69,71,72,109]
USERS individuals or groups that use public data for achieving the targeted effects and gaining value mostly in the form of product, advantage or practice	49	Citizens	[2,8,10,11,19,21,23,26–31,37,38,44,46,47,50–53,58,59,61,66,69,70,72,78–84,86,91,94–98,103–105,109,110,115]
	24	Business	[4,8,9,22,23,25,38,41,45,48,55,76–82,86,96,109,110,112,115]
	20	Researchers	[6,8,9,16,19,32,38,45,46,49,55,76,82,83,94,95,105,106,109,111]
	19	Developers	[9,18,28,29,37,40,46,48,54,61,70,79,80,84,85,100,101,110,112]
	13	NGOs	[4,17,29,32,51,82,84,86–88,91,96,109]
	8	Journalists	[7,9,26,44,59,81,86,88];

The conditions of OGD utilization are also separated into two categories: technical and social. *Technical conditions* are features such as the quality of data, their availability, and the infrastructure for making them available. *Social conditions* are of an institutional nature (legislation, policy, etc.), but they also refer to the skills of users. Both types of conditions are well studied, since many scholars have recently attended to the availability of data [2,26,27,51,55,66], legal and regulatory issues [1,61,78], barriers to and enablers of OGD [10,28], and many other conditions that impact OGD utilization. However, each study concentrated on different types of conditions and used a different methodology to measure the impact, which makes it difficult to generalize their results.

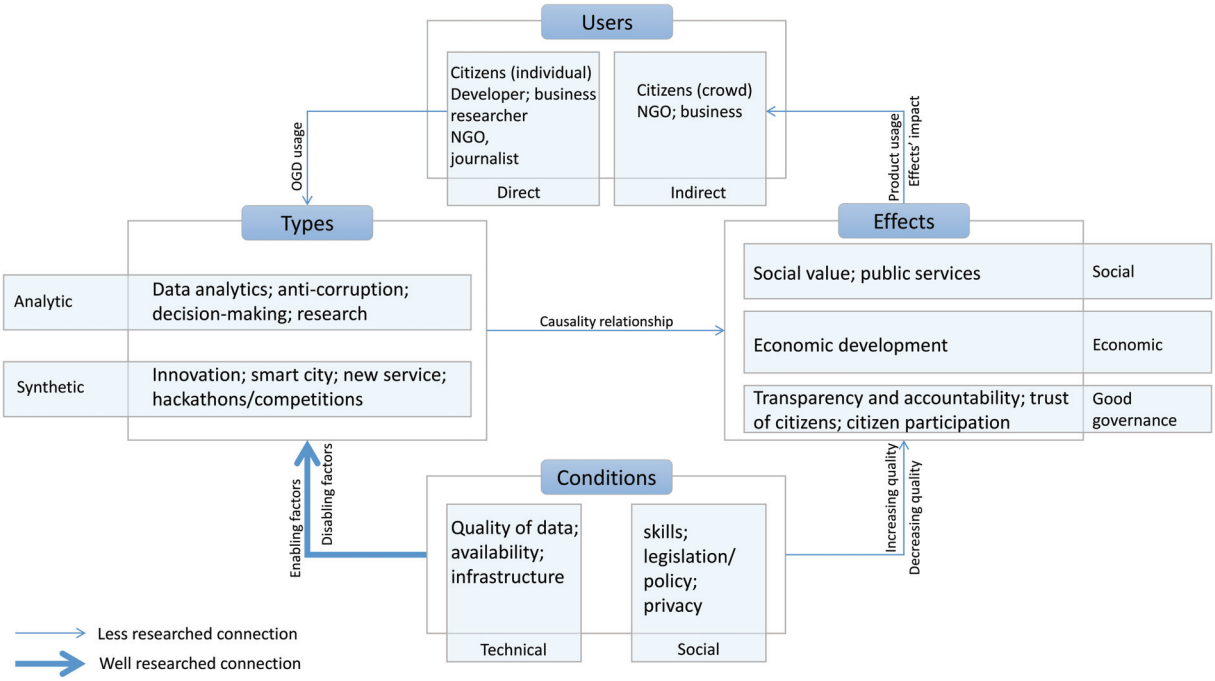

Fig. 9. OGD utilization framework.

The review found various hypothesized and established effects of OGD utilization: *social effects* include social value generated by utilizing OGD and public services (e.g. [22,24]), *economic effects* include OGD utilization for economic development and increasing the efficiency of various economic activities (e.g. [28,90]), and *good governance effects* include transparency and accountability, the trust of citizens, and citizen (e.g. [51,91]).

We found a distinction between *direct users* – those who make use of the open government data themselves – and *indirect users* – those who make use of data that has been processed by intermediaries. According to the findings of this review, studies that investigate OGD stakeholders [32] and commercial uses of OGD [77] discuss users more comprehensively. The authors highlight the benefits of OGD for different users, including commercial organizations [44,55,79], which have extensive expectations for OGD. In addition to those who have professional skills and technical knowledge, users also include those who can utilize simple datasets or who consume the effects of OGD utilization. The results show that most studies globally describe users (like citizens) rather than focusing on specific types or groups of users, and users' motivations are less researched.

5.2. Challenges and opportunities for future research

The review revealed some gaps in the literature on OGD utilization. First and foremost, we found that many of the effects of OGD were not empirically tested but only proclaimed. More rigorous empirical research is needed to assess if the estimated effects of OGD are actually measurable. Our findings highlight that various relations are proposed but only the relation between conditions and data utilization has been empirically tested. Below we will highlight four potential future research directions.

5.2.1. Investigate the link between type of utilization and type of users

The relation between users and types of utilization could be studied. In other words, what types of users are there and in what way does this shape the way OGD is used in practice. For instance, we know very little which citizens use OGD but more importantly we do not know the type of utilization that would be interested in. Our review made clear that there is a wide range of potential utilization types, and some may be more closely aligned with citizen preferences than other. To improve usage, we would need to better map the link between *who* uses OGD and *how* this type of user will do so. A promising way to enhance OGD utilization might be to investigate users and their motivation, which could improve the efficiency and number of utilization types and their positive results.

5.2.2. Investigate the link between type of user and type of effects

Another link that warrants empirical attention is the link between types of users and effects. How will different users social, economic and governance effects? For instance, data journalist will produce newspaper articles and may influence public debates and possibly resulting in better governance, whereas entrepreneurs will be likely to try to find a business model that brings economic gain. So far, the literature has paid little empirical attention to the conditionality of the type of use, users and potential effects and further research is needed.

Furthermore, there is a strong focus on good governance effects, such as transparency and accountability. As these are core good governance principles, but there are other good governance effects that are currently lacking serious attention. These include citizen satisfaction [47], cost reduction [28], crowdsourced monitoring and cooperative planning [87], fostering competitiveness [52], and better urban planning [79,80]. Overall, we need more empirical evidence to prove the estimations made in the literature and to establish mechanisms for measuring the mentioned effects.

5.2.3. Investigate the moderating conditions of OGD effects

The third link in our framework that requires investigation is between conditions and effects. To result in positive outcomes on society, governance and economy with utilization of OGD, we need to know more about what conditions moderate these effects. For instance, there may be utilization for analytic or synthetic purposes, but this will only result in positive outcomes (stronger economy, better governance) if certain conditions are met. Our review showed that quality of data, skills, policy and legislation are all potential conditions that effect the link between usage and outcome. We know very little, however, what conditions moderate what type of use and which of these conditions are more or less important. We encourage scholars to develop empirical studies that investigate these conditions as potential moderating variables between OGD usage and one or more potential outcomes.

5.2.4. Establish causal link between utilization and potential OGD outcomes

The fourth and final direction is a more general concern and more difficult to solve research issue. The causal link between utilization types and effects is another important connection that requires rigorous research to reveal direct causality relation among a specific utilization dimensions and its effects. To be able to draw causal inferences other research designs may be needed. We found that the predominant research type in OGD studies is qualitative or quantitative (mostly survey based). Although these methods have their merits, they may less successful in drawing robust causal inferences about cause and effect, as reverse causality may be an issue.

For instance, on the one hand, using OGD may result in greater wealth when successful businesses are created. But the reverse possible as well, wealthier jurisdictions (states, countries, cities) may also have more resources and more enterprises already. To investigate truly causal effects carefully designed

experiments are needed, a trend already witnessed in some areas related to OGD, such as government transparency [92]. Experiments are useful to establish cause and effect separately, by carefully manipulating one or two crucial variables that are expected to cause an effect. For example, to investigate the effect various types of utilization, in a field experiment a researcher could encourage various slightly different datasets encouraging data analytics, research, or something else, and closely monitor results in what type of effect.

5.3. Practical implications

We identified a growing attention on the OGD initiatives, and also an increasing need to understand the nature of OGD utilization and its factors. In this regard, the systematic review delivers a ground for practical decision-making regarding OGD utilizations. Policymakers wishing to achieve better utilization outcomes are advised to evaluate possible types of utilization in a specific context. Moreover, it is required to understand better the conditions of OGD utilization process which consist social and technical components. This is particularly important as the conditions moderate the effects of OGD utilization. Thus a holistic picture on OGD utilization is needed, including the consideration of diverse user groups, their requirements and potential effects. In respect of policy, there are strong implications that the discussed four factors have a substantial role to play in the success of OGD initiatives, nevertheless evidence is currently not systematic and strong enough to inform policymakers on how they can consider, support and facilitate potential outcomes.

6. Conclusion

This article presented the results of a systematic literature review on OGD by analyzing 101 studies. As with all research, our study is subject to several limitations. OGD is relatively new field of study so that, there are limited number of empirical studies which researched OGD utilization. We used only 4 the most recognized academic databases: Scopus, Web of Science, ACM and ScienceDirect. An additional search in other databases (*Emerald et al., IEEE and InderScience*) did not result in any new entries in our corpus. The searching process may have also excluded some relevant studies which cover OGD but named differently such as “open transportation data”, “open healthcare data” etc. However, we believe that the selected wide-ranging studies still afford to provide a comprehensive description of the current state of OGD research.

The review of literature resulted in a OGD utilization framework, consisting of four generic categories (users, effects, types and conditions) with a variety of subcategories. The framework shows the multitude of relations between these four categories and also highlights that we have little empirical knowledge on most of the relations that relate to the effects of OGD. While most authors highlight positive effects, many studies focus on OGD initiatives, facilitators, barriers and challenges. Overall, this paper offers an overview of the current OGD research, and where we can go from here.

Investigating the effects of OGD on social, economic and governance outcomes is a formidable task however. As we mentioned in the previous paragraph it is hard to try determine cause and effect. Experimentation with OGD could be a possibility. However, we also envision that qualitative studies using in-depth interviews may be able to trace causal mechanism between the utilization of certain OGD initiatives and its effects.

It is important to keep improving our efforts to investigate who, how and why OGD leads to positive outcomes for society. It is not enough to assume that these effects will occur, and that they will occur

automatically. The key contribution of this paper to the literature is the framework unravelling the various implicit relationship in research on the use of OGD. The framework we developed will help future research to systematically analyze the relations between OGD utilization and various sorts of effects. This is important because while OGD is proffered as a solution to many issues of public officials, NGOs and activists, this promise is yet to be proven. It is our duty as scholars to show whether and how this promise can be fulfilled.

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