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A systematic literature review of open innovation in the public sector: comparing barriers and governance strategies of digital and non-digital open innovation

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ABSTRACT
Based on the PRISMA approach, this article presents a systematic review of how barriers and governance strategies are different between digital and non-digital open innovation (OI). The results show that relational barriers are more influential for non-digital OI, while capacity- and technical-related barriers are the main challenges for digital OI. Moreover, it finds that political commitment and employment of intermediaries are universal strategies for OI. Coercive and mandate strategies are effective only for inter-governmental OI. When citizens and private actors participate offline, strategies are often persuasive-oriented and stress relational governance; when they participate online, strategies focus on technical capacity building.

Introduction

Open innovation (OI) in the public sector is identified as the act of governments leveraging resources and knowledge contributed by peer government departments, citizens, and private sector organizations to solve public problems (Bekkers and Tummers 2018), increase the innovativeness of public services (Mergel and Desouza 2013), and more importantly contribute to the creation of public value (Crosby, T Hart, and Torfing 2017).

Although the OI concept is relatively new in the public sector, calling on stakeholders to help solve public problems is not. Traditionally, governments design opportunities (together with participation qualifications, procedures, and rules) for stakeholders to become involved in processes of problem-solving and service provision. These opportunities are offline, including, for instance, *inter-agency meetings* where government departments share information, unite problem understanding and formulate joint policies to promote public innovation (Page 2003), *co-production forums* where citizens engage with governments to co-design and co-implement public services (Flemig and Osborne 2019; Loeffler and Bovaird 2019), and *public-private partnerships* where governments use tendering and contract to absorb knowledge and financing and human resources from the private sector for the purpose of public

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innovation (van Gestel et al. 2008; Himmel and Siemiatycki 2017). In this article, we define these traditional, offline forms of OI as non-digital OI, where stakeholder engagement does not depend on digital technologies but is subject to formal regulations, procedures, and contracts.

Digital government transformation, driven by the emergence of information communication technologies and the development of the internet, as well as the open government data (OGD) initiatives, has changed the way that governments leverage collective intelligence to solve public problems. Governments have started to design online opportunities for stakeholder engagement with public innovation, i.e. the so-called e-participation (Tai, Porumbescu, and Shon 2019). For instance, government agencies jointly build *one-stop online public services* and develop *collaborative e-government* (Gil-Garcia, Chengalur-Smith, and Duchessi 2007). Governments generate information from citizens and solicit innovative solutions to improve public services through *crowdsourcing*, i.e. open call online (Liu 2017; Mergel 2018). Governments release online OGD to empower private software developers to design innovative service applications, or to organize contests such as *civic hackathons* to develop novel prototypes for services (Johnson and Robinson 2014; Yuan and Gascó-Hernández 2019). To compare with non-digital OI, digital OI usually has few imposed rules, for the purpose of achieving a higher level of openness and potentially a bigger size of participants and submitted proposals.

The various practice activities of OI in the public sector has led to an accumulation of a body of academic knowledge and attracted a few scholars to synthesize this knowledge. Currently, there are at least four systematic literature reviews in public administration journals that aim to integrate the various insights gained on OI (Voorberg, Bekkers, and Tummers 2015; De Vries, Bekkers, and Tummers 2016; Cinar, Trott, and Simms 2019; Lopes and Farias 2020). These reviews seek to provide an explanation for the differential success of OI. However, the existing reviews pay little to no attention to the digital transformation of OI. Barriers and governance strategies are only synthesized in arenas of non-digital OI. For instance, Voorberg, Bekkers, and Tummers (2015) investigated the types, objectives, outcomes, and conditions of offline co-production, but did not mention how digital technologies affect the way that citizens co-produce public services. Similarly, De Vries, Bekkers, and Tummers (2016) examined the types, goals, antecedents, and outcomes of OI, but only categorized innovation from the process, product, and conceptual dimensions, not from digital and non-digital dimensions. Cinar, Trott, and Simms (2019) specifically studied barriers of OI and identified how the barriers will change in different innovation stages, but did not explicitly show how the barriers are different between digital and non-digital OI. Lopes and Farias (2020) turned to governance tools and strategies for traditional citizen participation in public innovation, leaving no assessment of whether these governance strategies are also effective for digital OI. Thus, to date, the literature lacks a systematic comparison of barriers and governance strategies between digital and non-digital OI.

To bridge this gap, our systematic review focuses on identifying non-digital and digital OI and investigates how barriers and governance strategies of OI will change

under digital transformation. Therefore, our review addresses the following research question:

How are barriers and governance strategies of digital OI different from those of non-digital OI?

Bridging this gap has important theoretical and practical implications. Theoretically, our review provides new insights on different characteristics of barriers and governance strategies between digital and non-digital OI, and thus generating a new understanding of the concept of OI. In practice, our review on the changes of barriers and governance strategies during digital transformation provides a timely reminder for politicians, public managers, and government administrators to take transformative leadership for OI and enables them to manage innovation in a more effective and proactive manner in the digital era governance.

This article is organized as follows. Section 2 reports the methodology used to conduct the systematic review, where we describe eligibility criteria, search strategies, and study selection. Section 3 presents the results of the systematic review, including the characteristics of the eligible studies and the answers to the research question. Finally, in section 4 we draw conclusions and develop a future research agenda on OI in the public sector.

Methodology

This article adopts the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) approach to conduct the systematic literature review, which differs from traditional literature reviews in that it is more replicable and transparent, involving several explicit steps, such as using a standardized way to identify all the likely relevant publications (Moher et al. 2009).

Eligibility criteria

Six eligibility criteria are adopted in this article to identify relevant publications:

- *Field*: Research should be conducted in the public sector. The public sector here refers to those parts of the economy that are either in state ownership or under contract to the state, plus those parts that are regulated or subsidized in the public interest (Flynn 2007, 2).
- *Topic*: Articles to be included in the review need to focus on open innovation. However, as the introduction shows, this is not limited to those articles that have the term 'open innovation' in their titles, keywords, or abstracts. Many theoretical terms, such as collaborative innovation, inter-agency collaboration, cross-sector collaboration, co-production, public-private partnership, collaborative e-government, open government data, crowdsourcing, and civic hackathon are closely relevant for OI. According to Sørensen (2020), the above-mentioned collaborative activities can be regarded as open innovation if they generate innovation outcomes. Drawn on Voorberg, Bekkers, and Tummers (2015), we understand that innovation outcomes can be both visible and invisible. Visible outcomes are often referred to as new products or concrete economic gains from innovation; while invisible outcomes include intangible benefits and improvement on those unmeasurable social aspects, ranging from enhanced public values, better social

security, more effectiveness and efficiency, trust-building to enhanced awareness of common problems.

- *Study design*: Both empirical studies and theoretical studies are included in our review, though the pure theoretical-oriented articles are only minor in number. We do so because we not only aim to synthesize the empirical evidence but also try to create a dialogue with those authors who conduct theoretical thinking on open innovation previously.
- *Language*: Only articles written in English are eligible, which is common for systematic reviews, given the practical difficulties of translation.
- *Publication year*: Articles are searched and included that are published from all past years, that is, prior to 30 June 2020.
- *Publication type*: We only include international peer-reviewed journal articles from the ISI Web of Science Core Collection database.

Search strategies

We use four search strategies. First, in order to identify the articles that address open innovation, we use the terms open*, collaborat*, inter-sector*, cross-sector*, inter-agency, co-product*, public-private, e-govern*, digital govern*, open government data, crowdsourc*, together with the term inno-vat* to search for articles. Second, we use two steps to narrow the search results within the public sector, one choosing the Social Sciences Citation Index, and another choosing the disciplinary categories of 'Public Administration' and 'Political Science'. For the topic revolving around e-government, we also include the category of 'Information Science Library Science', in order to select some important journals such as Government Information Quarterly. Third, we assess the appropriateness of the topic in the records by screening titles and abstracts. Fourth, we assess the appropriateness of the content in the records by reading full texts. We exclude those articles which do not discuss any issues of barriers or governance strategies of open innovation.

Record selection

The eligibility criteria and the search strategies ultimately lead to 174 studies included in our systematic review. Our assessment and selection process is presented in Figure 1.

Results of systematic review

General characteristics of studies

Before answering our research question, we address some characteristics of the studies included in our review.

Publication year

Figure 2 presents the evolution of the number of studies until June 2020. As can be seen, the number of articles published remained fairly constant from 1995 to 2011, at
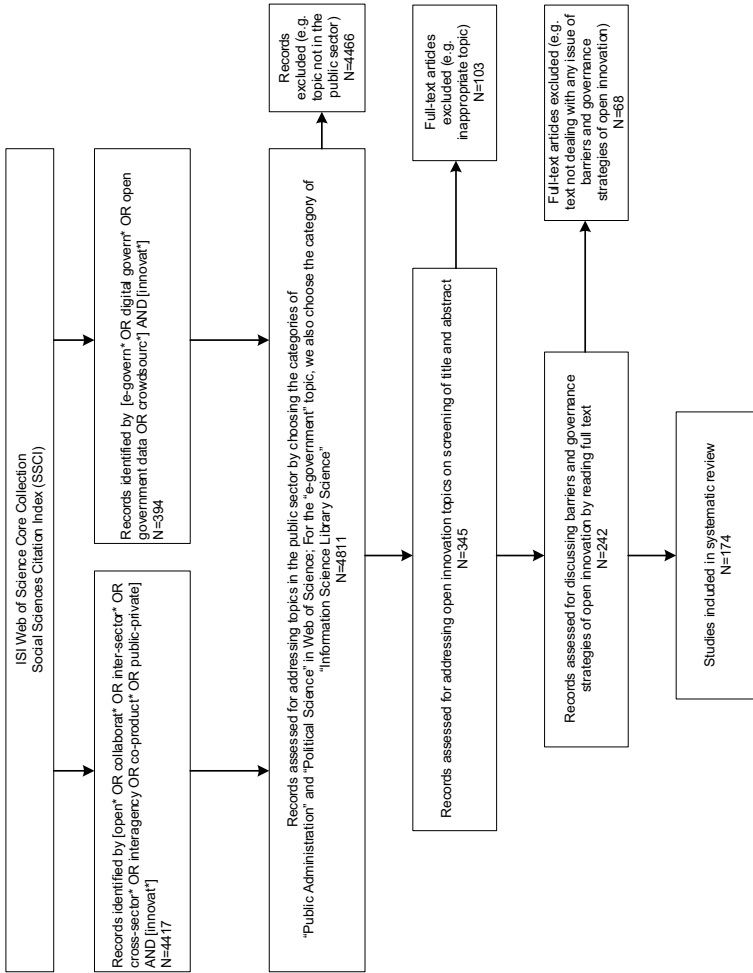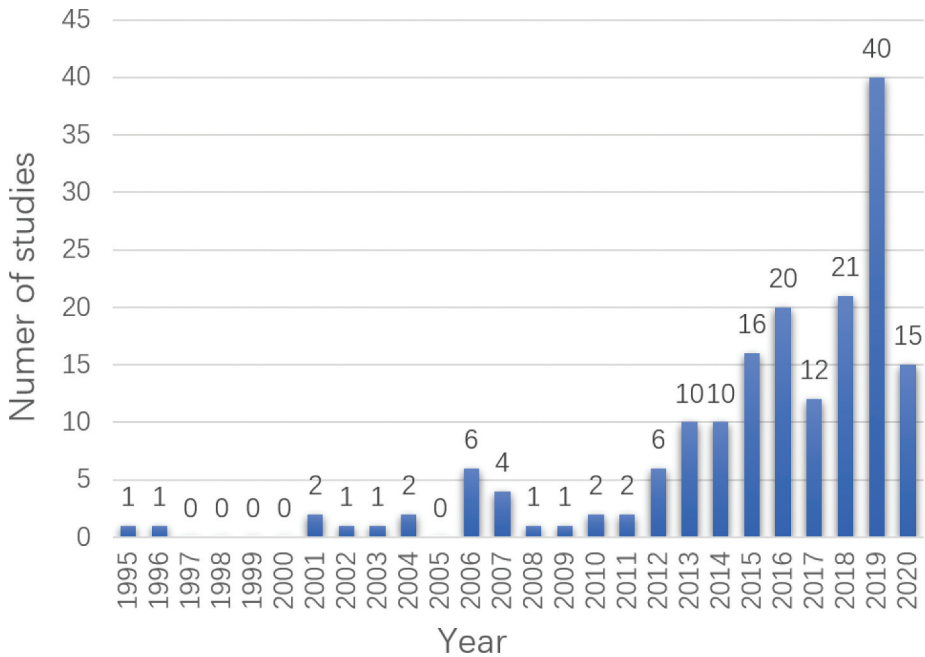
Figure 1. The PRISMA flow diagram.

Figure 2. Year of publication for articles included in the systematic review.

roughly 1.5 articles per year (24 articles in 17 years). However, the period 2012–2018 showed a considerable increase, to nearly 13.5 articles per year against the previous average of 1.5 (95 articles in 7 years). Even more significantly, the most recent period, 2019-mid 2020, shows a larger increase, to almost 36.5 articles per year (55 articles in 1.5 years). This is a very clear indication of the rapid recent growth in research on OI in the public sector.

Journals

The reviewed articles are published in 34 different journals; only the journals (22, 64.7%) that publish at least two OI articles are presented in Figure 3. The journals are all covered within the Public Administration or Political Science categories, except one, Government Information Quarterly, coming from the discipline of Information Science. The top three journals providing the greatest coverage of the topic are: Public Management Review ($n = 45$), Government Information Quarterly ($n = 26$), and Public Money & Management ($n = 15$). They are followed by Public Administration Review ($n = 11$), International Review of Administrative Sciences ($n = 10$), and Australian Journal of Public Administration ($n = 7$).

Policy fields and government layers

The review shows that OI is a practice to be found in numerous policy fields ($n = 21$), including public health, social care, urban management, emergency management, public safety, employment, education, transportation, sustainability, culture, infrastructure, regulation and law, and so on (Figure 4). The diversity of policy fields also
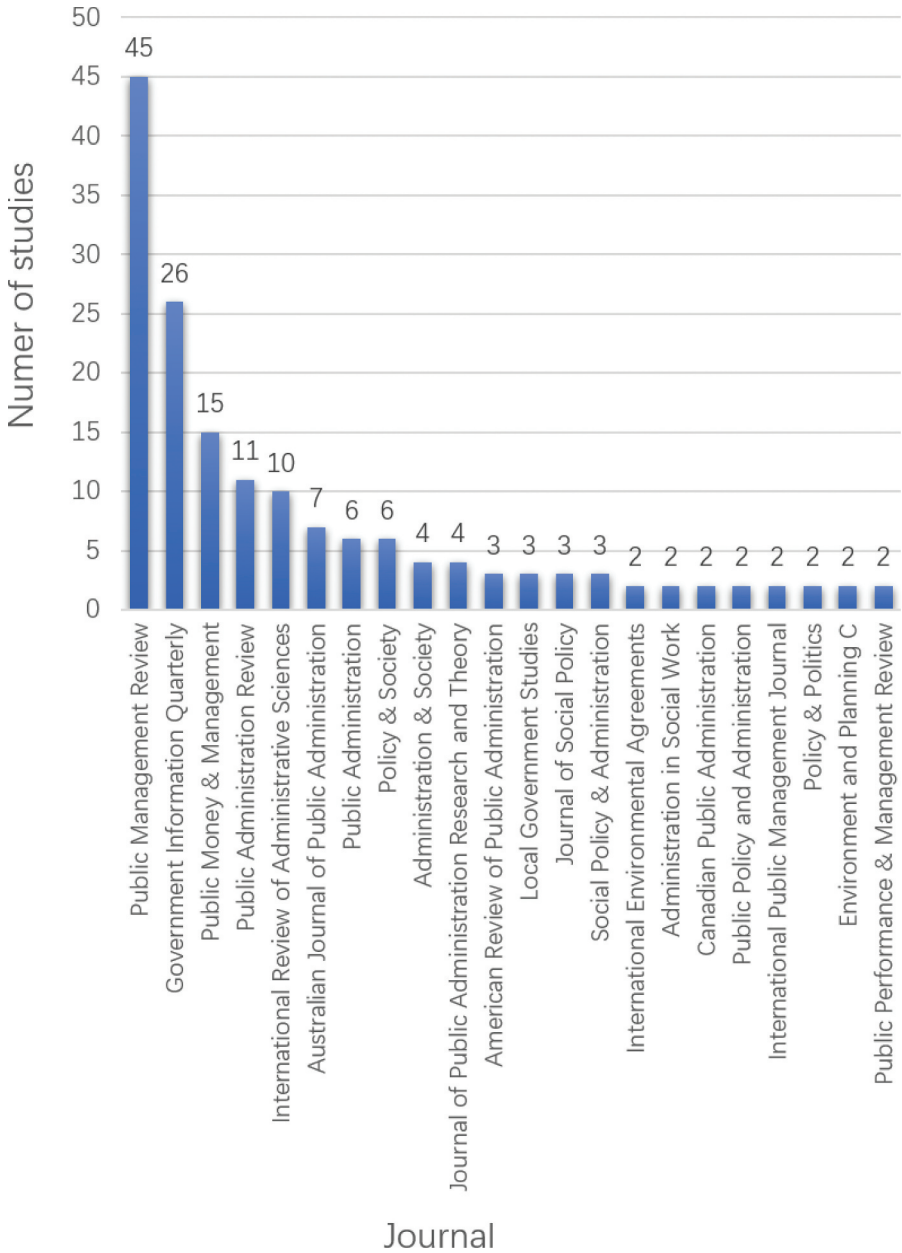
Figure 3. Publication journals (only journals that publish at least two OI studies are presented).

indicates that our search strategies cover the key policy areas for OI. In addition, the largest group of OI studies were conducted on the local government level ($n = 81$, 46.5%), followed by central government ($n = 51$, 29.3%) and others ($n = 42$, 24.2%) that do not mention government layers.
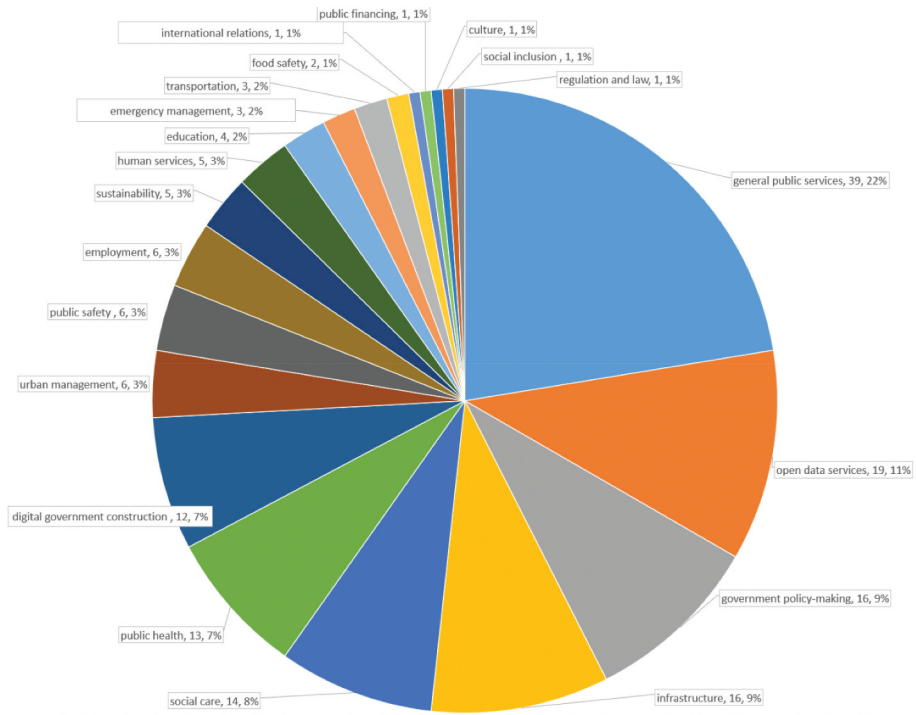
Figure 4. Policy fields covered in the reviewed studies.

Types and definitions of OI

Our review identifies six types of OI, according to the 'digital vs. non-digital' dimension and the dimension of 'who engages with government' (see Table 1). The number of studies for each type is shown in Figure 5.

Non-digital public-public OI

Non-digital public-public OI refers to government reform through reorganizing spatial, institutional, functional, or operational scale, which aims to overcome geographical, administrative, and political fragmentation, and enables government agencies from different areas, sectors, and jurisdictions to meet each other, and to work together in order to understand public problems at an upper scale and strive for new solutions for the problems (Ward et al. 2018). For example, under the central government mandate, geographically proximate city governments in China form into urban agglomerations, and city leaders meet regularly to discuss and formulate inter-city agreements to solve regional air pollution. Also, in China, the State Taxation Administration and the Ministry of Science and Technology collaborate via integrating their respective functions on tax review and determination of scientific and technological achievements to formulate joint policies on tax reduction for qualified high-tech enterprises (Mu, de Jong, and Koppenjan 2019).

Table 1. Types of OI.

	Types of OI in the reviewed studies		
	Public-Public OI	Public-Citizen OI	Public-Private OI
Non-digital OI	• Intergovernmental collaboration • Inter-Agency collaboration	• Co-production, including co-commissioning, co-design, co-creation, co-implementation, co-delivery and co-evaluation or co-assessment. • Experimental co-production, such as innovation labs, urban living labs.	• Public-private partnerships (PPPs) • Public-private collaboration • Public-private innovation • Public-private co-production
Digital OI	• Collaborative e-government • Collaborative e-governance • Collaborative digital government	• Crowdsourcing or citizensourcing	• Private-initiated OGD-driven innovations • Government-initiated civic hackathons

Digital public-public OI

Non-digital public-public OI usually needs face-to-face interactions, but digital public-public OI depends on information and communication technologies (ICTs) to realize online intergovernmental integration and collaboration for better public services (Luna-Reyes and Gil-Garcia 2014). It refers to collaborations between government agencies to share information, adjust procedures, and build up and operate intergovernmental and cross-boundary digital platforms in order to provide citizens and businesses with improved, integrated, and coordinated public services (Fishenden and Thompson 2013). An example is the 'GOV.UK' digital platform where the websites of all government departments and many other agencies and public bodies in the UK are merged, and citizens and businesses can find all services through this one-stop portal e-government. Another example is the Austrian 'no-stop shop service' through integrating data from multiple government departments and providing proactive services without any paper form; that is, a citizen only needs to give his or her consent and does not have to complete repetitive forms or perform any action to receive services (Scholta et al. 2019).

Non-digital public-citizen OI

Non-digital public-citizen OI is found in situations where individuals or groups of citizens intensely engage in any of the design, management, delivery, and/or evaluation of public services (Osborne, Radnor, and Strokosch 2016). In our reviewed literature, un umbrella term depicting such OI is co-production. Voorberg, Bekkers, and Tummers (2015) regard co-production and co-creation as interchangeable terms, but other scholars, for example, Brandsen, Steen, and Verschuere (2018. Ch.2), argue that they are different: 'when citizens are involved in the general planning of a service, perhaps even initiating it, then this is co-creation, whereas if they shape the service during later phases of the [policy] cycle it is co-production'. Scholars further create typologies to set clear boundaries for co-production. Osborne, Radnor, and
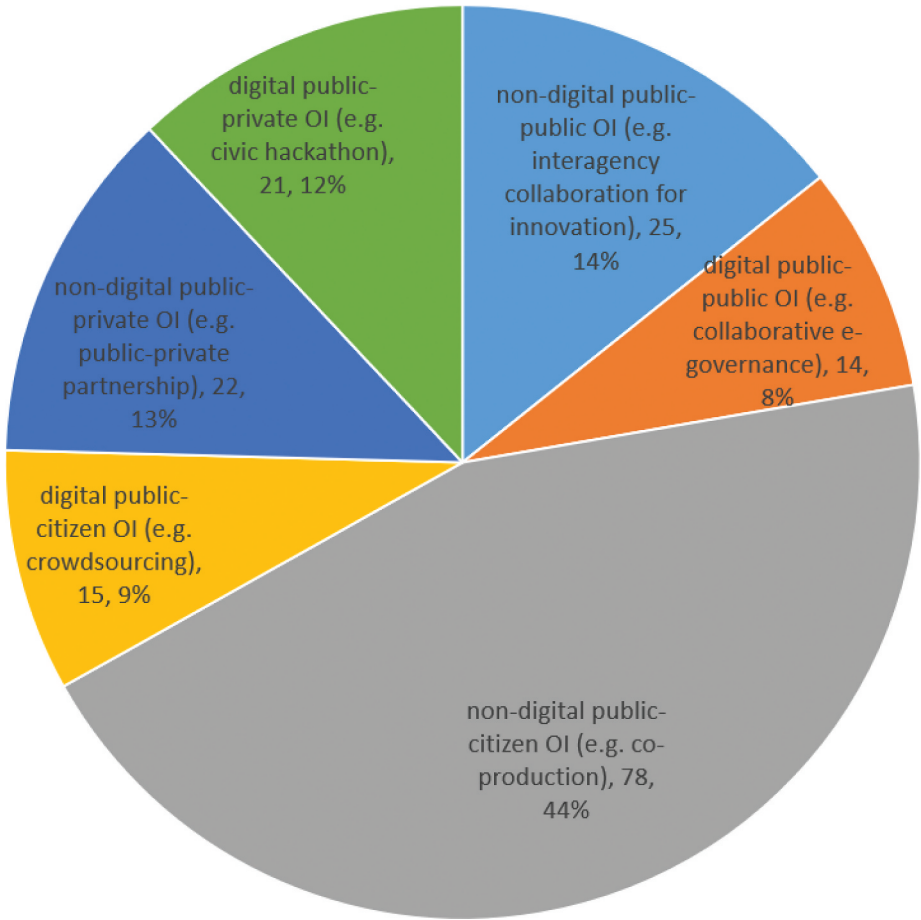
Figure 5. Number of studies for each type of OI.

Strokosch (2016) consider both voluntary and involuntary involvement of citizens in public services and distinguish *consumer co-production* that is involuntary and unavoidable involvement of citizens given that production and consumption of services occur simultaneously in time and space, *participative co-production* that citizens can take a more active role but their involvement is at the behest and control of the service provider, and *enhanced co-production* that gives citizens more power and combines citizens' knowledge into service design and delivery. Loeffler and Bovaird (2019) do not agree with the involuntary or unconscious aspect of co-production and emphasize the necessity of formal regulations and procedures to legitimate citizen participation. They build up the four 'Co's model, which stresses the importance of true power-sharing and suggests that co-production is conditioned by citizens having a real voice in commissioning decisions (co-commissioning), designing services (co-design) and giving feedback and asking questions to public service providers (co-assessment),

and making a significant contribution in service delivery by taking compliant actions (co-delivery).

Digital public-citizen OI

Digital public-citizen OI is driven by the advancement of e-government and digital technologies that promote governments to utilize crowdsourcing to generate better public services with lower costs (Liu 2017). Lember, Brandsen, and Tõnurist (2019) and Casula, Leonardi, and Zancanaro (2020) consider crowdsourcing as a model of web-based online co-production or a result of evolution of co-production in the information age. Crowdsourcing is originally defined as the act of an organization taking a function once performed by an organization's own employees and outsourcing it to people outside the organization through an open call online (Jeff 2006). When the concept enters the public sector, scholars identify several functions of crowdsourcing. First, an important goal of crowdsourcing is to involve citizens in the production of public services, such as the 311 system for requesting various local government actions for non-emergency matters including pothole or streetlight reports in the US (Clark, Brudney, and Jang 2013). Second, governments adopt crowdsourcing for soliciting solutions, such as the 'Challenge.gov' where the federal government in the US sends open calls online for proposals to solve specific public problems (Mergel 2018; Mergel and Desouza 2013). Third, crowdsourcing is applied as a new online tool for policy-making (Taeihagh 2017). For example, the UK central government draws on crowdsourcing through the 'red tape challenge' to conduct regulatory reform and e-rulemaking (Lodge and Wegrich 2015).

Non-digital public-private OI

Non-digital public-private OI is usually found in government procurement of public services or infrastructure projects from private parties. Although many interchangeable terms exist to describe the procurement process (e.g. public-private collaborations, Crispeels, Willems, and Scheerlinck 2018; public-private innovations, Smith, Sochor, and Karlsson 2019; public-private networks, van Gestel et al. 2008; public-private co-production, James and Jilke 2020), the most commonly used term is public-private partnerships (PPPs), which depicts the procurement process as a durable cooperation (based on long-term contract) between governments and private parties in which they jointly develop innovative products and services and share risks, costs, and resources which are connected with these products (Savas 2000). For instance, an innovative technology 'Mobility as a Service' is created to enable integrated journey planning and payment in West Sweden through a PPP project (Smith, Sochor, and Karlsson 2019). An innovative plan 'Combination Model' for intensive and effective use of land is generated to solve the shortage of space in Rotterdam port by interweaving PPP to bring government advantages (accountability and responsibility) and private advantages (efficiency and expertise) into full play (van Ham and Koppenjan 2001).

Digital public-private OI

With the ubiquitous growth of information technology and the internet, alternative options for governments to outsource public services exist (McBride et al. 2019). Compared with the use of a tightly prescribed and standard vendor-seeking process, open government data (OGD) initiatives now serve as a replacement for RFPs

(requests for proposals) to empower business sectors to generate new insights on public problems and to design innovative software applications or other digital products to improve public services (Chatfield and Reddick 2017; Gascó-Hernández et al. 2018). Our review identifies two models of digital public-private OI. One is private-initiated OGD-driven innovations (Janssen et al. 2017). An example is the Climate Corporation's 'Climate FieldView' that helps farmers to make decisions related to agricultural activities, based on open data from the National Weather Service, US Geological Survey, and National Aeronautics and Space Administration. The other model is government-initiated civic hackathons (Yuan and Gascó-Hernández 2019). Civic hackathons are time-limited (typically hours or days) events where citizens and businesses can access government data and intensively collaborate on new software applications that meet the public challenges posed. Civic hackathons are often coupled with prize money or other material rewards for the winner. An example is the 48-hour 'Canadian Open Data Experience' hackathon, whose winner is an app called 'newRoots' designed to help new immigrants and current residents to find a new neighbourhood that matches their employment interests with housing availability (Johnson and Robinson 2014).

Changes of barriers from non-digital to digital transformation

In this section we analyse the changes of barriers from non-digital to digital transformation in different types of OI.

Public-public OI: barriers change from 'conflicting policy framework, power imbalance, and multiple accountability disorder' to 'inflexible SOPs, technical disparity, and ownership ambiguity'.

For non-digital public-public OI, three relational barriers are identified in the reviewed studies. First, the conflicting policy framework and incompatible organizational goals between government agencies may hamper OI (Mu, de Jong, and Koppenjan 2019). For instance, Ward et al. (2018) demonstrate that different institutional structures and rules, including the varying breadth and scope of agency goals and mission misalignment, constitute important barriers in developing and implementing an inter-agency partnership of emergency management. Second, the large power imbalance also blocks OI, because if some agencies do not have the capacity, status, or resources to participate or to participate on an equal footing, the collaboration process will be prone to manipulation by strong actors. As Lomas and Rachlis (1996) show, the previously independent agencies incorporated into a block-funding taskforce for human service delivery are not of equal political and public influence, consequently leading to serious unfair budget allocation. Third, the multiple accountability disorder (MAD) may block OI. Koppell (2005) explains that a MAD may happen when there is a layering of accountability or if an organization is perceived to be accountable to numerous sources. Thus, it can be unclear for the agencies to whom the innovation is accountable and for what. As Halligan (2007) shows, in a new agency that combines the functional separation of social service providers, the agency faces the dilemma of dual obligations: political expectations/mandates and preferences that reflected the interests of its clients.

When it comes to digital public-public OI, it emphasizes collaborative e-government and integrated online customer services, which contradicts the traditional bureaucratic paradigm that emphasizes standardization, departmentalization, and

division of labour. Therefore, there might be adaptive barriers, and these adaptive barriers go far beyond technology per se. They call for new organizational capacities, new forms of leadership, and perhaps even a redefinition of purpose (Allen et al. 2001). Consequently, the low capacity to flexibly adjust standard operating procedures (SOPs) is the major barrier, because changes in SOPs need to be vetted, tested, and approved by top management and flexibility in adjusting organizational rules rarely exists. In addition, the disparities in technical capacities (e.g. information quality, system service quality and capacity) make up another barrier (Gil-Garcia, Chengalur-Smith, and Duchessi 2007). The lack of adequate professional expertise, insufficient hardware and software skills may limit the potential overall effectiveness of collaborative e-government. Moreover, there are also ownership-driven barriers. Shared use of ICT resources and information stored in these systems raises the question of ownership, responsibility and funding, the functional division of tasks/allocation of budgets between government agencies and levels (Brugger 2018).

Public-citizen OI: barriers change from 'tension-avoiding administrative culture and citizens' lack of self-efficacy' to 'limited organizational and political capacities and citizens' digital divide'.

Voorberg, Bekkers, and Tummers (2015) conduct a systematic literature review of co-production. In their review, the barriers of co-production can originate from public organizations (e.g. lack of communication infrastructure with citizens; a passive attitude of politicians and street-level bureaucrats; risk-averse and conservative administrative culture) and from citizens (e.g. lack of civic duty or incentives to improve government; a low sense of ownership of public problems; inadequate social capital; a low level of government trust). Our systematic review adds some new findings to Voorberg et al.'s. First, we find that the tension-avoiding administrative culture constitutes another barrier to co-production. Public officials will not invite citizens to participate if they realize that what citizens pursue in public services is not consistent with what the performance evaluation measures (Brown and Head 2019). Thus, co-production may experience value tensions and disagreements between public officials and citizens on what to achieve; the negotiation can be time-consuming, raises transaction costs, and finally may result in user dissatisfaction because of a failure to fulfill citizens' high expectations (Touati and Maillet 2018). On the citizen side, we find that citizens may have a strong civic duty or a sense of ownership of public problems, but they lack self-efficacy. Based on a survey on environmental co-production, Alonso et al. (2019) demonstrate that citizens will not take pro-environmental activities when they feel they cannot make a difference.

Offline co-production between public organizations and citizens is highly regulated and follows strict rules and regulations. However, the innovation acquisition process of crowdsourcing stresses a much higher degree of openness and few imposed rules and regulations (Mergel 2018). Consequently, two capacity-related barriers emerge at organizational and political levels on the side of public organizations. First, public organizations have to embrace a much more diverse solution provider space and have limited assurance that the large number of solutions that citizens provide are all useful or even implementable. In the case of Challenge.gov, Mergel and Desouza (2013) provide such evidence that because of the limited capacity to evaluate the innovativeness and appropriateness of the submitted solutions, government agencies are limited in the type of problems that they can crowdsource. Second, the crowdsourcing process can be hindered by low political capacity. Torfing and Ansell (2017) point out that

politicians do not support or even halt crowdsourcing because they feel disempowered by active citizens who want a direct influence on their living conditions, the attempt to reduce their political role in defining overall goals, standards and budget frames; or because they are unable to manage the potential risks associated with policy innovation; or they strive for ideological purity and find it difficult to engage in an open-minded debate with citizens. On the side of citizens, a commonly witnessed challenge is the so-called 'digital divide', which means citizens may lack sufficient skills and knowledge to use online public services; and new technologies cannot be integrated into people's daily routines due to the lack of e-governance culture/interest (Meijer 2015).

Public-private OI: barriers change from 'weak connections with citizens and malicious risk transfer' to 'data provenance, quality and protection problems, and limited government capacity to sustain the development of innovation prototypes'.

Although many successful innovations are reported in PPP projects, it is undeniable that innovation is not inherent to PPP, and sometimes PPP in itself poses important barriers for OI. Several studies in our literature review have yielded similar findings that the exclusive government-business interface and the lack of citizen involvement in PPP projects may lead to failed innovations because public preferences and opinions are not represented and thus the design or delivery of public services may deviate from public interests (Nederland and Klijn 2019; Boyer 2018). Research by Nederland and Klijn (2019) suggests that it is the tendering process and the presence of rigid contract in PPPs that block citizen involvement, because the tendering process contains much confidential information on prices and tendering offers of private consortia that is not publicly available, and because after the tendering process, the content of PPP project has been basically determined, leaving little room to consider knowledge and experiences from citizens. In addition, our review identifies that innovation is a highly risky business and the risk-averse motivation of private parties may dampen innovation in PPPs (Flemig, Osborne, and Kinder 2016). Scholars recognize that the actual purpose of public and private partners is to transfer risks maliciously to the other party, rather than to innovate. As Crispeels et al. (2018) show in the case of drug development, public-private innovation is considered as a suboptimal solution; only when the innovation product has poor market prospects, the product is likely to be developed in open collaboration, while products with better prospects are more likely developed internally. In fact, there is an ex-ante project selection bias in both the public and private sectors. Instead of sharing knowledge or mutual learning, governments choose to collaborate with private parties when the project's ex-ante assessed risk on failure is considered too high. By doing so, governments can shift responsibilities and key politicians can avoid blame when the project fails. Private enterprises use their knowledge advantages to select potentially high risky and less successful projects and collaborate with governments in order to mitigate financial risks.

By contrast, digital public-private OI shows greater transparency and a higher level of liberalization and decentralization in promoting public innovation. Despite this, a list of barriers associated with OGD-driven innovation has been identified in our literature review. Dawes, Vidiasova, and Parkhimovich (2016)) use the sociotechnical perspective to display that innovation barriers not only stem from data provenance and quality problems such as data validity, completeness, technical and semantic interoperability, privacy and confidentiality, but also concern governance capacity problems, including fear of misinterpretation and abuse of data, lack of appropriate

legislation or uniform policies for data publication, and ignorance of the differences among government levels or between departments. For example, Klievink et al. (2017) use the Dutch public sector's open data practice to illustrate that governments may be technically capable of releasing big data, but they will not significantly gain from OGD-driven innovation activities if the applications do not fit the departments' main statutory tasks or do not align with the existing governance and institutional structures. Regarding the government-sponsored civic hackathons, scholars report that a major barrier is the sustainability issue of the winner's innovation prototypes. As Kankanhalli, Zuiderwijk, and Tayi (2017) reveal, civic hackathons are more advantageous in promoting engagement over pursuing complete innovation products. At the end of the events, most of the digital prototypes are only initial designs that still need further incubation. However, Dawes, Vidiasova, and Parkhimovich (2016) point out that governments usually lack adequate capacities and resources to sustain multiple prototypes resulted from civic hackathons. Consequently, end results or final innovative products for public services cannot be reached from civic hackathons.

Changes of governance strategies from non-digital to digital transformation

Among our reviewed articles, only a part mentions governance strategies to remove the barriers of OI. Moreover, not all the barriers are equipped with corresponding governance strategies. Our review recognizes some common governance strategies for all types of OI, and some specific ones for certain types of OI. Besides, our review identifies the changes in governance strategies under digital transformation.

Political commitment and employment of intermediaries are common governance strategies for all types of OI.

First, authors recognize the important role of political commitment in removing the barriers for all types of OI. As Torfing and Ansell (2017) point out, promoting a more frequent and systematic engagement of politicians may help remove substantial difficulties in OI process, because politicians, driven by the alarming decline in citizens' trust, and the eagerness of societal problems, will play active roles of sponsors, conveners, facilitators, and catalysts of creative problem-solving. Similarly, Munro (2019) stresses the critical importance of long-term political commitment by keeping politicians informed and involved, so that politicians understand more about the innovation context and know where the leadership actions are most helping to achieve innovation outcomes.

Second, intermediaries can be hired or individual boundary spanners can be appointed in order to coordinate and/or meta-govern the day-to-day management of all types of OI. For example, Kim and Jang (2018) use the case of national innovation system to illustrate the necessity of establishing or empowering a coordinative body to encourage heterogeneous actors to cooperate with an effective communicative system. Similarly, Shepherd and Meehan (2012) propose to employ a person whose task is to coordinate through all different levels, in order to ensure the implementation of the innovative solution and an ongoing commitment to maintaining the relationships in order to resolve the challenges that will inevitably arise during implementation. In line with Shepherd and Meehan, Kapucu (2006) in the case of emergency response points out the significant role of individual boundary-spanners to secure stable communications at the time of a disaster and to build mutual trust. Other research notes that the use of intermediary institutes is also helpful. For instance, Taylor et al. (2014) show

that public libraries can act as the intermediary institutes between governments and citizens to transfer information and provide free public access to the internet, where public librarians can serve as assistants to citizens as they are trained for operating digital government services.

Public-public OI: 'top-down mandate decisions and intra-governmental capacity building' are effective for both digital and non-digital OI.

Our review identifies two governance strategies for public-public OI, which are effective for digital and non-digital forms. First, authors propose that top-down management decisions or tight central mandates may help public-public OI. For example, Mergel (2018) notes that in most of the government agencies, instead of bottom-up initiatives, the pressure to adopt OI approaches is pushed down from the top of the agencies to the frontline implementers. In addition, authors recognize that the top-down mandates are often accompanied with corresponding rules and guidelines, or coercive and compulsory policies, which makes it explicit regarding who should participate, where, when, and how, and facilitates inter-agency interaction by clarifying common goals and shared roles and responsibilities (Torfing 2019). As Ganapati and Reddick (2012) show, the most instrumental strategy to promote OI in US state governments is imperative from the state legislature that requires the implementation of open innovation.

Second, apart from top-down decisions, government agencies need to develop in-house expertise and skills and improve internal capacities while participating in OI programmes. This is partly sourced from the threat of power asymmetry or technical disparity to OI. If an agency cannot play on an equal ground due to week in-house competence or lack of expertise, then collaboration is subject to unbalanced power or capacity and thus risk to fail. This viewpoint is also supported by Herstad et al. (2010), who note that knowledge sharing and mutual learning in OI must be maintained by means of internal R&D because internal activities are critical for the ability of participants to absorb knowledge from the external environment.

Public-citizen OI: governance strategies shift from 'supportive and persuasive approaches' to 'reward and review approaches'.

In the review, we recognize that governance strategies for non-digital public-citizen OI are often supportive- and persuasive-oriented. First, authors recommend lowering thresholds for citizen participation, reducing participation cost, providing financial support when necessary and generating a feeling of ownership (Voorberg, Bekkers, and Tummers 2015). Specifically, Tummers and Rocco (2015) suggest a strategy called 'moving toward clients', meaning that frontline workers cope with service delivery in ways that are beneficial for clients, even in difficult circumstances such as the need for rule-bending and rule-breaking, rather than 'moving away' or 'moving against' clients through routinizing, rigid rule-following and rationing. Other research recommends the use of training programmes. For instance, Ayele et al. (2012) illustrate how local governments in developing countries can increase the capacity of farmers to join in co-production programmes by organizing training sessions on fodder seed multiplication.

Second, authors suggest a discursive or persuasive strategy to govern non-digital public-citizen OI. For example, Torfing (2019) notes that the discursive construction of the urgency of a problem is an effective way to motivate citizens to actively participate in co-production. Similarly, Li (2019) emphasizes the framing/storytelling skills that public managers or meta-governors may use to create visionary common goals. Moreover, Meijer (2015) highlights that fixing technological problems is not enough

for effective co-production, argumentative or persuasive strategies are needed for tackling citizens' participation barriers.

However, in digital public-citizen OI such as crowdsourcing, authors emphasize the role of reward and peer review in governing OI. To incentivize citizen participation, prizes and rewards have frequently been discussed in the crowdsourcing literature. For instance, Liu (2017) suggests that monetary rewards can increase participation mainly because participants treat crowdsourcing projects as employment and expect rewards for their effort. Apart from monetary compensations, evidence shows that some governments offer virtual commodities to people who submitted ideas or whose ideas are implemented, and this virtual commodity can be used to purchase or receive discounts from local shops (Newsom 2013). Other scholars argue that monetary awards may increase the number of solutions submitted but cannot ensure the quality of the submitted solutions (Martinez and Walton 2014). In response, Liu (2017) suggests designing a fair selection and review mechanism for crowdsourcing (e.g. a rating system that incorporates voting by and comments from participants), because governments may benefit by empowering participants to select and review their own contributions. To further enhance the quality of citizens' contributions, authors also recommend integrating a reputation system into the crowdsourcing process (Liu 2017). A reputation system combines the outputs (e.g. ratings, voting, and scores) from peer review with the participants' activity history, and displays those aggregated reviews, to indicate the participants' levels and qualities of contributions.

Public-private OI: governance strategies shift from 'relational contracting' to 'data quality management and legal framework construction'.

In response to the malicious risk transfer in PPPs, scholars suggest adopting the relational governance approach to complement or substitute the contractual approach (Warsen, Klijn, and Koppenjan 2019; Benítez-Ávila et al. 2018). Warsen, Klijn, and Koppenjan (2019) show that rather than making the contract more extensive and detailed, relational contracting gives room to social relationships where mutual trust and norms of flexibility, solidarity, and sharing information are pivotal in ensuring good performance. If partners mutually trust each other, they are convinced their partners will not behave opportunistically, and thus they will be prepared to invest their resources in collaboration, share information, and make investments in uncertain activities, which are conducive to innovations. Nederland and Klijn (2019) add that relational governance is also advantageous to formulate flexible contracts. Under flexible contracts, the wording of the terms is not taken literally to the letter of the law; when difficulties or uncertainties emerge in projects, the contracts can be made more flexible and allow for negotiation between partners for the greater good and long-term viability of the project.

Regarding digital public-private OI, the governance focus is not on relational contracting, but on OGD's quality management. Private companies that use OGD to design innovative digital products for public services usually need multiple datasets from various structured and unstructured sources. Research in OGD has shown that the quality rather than the quantity of data matters for digital service innovation (Janssen et al. 2017). In our review, governance strategies for data quality range from institutional arrangements to technical support. Safarov (2019) points out that embedding OGD initiatives in a strong legal framework is a precondition to achieve the innovative potential of OGD because both government agencies and OGD users require clear guidelines on such matters as copyright, data privacy and protection,

tort, and liability laws. Ruijer et al. (2020) also suggest that the availability of a legislative framework helps mitigate political risks of OGD, as otherwise government agencies for whom the legitimacy and economic gains of OGD practices are less clear will avoid or defy to release data. Apart from legislative conditions, Safarov (2019) also mentions the importance of organizational arrangements in OGD-driven innovation, which takes the responsibility for checking the accuracy, format, and completeness of multiple data sources and collecting the missing data. In addition to organizational arrangements, scholars recognize that OGD implementation needs an infrastructure (e.g. a digital platform such as data.gov.uk) to deliver data.

Conclusions and future research

OI has been cited as an important strategy for public service improvement, public value creation, and public policymaking. In recent years, the digital transformation of government, based on ICTs and the internet, has added fuel to OI, and changed the way that governments interact with stakeholders and leverage collective intelligence. Thus, under digital transformation, OI in the public sector needs to overcome different barriers, and demands shifting governance strategies, which leads to the need for this review to study the different characteristics of barriers and governance strategies of non-digital and digital OI.

The results of this review indicate that *relational barriers are relatively more influential for non-digital OI*. For instance, when OI happens between government agencies, relational factors such as conflicting policy frameworks, incompatible organizational goals, and power imbalance constitute the major barriers. When governments collaborate with citizens, value tensions, and citizens' low trust in government become the relational barriers of OI. In the case of PPPs, relational barriers exist in weak connection with citizens and the public-private relation can be further damaged by malicious risk transfer. On the other hand, *capacity- and technical-related barriers emerge as the major challenge for digital OI*. In other words, *governments not only suffer technical difficulties associated with e-participation but also suffer limited organizational, political, institutional capacities for governing e-participation*. For instance, governments' technical skills and citizens' digital divide are major barriers to digital OI. In addition, governments' limited capacities to evaluate the submitted solutions, sustain the development of innovation prototypes, and to construct legal frameworks to protect data are the challenges for digital OI. *Such transformation from relational barriers to capacity- and technical-related barriers indicates that digital technologies may reduce the need for direct government-stakeholder interaction that is usually full of tensions, but simultaneously they bring about new capacity-related challenges to steer the technologies.*

Our review also reveals that *to remove the barriers of OI, governance strategies need to be appropriately adopted by governments*. Long-term political commitment and employment of intermediaries are beneficial for all types of OI. Coercive, mandated, and top-down interferences, as well as developing in-house expertise and skills, are advantageous for public-public OI in both digital and non-digital forms. When there is offline citizen participation, the governance strategies cannot be coercive but are better to be soft, supportive, discursive, and persuasive oriented. However, for online citizen participation, governance strategies should be shifted towards building up a reward and review mechanism that can evaluate citizens' submitted proposals. Here,

governments are neither the only nor the most important actor that can govern the OI process; the citizens themselves, who review and score proposals, are also an important actor that self-organize, bypass governments, and evaluate the solicited solutions. In public-private OI, governments' strategies should shift from relational contracting to data quality management and legal framework construction under digital transformation.

Given these conclusions, what does a possible future research agenda look like?

First, our review identifies three dyads of collaboration for innovation. However, many public innovation activities involve multilateral relations between government agencies, citizens, private sector organizations, and even non-profit organizations. Thus, our first suggestion for future research is to investigate what barriers there are and what governance strategies can be applied for OI that is composed of multilateral, rather than bilateral actors.

The second suggestion is to study the mutually influencing relationships between digital and non-digital forms of OI. In our review, we focus on comparing the different characteristics of barriers and government strategies between digital and non-digital OI; however, we do not investigate how/ whether digital OI and non-digital OI may affect each other. For example, current studies analyse inter-agency collaboration and collaborative e-government in two separate streams. However, these two types of OI are related: inter-agency collaboration may enhance inter-agency communication and trust, which, in turn, may contribute to their collaborative e-government. Another example is whether the growing popularity of crowdsourcing (online citizen participation) would reinvigorate offline forms of citizen participation. Moreover, whether and how private innovators driven by OGD can build formal contractual relationships with governments, in order to sustain the development of innovation prototypes.

Another suggestion for future research would be about the dynamic mechanisms that lead various influencing factors (e.g. barriers and governance strategies) to innovation outcomes. In the reviewed studies, we note that authors adopt a static view of the barriers and governance strategies. The most common research question is what the influencing factors are for OI. However, authors did not analyse the factors from a processual perspective. Consequently, many issues arise, for instance, which factors emerge at the beginning/initiation phase of an OI process? Similarly, what are the factors that are more likely to emerge in negotiation and implementation phases? More importantly, how an early challenge may trigger other challenges in later phases? And what are the causalities that link sequential factors to an outcome? Such research questions from a dynamic or processual perspective are not fully explored yet, and thus worth our attention in future research.

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