Re-defining open government data standards for smart cities' websites: a case study of selected cities

Martin Lnenicka and Stuti Saxena

Purpose: The aim of this research is to study the select Smart Cities of Czech and Indian counterparts and assess the extent to which Open Government Data (OGD) standards are being adhered to using select indicators.

Design/methodology/approach: We integrate the benchmarking frameworks provided in literature on OGD and apply them to evaluate the OGD standards of the Smart Cities websites.

Findings: Whereas the Czech Smart Cities are relatively more advanced in their OGD initiatives, the Indian counterpart is far lagging behind in their endeavours.

Originality/value: While there are many studies on OGD and Smart Cities, there has been no study which seeks to appreciate if the OGD initiatives are being adhered to by the Smart Cities.

Keywords: Open Government Data, Smart City, Data Infrastructure, Smart City Website, Benchmarking Framework, Model, Website Evaluation

Paper type: Case study

1 Introduction

According to United Nations (2016), it is expected that two thirds of the world's population is expected to live in cities by 2050. Smart Cities will be a critical component of digital government since local governments are key players in addressing concerns affecting people's daily lives and fostering sustainable development (United Nations, 2018; United Nations, 2020). The investment in leveraging emerging technologies for Smart City development is expected to expand at a compound annual rate of 16.5% over the next five years, reaching $252.6 billion by 2025 (United Nations, 2020). Smart Cities initiatives are spreading all around the globe and the pilot study presented in the United Nations E-Government Survey 2018 showed that 68% of the cities analysed had evidence of Smart Cities initiatives on their websites. As part of the 2020 Survey process, selected cities were assessed regarding their levels of e-government development. Local governments are creating Smart Cities, but the results imply that most city portals and websites are still offering very basic features, such as information provision but little or no services provision (United Nations, 2020).

At the same, the delivery of services and information to citizens is shaped by Open Government and standards for disclosing and publishing of Open Government Data (OGD). To enable work with these data, governments have created platforms, portals, and websites that provide various features to support these efforts. Taking both these concepts into account, we examined selected Smart Cities websites and evaluated them against a benchmarking framework that comprises OGD stages and corresponding features. We aim to identify the current status of OGD standards in Smart Cities and how it is reflected in the design of Smart Cities websites. The motivation behind this research is to help governments in improving their websites and provide a closer look on how data infrastructures are built and interrelated to enable efficient data flows in Smart Cities.

The structure of the paper is as follows: Section 2 reviews the literature on Open Government Data; Section 3 summarizes the literature on Smart Cities; Section 4 provides an overview of methodology

and benchmarking framework; Section 5 provides the results; Section 6 provides the discussion and Section 7 concludes the study.

2 Open Government Data

OGD have been conceptualised in terms of data provided by the government via online platforms that are easily accessible by the public and other stakeholders for being reused in multiple ways. OGD are freely available and the terms and conditions for reusing the datasets are provided via the online portals. OGD may be linked with different socio-economic sectors like weather, agriculture, industry, energy, power, education, trade, etc. (Ubaldi, 2013). OGD have been conceived as an advanced format of e-government wherein the provision of public services is furthered apart from citizen engagement and citizen participation in public policymaking. According to Hivon and Titah (2017), citizens are central to the success of open data initiatives. It is important that for the long-term viability and sustainability of the OGD initiative, the quality of the published datasets should be excellent. For instance, the datasets should be relevant, metadata should be provided for each dataset, interactive features should be provided for facilitating increased reuse, datasets should be amenable to statistical calculations and measures, datasets should be published in legible formats, etc. (Jaeger *et al.*, 2012).

As a newly-emerging research area, OGD has been investigated in diverse ways. Two major themes emerge in OGD-focused research. The first theme relates to the theoretical contributions in the form of model propositions for investigating OGD. Saxena (2017b) provided a typology of countries on the basis of their OGD-adherence ("laggard", "caged", "forerunner" and "champ") wherein the "Laggard" countries are the ones where there are hindrances associated with OGD implementation and OGD-usage; "Caged" countries are those with less propensity to implement OGD initiative but increased potential of usage by different stakeholders; "Forerunner" countries as those which hold high potential of rolling out an OGD initiative but low potential of usage by different stakeholders; and "Champ" countries as those which ranked high in terms of implementation of an OGD programme as well as usage by diverse set of stakeholders (p. 219). Martin (2014) underlined the social and technological aspects of OGD initiatives. Five dimensions have been identified in the study: digital technologies (configurations that include tangible artifacts, the skills of technologists and users, and the interfaces of artifacts with the wider technical infrastructure), user practices (manner in which data are being reused by a large cross-section of stakeholders), public management practices (includes the processes of data and Information and Communication Technologies (ICT) management, and established data-related policies), institutions (include the sets of rules that connect data users and government organizations, including data markets and regulatory frameworks for government data), and resources (the resources drawn upon by actors shaping the OGD data agenda as including social capital; cultural capital; economic capital; and symbolic capital).

Another model proposed by Kalampokis and his colleagues (Kalampokis *et al.*, 2011a; Kalampokis *et al.*, 2011b) wherein the stages of development of an OGD initiative have been outlined: "downloadable files" (data are available in simple formats), "linked data" (data are linked with another one and reused), "direct data provision" (all data are available via a portal and synchronized with time) and "indirect data provision" (actual data are provided and the user is responsible for further aggregation and processing of the data). Finally, Sieber and Johnson (2015) provided a typology where four models (stages) have been outlined: "Data over the wall" (direct publication of the datasets online), "Code exchange" (furthering citizen-government interaction through contests and training events, etc.), "Civic issue tracker" (promoting citizens' contribution to the existing datasets) and "Participatory open

data" (active citizen engagement is realized wherein the quality of the datasets is superior and the citizen-government interaction via the OGD portal is maximized).

The second major theme in OGD-research is linked with the discussion of the drivers and barriers in roll-out, adoption and implementation of the OGD initiative (Charalabidis *et al.*, 2016; Huijboom and Van den Broek, 2011; Janssen *et al.*, 2012; Saxena, 2017a). This group of research holds immense relevance for deriving key lessons for the sustainable implementation of OGD initiative in diverse contexts (for instance, Afful-Dadzie and Afful-Dadzie, 2017; Nugroho *et al.*, 2015; Saxena and Janssen, 2017; Wirtz *et al.*, 2017; Zuiderwijk *et al.*, 2015). Some of the studies are presented as case studies and others are grounded in qualitative or quantitative research methods. These studies provide clues regarding the differences in developing versus developed countries as far as the critical factors for the success of the OGD initiative are concerned.

3 Smart Cities

While there are various definitions of a Smart City and there is no one definition of a Smart City (Anand, *et al.*, 2018), the term generally refers to the management of urban environments through ICT (United Nations, 2016) and the framework for implementation of a vision of advanced and modern urbanization (PWC, 2021). A typology of Smart City functions (dimensions) by Giffinger *et al.* (2007) includes smart economy, people, governance, mobility, environment, and living. These are also reflected in the definition of Caragliu *et al.* (2011) who believe a city to be smart when "*investments in human and social capital and traditional (transport) and modern (ICT) communication infrastructure fuel sustainable economic growth and a high quality of life, with a wise management of natural resources, through participatory governance*." Abella *et al.* (2017) emphasize that this is "*a public-private ecosystem providing services to citizens and their organisations.*" According to Batty *et al.* (2012), smart cities include mechanisms for "*improving competitiveness in such a way that community and quality of life are enhanced*"- a view that was reiterated by Aijaz (2016). Smart Cities should be called Smart Sustainable Cities and the frameworks for their evaluation should also include impact indicators that measure the contribution towards the ultimate goals (Ahvenniemi *et al.*, 2017).

One of the main aspects of making cities smarter is monitoring and analysing the relevant data flows within the city and opening up these data to citizens and other stakeholders (Batty *et al.*, 2012; Chauhan *et al.*, 2018; Janssen *et al.*, 2015; Kar *et al.*, 2019). The growing volume and variety of data produced in the urban ecosystem are crucial for obtaining the city's insights and building knowledge-based solutions (Neves *et al.*, 2020). Establishing of OGD initiatives for Smart City contexts contributes to create value generating mechanisms and enhance the delivery of public value to stakeholders (Chatterjee and Kar, 2018; Pereira *et al.*, 2017). Abella *et al.* (2017) introduced a theoretical model of value creation by the reuse of data in Smart Cities. It operates using the following three stages:

1) the release of data by the Smart City including several of the dimensions that make data appealing for reuse;

2) the analysis of the mechanisms to create innovative products and services; and

3) the explanation of how these products and services impact its society.

A theoretical framework introducing a more detailed view of the impacts of open data initiatives on smart cities' sustainable development was elaborated by Neves *et al.* (2020). Ojo *et al.* (2015) explored the convergence of Smart Cities and OGD initiatives to reveal that the governance and economy

domains will be impacted the most. They also showed that the nature of datasets published by these cities is supporting innovation. Static OGD and innovative actions in selected cities were evaluated Ghahremanlou *et al.* (2019) regarding the following impact domains (general themes): art and culture, built environment, business and economy, community, energy, education, governance, health and well-being, nature environment, and transport and mobility. They concluded that only a few of OGD datasets are properly linked to the innovation actions and projects in cities. Finally, regarding the e-government context in which OGD efforts are set up, Fietkiewicz et al. (2017) evaluated the maturity and usability levels of Smart Cities' governmental websites worldwide. They applied the following pillars: information, communication, transaction, integration, and participation.

Therefore, Smart Cities should provide platforms and tools to engage and connect citizens with data and corresponding public services. As stated by Meijer and Bolívar (2016), it is about "*crafting new forms of human collaboration through the use of ICT*." Similarly, cooperation and sharing both experiences and resources to maximize progress towards the common goal while minimize duplication of efforts and repetition of the same mistakes is needed (Ghahremanlou *et al.*, 2019). According to Janssen *et al.* (2015), the challenge is "*in making the data ready for use and combining them with other data.*" Regarding the concepts of data discoverability, accessibility, and reusability, Smart Cities' websites should provide features that support OGD standards.

4 Methodology and Benchmarking Framework

The methodology of the paper is based on a descriptive literature review of frameworks used to benchmark the maturity of OGD. While at first the stages were related to the levels of e-government development, the implementation of open data principles on open data portals represented another development step. However, with the emergence of tools for big data analytics, machine learning, and Internet of Things (IoT) that were mostly deployed on reginal and local levels, the need for open data has been redirected to Smart Cities ecosystems (Chauhan *et al.*, 2018; Janssen *et al.* 2015; Lněnička and Komárková, 2019). In this regard, this paper fills this gap by re-defining OGD standards for Smart Cities' websites.

The benchmarking framework including literature sources is in Table 1. It was elaborated based on related works that deal with OGD platforms, portals, and websites and their features provided to citizens and other stakeholders. Our framework merges OGD stages and Smart City dimensions as the targeted areas for OGD reuse (Figure 1). From existing OGD models we chose the one that follows the stages (levels) of development for a service that uses ICT. Since OGD efforts are set up in the e-government context, most of the relevant models include stages that follow each other progressively. Because of the widely and successfully use of these models in the e-government practice for the last 20 years, we applied the model that provides a similar and proven approach.

The open data stages by Sieber and Johnson (2015) are extended by including corresponding features found in literature representing each stage. The six functions of the Smart City were identified by Giffinger *et al.* (2007). In contrast to Sharifi (2020), who included data as a seventh function, we argue that all of them should be supported and enhanced by open data flows to fulfil their potential for creating smarter and more accessible cities. Although the stages should follow each other progressively, governments and cities may prioritize some or only one of them.

Table 1: The framework with stages, corresponding features, and references.

Stage	Features / characteristics	References

Data over the wall	Downloading of datasets	Bonina and Eaton (2020); Hivon and Titah (2017); Máchová and Lněnička (2017); Sieber and Johnson (2015)
	Searching, filtering, and sorting of datasets	Hivon and Titah (2017); Máchová and Lněnička (2017); Saxena (2018); Sieber and Johnson (2015)
	Machine-readability and technical standards (licenses)	Ghahremanlou *et al.* (2019); Bonina and Eaton (2020); Máchová and Lněnička (2017); Neves *et al.* (2020); Sieber and Johnson (2015)
	Visualization and analytics tools	Hivon and Titah (2017); Máchová *et al.* (2018); Sieber and Johnson (2015)
	Application Programming Interface (API)	Bonina and Eaton (2020); Ghahremanlou *et al.* (2019); Hivon and Titah (2017); Máchová and Lněnička (2017); Sieber and Johnson (2015)
	Reporting errors	Sieber and Johnson (2015)
Code exchange	Number of downloads and reuses	Hivon and Titah (2017); Máchová and Lněnička (2017)
	List of applications using datasets (new services)	Hivon and Titah (2017); Ghahremanlou *et al.* (2019); Máchová and Lněnička (2017); Sieber and Johnson (2015)
	Events, conferences, workshops, or application contests	Bonina and Eaton (2020); Hivon and Titah (2017); Neves *et al.* (2020); Sieber and Johnson (2015)
	Number of participants in activities	Neves *et al.* (2020); Sieber and Johnson (2015)
	Online promotion and sharing (social media and news media)	Hivon and Titah (2017); Máchová and Lněnička (2017); Máchová *et al.* (2018)
	Semi-close, close, and confidential data	Ghahremanlou *et al.* (2019)
Civic issue tracker	Reporting of civic problems (e.g., fire, accidents, drainage problems, floods, potholes, etc.)	Bonina and Eaton (2020); Sieber and Johnson (2015)
	Suggesting and requesting new datasets including converting data in a raw format	Hivon and Titah (2017); Máchová and Lněnička (2017); Máchová *et al.* (2018)
	List of requests, questions, and their status	Máchová *et al.* (2018); Neves *et al.* (2020)
	Revised and updated datasets	Sieber and Johnson (2015)
Participatory open data	Forums, guidelines, tutorials, and best practices (new skills learned and experience sharing)	Bonina and Eaton (2020); Hivon and Titah (2017); Máchová and Lněnička (2017); Máchová *et al.* (2018)
	User rating, comments, forms, and active feedback (opinion sharing)	Máchová *et al.* (2018); Sieber and Johnson (2015)
	The quality of datasets (5-star open data scheme, high-value datasets)	Bonina and Eaton (2020); Ghahremanlou *et al.* (2019); Hivon and Titah (2017); Sieber and Johnson (2015)

	Metadata – permit statistical analysis, interpretation, visualization, and mapping	Bonina and Eaton (2020); Ghahremanlou *et al.* (2019); Sieber and Johnson (2015)

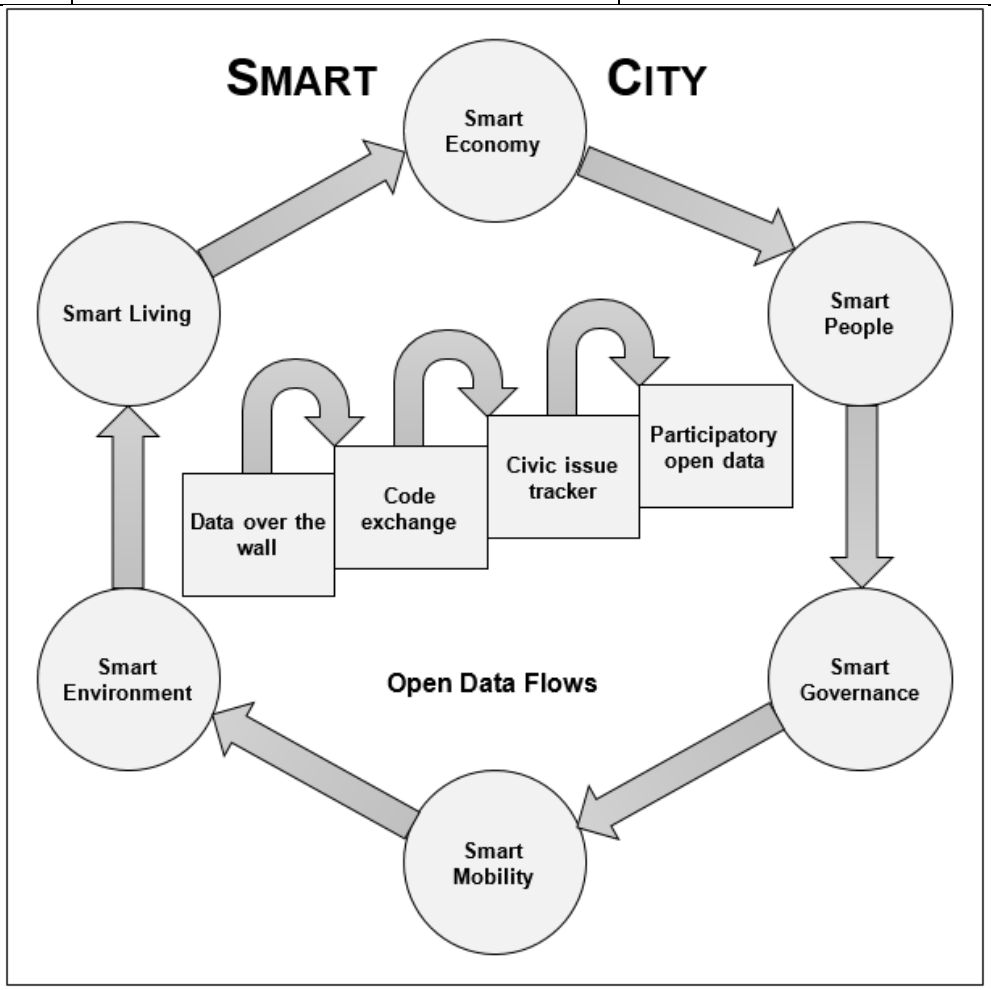

Figure 1: A visualization of OGD stages in a Smart City.

The benchmarking framework was used to get data for analysis. A three-point scale was applied for evaluating the provision of features by Smart Cities websites. The highest score (fully fulfilled = 3) can be obtained if the website provides the respective feature for users without registration or any other limitation or cost. The score partially fulfilled = 2 receives the website that requires registration, limits the use of feature, or although it does not provide the feature it can be replaced by similar feature. Finally, the score not fulfilled = 1 gets the website that does not support the feature in any way. It should be also noted that only the presence of features was considered, not the website design and its aspects dealing with accessibility, usability etc.

Each website was evaluated in November 2020 by a single person and then verified by another person to reach a consensus on a score. Regarding the intercoder reliability it was agreed that each score will include a percentage that represents how confident is the person in his evaluation. If the difference between the percentages from both persons was greater than 20%, then the presence of the feature on concrete website was re-evaluated and re-discussed to achieve the score.

Czech Republic and India were chosen as target countries for this study because of authors' familiarity with the OGD and Smart City ecosystems in each country. This enables us to fully explore the websites as well as the links between OGD in Smart Cities. The gained insights should serve as a basis to identify

shortcomings in the proposed benchmarking framework and respective process and to include more countries to be benchmarked against others. The sample of Smart Cities in Table 2 was selected to represent cities with various population sizes.

Table 2: A list of evaluated Smart Cities.

City	Strategy name	Population	Website
Smart Cities' websites – Czech Republic[1]			
Prague	Smart Prague 2014-2020	1,324,277	https://smartprague.eu/ • https://golemio.cz/ • http://opendata.praha.eu/
Brno	Strategy Brno 2050	381,346	https://brno2050.cz/ • https://data.brno.cz/ • https://kod.brno.cz/
Pilsen	Smart City Strategy	174,842	https://smartcity.plzen.eu/ • http://tutaplzen.cz/ • https://opendata.plzen.eu/
Jihlava	City with good address	51,216	http://www.jihlava.dobramesta.cz/
Tábor	Tábor – Smart City with face	34,277	http://taborudrzitelne.cz/
Písek	Blue-yellow book Smart Písek	30,415	https://smart.pisek.eu/
Smart Cities' websites – India[2]			
Ahmedabad	Ahmedabad Smart City Mission	5,577,940	https://ahmedabadcity.gov.in/portal/smartcitymission.jsp
Surat	Surat Smart City Development Ltd.	4,467,797	https://www.suratsmartcity.com/
Pune	Pune Smart City Development Corporation Limited	3,124,458	https://punesmartcity.in/
Kochi	Smart City Kochi	602,046	https://smartcity-kochi.in/
Udaipur	Udaipur Smart City	451,100	http://udaipursmartcity.in/
New Delhi	New Delhi Smart City	142,004	https://smartcity.ndmc.gov.in/

5 Results

Each website could get a score from 3 to 1. The final score was achieved by consensus between the two persons. The results of the evaluation are shown in Table 3 and Table 4. Then, mean value of OGD stages for evaluated websites was calculated, as depicted in Figure 2.

Table 3: Results for Czech Smart Cities websites.

Stage	Feature	Czech Smart Cities websites					
		Prague	Brno	Pilsen	Jihlava	Tábor	Písek
1. Data over the wall	1.1	3	3	3	1	2	2
	1.2	3	3	3	1	1	1
	1.3	3	3	3	1	1	2
	1.4	3	3	3	1	1	1
	1.5	3	3	3	1	1	2
	1.6	2	2	2	1	1	1
2. Code exchange	2.1	2	2	1	1	1	1
	2.2	3	3	1	1	1	1

[1] Population in Municipalities - as of 1.1.2020

[2] Population as ascertained in Census 2011 (https://www.census2011.co.in/)

	2.3	2	2	3	2	2	2
	2.4	2	2	2	1	1	1
	2.5	2	2	2	2	2	2
	2.6	1	2	2	1	1	1
3. Civic issue tracker	3.1	3	3	2	1	1	1
	3.2	2	3	1	1	1	1
	3.3	1	1	1	1	1	1
	3.4	2	2	2	1	1	1
4. Participatory open data	4.1	2	2	2	2	2	1
	4.2	1	3	1	1	1	1
	4.3	1	1	1	1	1	1
	4.4	2	2	2	1	1	1

Table 4: Results for Indian Smart Cities websites.

Stage	**Feature**	Ahmedabad	Surat	Pune	Kochi	Udaipur	New Delhi
1. Data over the wall	1.1	1	1	1	1	1	1
	1.2	1	1	1	1	1	1
	1.3	1	1	1	1	1	1
	1.4	1	1	1	1	1	1
	1.5	1	1	1	1	1	1
	1.6	1	1	1	1	1	1
2. Code exchange	2.1	1	1	1	1	1	1
	2.2	1	1	1	1	1	1
	2.3	1	1	2	2	1	1
	2.4	1	1	1	1	1	1
	2.5	1	2	2	2	2	2
	2.6	1	1	1	1	1	1
3. Civic issue tracker	3.1	1	1	1	1	1	1
	3.2	1	1	1	1	1	1
	3.3	1	1	1	1	1	1
	3.4	1	1	1	1	1	1
4. Participatory open data	4.1	1	1	1	1	1	1
	4.2	1	1	1	1	1	1
	4.3	1	1	1	1	1	1
	4.4	1	1	1	1	1	1

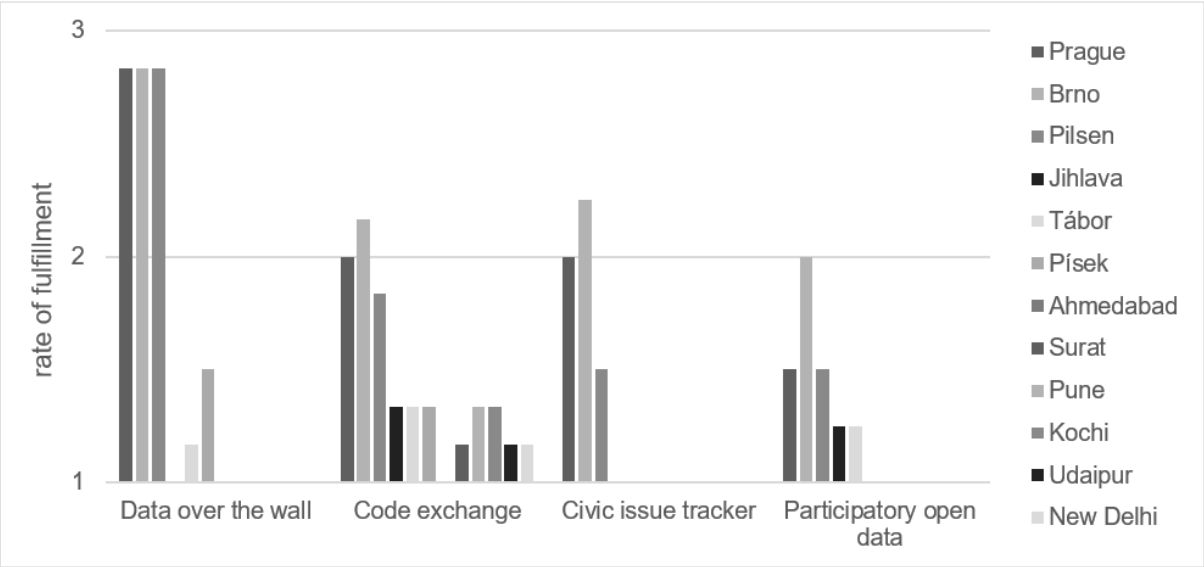

Figure 2: Mean value of OGD stages for evaluated Smart Cities websites.

Before discussing the results in detail, it should be noted that the essential difference between evaluated Smart Cities websites lies in their structure. The best evaluated websites are structured with direct connection to open data platforms providing smart city data and/or to OGD portals providing open data on the local or national level. This enables to ensure the overall interconnection of all projects, targeted areas, and corresponding data. Since one of the key tasks of Smart Cities is to create infrastructures and environments where people can use smart services, applications, data, and share ideas, focusing solely on content without attention to features that support these aspects hinders the implementation of Smart Cities.

The findings suggest that Smart Cities websites should serve as an entry point to a data infrastructure in which Smart City data platforms enable the connection of city applications and data. In the case of Czech cities, this model is followed by Prague, Brno, and Pilsen. These cities also received the highest scores for each of the evaluated OGD stages. Other Smart Cities websites were evaluated as “not fulfilled”. They only provide information about projects, their status and success. Events, conferences, workshops, or application contests are promoted on these websites or social media, however, no other information about their outputs or open data are published. This approach is most common for early adopters of Smart City solutions. On the other hand, each of these cities has launched at least one successful project involving open data but these data are not centralised or meet OGD standards.

Let us look in more detail at the most successful Smart Cities websites and highlight several important features that have attracted us most. According to the results, the overall score of the website of Brno was the highest. It is the only one that provides features meeting at least “partially fulfilled” for each of the stages. It is followed by Prague and Pilsen. The first stage “Data over the wall” was fully fulfilled for these three websites except of the feature for reporting errors which was not available, but the contact form can be used instead. The second stage was mostly represented by features that enable to online promote and share open datasets as well as information about events, conferences, hackathons etc. However, other information such as number of downloads and reuses or number of participants in activities are missing. Although there were found clear and comprehensive lists of applications using datasets, users usually need more information to decide whether they will use the application. In this regard, Smart Cities websites have to be more dynamic and interactive to engage more users. This is a way to support this process, by letting users know what other users prefer. The

issue about what data to publish or how to ensure access to semi-close, close, and confidential data is also not addressed by the websites. Only the website of Brno provides an option to register and log in aiming to create a secure channel for these data distribution.

The OGD stage “Civic issue tracker” should be emphasized most in the design of Smart Cities websites because the corresponding features are crucial to collect local civic issues, suggestions on approaches for improving city services, quality of life, requests on datasets etc. The Brno website received the highest score, especially for their form for requesting a new dataset to be published. On the other hand, none of the websites evaluated provide a list of requests, questions, and their status. Again, this issue may give a false impression about transparency of procedures and actions. Finally, the last OGD stage is not reflect by the websites a lot. Forums, guidelines, tutorials, and lists of best practices can be found rarely. However, features enabling user rating, comments, forms, and providing active feedback and opinion sharing are missing. One of the aspects of Smart Cities is to take decisions as close to citizens as possible. In addition, each Smart City has its specific projects and targeted areas. In this regard, it can be recommended that each Smart City should have its own data portal.

The results of the comparison showed that the main weakness of the existing Smart Cities websites is the lack of features that support active engagement and feedback of users in Smart city data flows, either by using applications or reusing open datasets. The trust of citizens also needs to be worked through publishing more detailed information on projects, applications, and datasets and by who, where, and for what purpose are used.

Results indicate that Indian Smart Cities are not really forthcoming in publishing their datasets online to be reused by a diverse group of stakeholders. Datasets are not available, and information has been provided in a haphazard manner. There are no efforts on the part of different ministries/government departments to provide datasets via the online Smart City portals. Despite being labelled as Smart Cities, the datasets are unavailable, let alone the provision of real-time availability of datasets. On the other hand, some of these cities have stand-alone OGD portals and data catalogues from 100 cities are centralized on https://smartcities.data.gov.in/. The question is whether and how this solution affects discoverability, accessibility, and delivery of information to citizens and other stakeholders.

The model in Figure 3 illustrates how open data in Smart Cities are usually disclosed and how these data flow. In most cases, a Smart City data platform is designed to offer city data under open licences to be reused, or Smart Cities data platform is available to centralize data catalogues and datasets from more cities in one place. These platforms differ from a city or national OGD portal by categorizing datasets according to projects or targeted areas, for instance safety and health, wastes, smart building and energy etc. OGD portals provide more general datasets.

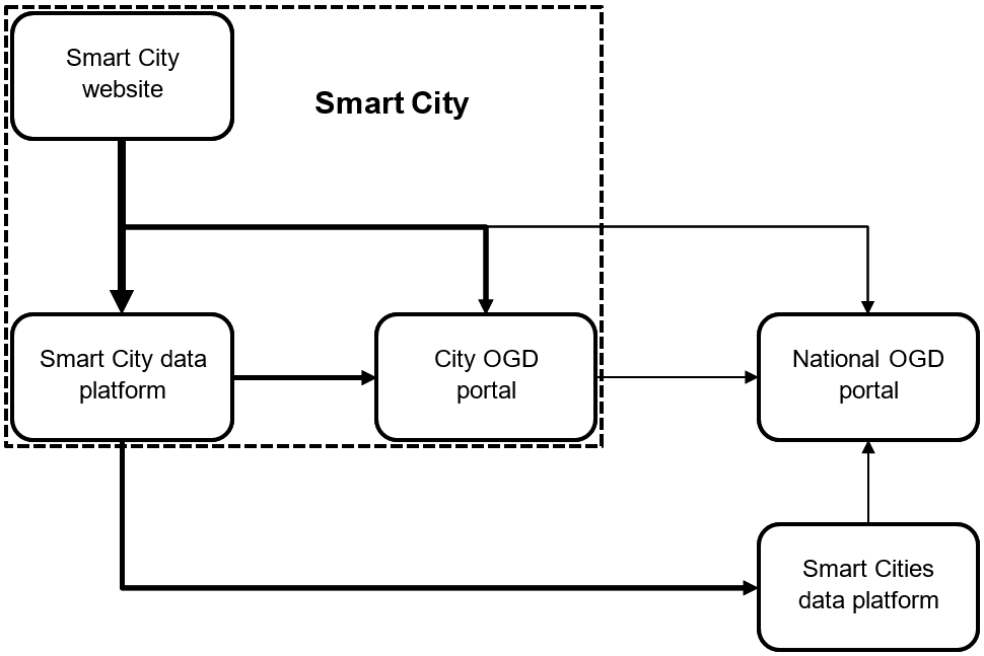

Figure 3: A model of data infrastructure for disclosing and sharing open data in Smart Cities.

6 Discussion

6.1 Theoretical implications

The theoretical implications of the results concern primarily further development of OGD frameworks and corresponding features on data portals enabling stakeholders to reuse OGD. Although the basic principles of open data are widely recognized their support by concrete features on websites is lacking. Websites are not limited to their content, i.e., the availability of open datasets under open licenses, but they should provide suitable features to work with the content. The process of a website creation includes various aspects that should be considered. Based on the results of this study, the first step should be an analysis of existing data infrastructures since some of the features may be duplicate with national or local open data portals. Smart City strategies are the central point that frames these efforts and should include requirements on these websites. In this regard, new theoretical models should be introduced to interlink all the elements affected.

For public policy needs, it is important that governments should direct their strategies and efforts to a single portal (Smart City website) where citizens can find everything they might need to improve their everyday life, including OGD and features to work with them. For this purpose, Lněnička et al. (2021) identified and classified the most important features and capabilities of OGD portals and ranked according to their importance. They also provided recommendations on how to incorporate them into designing and developing OGD portals. Thus, the literature on Smart City websites should consider this finding.

This study has shown that the standards of OGD can and should be applied in the context of Smart Cities, so that they can strengthen the requirements for transparent, accountable, and participatory governance. The results provide support for enhancing OGD models by the Smart City context in which data flows can be explored more deeply since the relations between citizens and other stakeholders are closer and better to be described on this level. It also contributes to the discussion on developing different variants of OGD models that can be used based on the specific environment's characteristics. This means that the sentiments and requirements of citizens should be considered as a key input for

relevant area-specific strategies and variants of OGD models. Therefore, further theoretical research should focus on linking these requirements with OGD models and functions of the Smart City in specific contexts.

6.2 Practical implications

The applicability of the findings derived from the evaluation of Smart Cities websites into the practice may be affected by various factors. The number of websites and the procedure of their evaluation may limit the ability to understand the diversity of the Smart City visions. Although the six functions of the Smart City identified by Giffinger *et al.* (2007) are widely cited as a key concept that provides the basis for building Smart City, each city may have its own priorities and targeted areas. This may have impact on the way how the city discloses open data and what features are available to work with them, including limited resources to implement them. It should be also noted that we focused only on the ecosystem of the Smart City, as can be seen in Figure 3, and did not evaluate centralized platforms integrating data from more cities.

Therefore, the discussion of our results can be divided into three categories. The first one is dealing with the methodology of our study. The benchmarking framework is based on the OGD model that is comprised of open data stages that should follow each other progressively. However, it can be argued that by using other OGD models the results may be different. Further, the features provided to work with datasets on websites are evolving, i.e., some features are vanished, and some new features are augmented, which may also affect the scores received. Finally, only two people conducted the evaluation (one evaluated the websites and the other checked the results to get a consensus) and some features did not have to be found by them in the website structure.

The second category has legislative, organizational, and social nature. Some difficulties arise from the preparation and implementation of the Smart City strategy. Janurova *et al.* (2020) analysed and evaluated the barriers that public administration representatives have to face during this phase. The main identified problems are shortage of experts in the Smart City area, political unrest, limiting and limited funding, poor interconnection with existing legislation, and excessive bureaucracy. In this regard, Meijer and Bolívar (2016) highlight that Smart City governance is not only a technological issue but it is "*a complex process of institutional change and acknowledge the political nature of appealing visions of socio-technical governance*." It is needed to consider all the components and relations between them that form the ecosystem to achieve the OGD efforts in Smart Cities (Lněnička and Komárková, 2019). More collaboration and cooperation among cities are needed to share experiences and resources, discuss successes and solutions, and challenges of Smart City strategies to maximize progress towards the common goal (Ghahremanlou *et al.*, 2019; United Nations, 2020).

The final category of issues is related to datasets and data infrastructures through which data flow. The reuse of Smart Cities' data to create added value and innovative services is a key element (Abella *et al.*, 2017). Ubaldi (2013) reported that many governments focus on the development of a data portal as if it were a higher priority than developing technical infrastructures to disclose public data for others to reuse. Although datasets may be available through Smart Cities websites they may be isolated from other OGD due to lacking data infrastructures which may result in missing opportunities for integrating and combining data from diverse sources. Other issues are related to datasets. Due to privacy restrictions, as well as the lack of willingness of authorities to open and share data, the number of relevant datasets available is limited (Jaeger *et al.*, 2012; Janssen *et al.*, 2015; Neves *et al.*, 2020). In order to help governments in deciding which datasets should be published to better support planning

and design of smart cities, indicator topics that were listed by Sharifi (2020) for each of the Smart City functions can be used. However, reusing datasets to create social and economic value for the society is also a challenge because it is important to understand how data-driven innovations are having an impact on these efforts (Abella *et al.*, 2017). Ghahremanlou *et al.* (2019) reported that value and positive return on investment require accumulation of a critical mass of datasets published, "*starting with datasets whose value is not so dependent on the availability of other data, and adding other datasets as value multipliers later make sense.*"

Some of the limitations of our study may be solved by future research. More users can be involved in the evaluation of Smart Cities websites as well as other OGD models can be used as benchmarking frameworks. An analysis of the citizen's needs and expectations from Smart Cities could be developed to provide a basis for setting up more efficient data flows it in order to create the maximum value for the citizens. Finally, we believe that our proposed framework could be applied or adapted to other contexts of OGD evaluation, such as usability testing to measure and analyse how well the users interact with Smart Cities websites.

7 Conclusion

Smart Cities websites are important in attracting citizens to use smart services, applications, and share ideas that will result in improving the quality of their lives. The crucial component of these websites are the data themselves. However, disclosure of them should meet certain standards. Selected Smart Cities websites were evaluated against the benchmarking framework that comprises OGD stages and corresponding features. The results are of importance for understanding how these websites meet OGD standards, how open data in Smart Cities are usually disclosed, and how these data flow through and outside the city. Future research will be focused on respective data flows and how can they be optimized to engage more citizens and other stakeholders in open data reuse in the Smart City context.

References

Abella, A., Ortiz-de-Urbina-Criado, M., and De-Pablos-Heredero, C. (2017), "A model for the analysis of data-driven innovation and value generation in smart cities' ecosystems", *Cities*, Vol. 64, pp. 47-53. https://doi.org/10.1016/j.cities.2017.01.011

Afful-Dadzie, E., and Afful-Dadzie, A. (2017), "Open government data in Africa: a preference elicitation analysis of media practitioners", *Government Information Quarterly*, Vol. 34 No. 2, pp. 244–255. https://doi.org/10.1016/j.giq.2017.02.005

Ahvenniemi, H., Huovila, A., Pinto-Seppä, I., and Airaksinen, M. (2017), "What are the differences between sustainable and smart cities?", *Cities*, Vol. 60 No. 1, pp. 234–245. https://doi.org/10.1016/j.cities.2016.09.009

Aijaz, R. (2016), "Challenges of making smart cities in India", *Center for Asian Studies*. Available at: https://www.ifri.org/sites/default/files/atoms/files/av87_smart_cities_india_aijaz_0.pdf, accessed on 23rd February, 2021.

Anand, A., Sreevatsan, A., and Taraporevala, P. (2018), "An overview of the Smart Cities Mission in India", *Centre for Policy Research*. Available at: https://cprindia.org/system/tdf/policy-briefs/SCM%20POLICY%20BRIEF%2028th%20Aug.pdf?file=1%26type=node%26id=7162, accessed on 23rd February, 2021.

Batty, M., Axhausen, K. W., Giannotti, F., Pozdnoukhov, A., Bazzani, A., Wachowicz, M., and Portugali, Y. (2012), “Smart cities of the future”, *The European Physical Journal Special Topics*, Vol. 214 No.1 , pp. 481–518. https://doi.org/10.1140/epjst/e2012-01703-3

Bonina, C., and Eaton, B. (2020), “Cultivating open government data platform ecosystems through governance: Lessons from Buenos Aires, Mexico City and Montevideo”, *Government Information Quarterly*, Vol. 37 No. 3, https://doi.org/10.1016/j.giq.2020.101479

Caragliu, A., Del Bo, C., and Nijkamp, P. (2011), “Smart cities in Europe”, *Journal of Urban Technology*, Vol. 18 No. 2, pp. 65–82. https://doi.org/10.1080/10630732.2011.601117

Charalabidis, Y., Alexopoulos, C., and Loukis, E. (2016), “A taxonomy of open government data research areas and topics”, *Journal of Organizational Computing and Electronic Commerce*, Vol. 26 No. 1-2, pp. 41–63. https://doi.org/10.1080/10919392.2015.1124720

Chatterjee, S. and Kar, A.K. (2018). Alignment of IT authority and citizens of proposed smart cities in India: System security and privacy perspective. *Global Journal of Flexible Systems Management*, Vol. 19 No. 1, pp. 95–107. https://doi.org/10.1007/s40171-017-0173-5

Chauhan, S., Agarwal, N. and Kar, A.K. (2016), "Addressing big data challenges in smart cities: a systematic literature review", *info*, Vol. 18 No. 4, pp. 73–90. https://doi.org/10.1108/info-03-2016-0012

Fietkiewicz, K. J., Mainka, A., and Stock, W. G. (2017), “eGovernment in cities of the knowledge society. An empirical investigation of Smart Cities' governmental websites”, *Government Information Quarterly*, Vol. 34 No. 1, pp. 75–83. https://doi.org/10.1016/j.giq.2016.08.003

Ghahremanlou, L., H Tawil, A.-R., Kearney, P., Nevisi, H., Zhao, X., and Abdallah, A. (2019), “A survey of open data platforms in six UK smart city initiatives”, *The Computer Journal*, Vol. 62 No. 7, pp. 961–976. https://doi.org/10.1093/comjnl/bxy081

Giffinger, R., Fertner, C., Kramar, H., Kalasek, R., Pichler-Milanovic, N., and Meijers, E. (2007). “Smart cities: Ranking of European medium-sized cities”, *Centre of Regional Science*, Vienna UT. Available at: http://www.smart-cities.eu/download/smart_cities_final_report.pdf, accessed on 23rd February, 2021.

Hivon, J. and Titah, R. (2017), “Conceptualizing citizen participation in open data use at the city level”, *Transforming Government: People, Process and Policy*, Vol. 11 No. 1, pp. 99–118. https://doi.org/10.1108/TG-12-2015-0053

Huijboom, N., and Van den Broek, T.A. (2011), “Open data: an international comparison of strategies”, *European Journal of ePractice*, Vol. 12 No. 1, pp. 4–16.

Jaeger, P. T., Bertot, J. C., and Shilton, K. (2012), “Information policy and social media: framing government—citizen web 2.0 interactions”, *Web 2.0 technologies and democratic governance* (pp. 11–25), Springer, New York. https://doi.org/10.1007/978-1-4614-1448-3_2

Janssen, M., Charalabidis, Y., and Zuiderwijk, A. (2012), “Benefits, adoption barriers and myths of open data and open government”, *Information Systems Management*, Vol. 29 No. 4, pp. 258–268. https://doi.org/10.1080/10580530.2012.716740

Janssen, M., Matheus, R., and Zuiderwijk, A. (2015), “Big and Open Linked Data (BOLD) to create smart cities and citizens: insights from smart energy and mobility cases”, In Tambouris E., *et al.* (eds.)

EGOV 2015. LNCS, Vol. 9248, pp. 79–90. Springer International Publishing, Cham. https://doi.org/10.1007/978-3-319-22479-4_6

Janurova, M., Chaloupkova, M., and Kunc, J. (2020), "Smart city strategy and its implementation barriers", *Theoretical and Empirical Researches in Urban Management*, Vol. 15 No. 2, pp. 5–21.

Kalampokis, E., Tambouris, E., and Tarabanis, K. (2011a), "Open government data: a stage model", In *Proceedings of the 10th IFIP WG 8.5 International Conference (EGOV 2011)* (pp. 235–246), Berlin Heidelberg: Springer. https://doi.org/10.1007/978-3-642-22878-0_20

Kalampokis, E., Tambouris, E., and Tarabanis, K. (2011b), "A classification scheme for open government data: towards linking decentralised data", *International Journal of Web Engineering and Technology*, Vol. 6 No. 3, pp. 266–285. https://doi.org/10.1504/IJWET.2011.040725

Kar, A. K., Ilavarasan, V., Gupta, M. P., Janssen, M., and Kothari, R. (2019), "Moving beyond smart cities: digital nations for social innovation & sustainability", *Information Systems Frontiers*, Vol. 21, pp. 495–501. https://doi.org/10.1007/s10796-019-09930-0

Lněnička, M., and Komárková, J. (2019), "Big and open linked data analytics ecosystem: Theoretical background and essential elements", *Government Information Quarterly*, Vol. 36 No. 1, pp. 129–144. https://doi.org/10.1016/j.giq.2018.11.004

Lněnička, M., Machova, R., Volejníková, J., Linhartová, V., Knezackova, R. and Hub, M. (2021), "Enhancing transparency through open government data: the case of data portals and their features and capabilities", *Online Information Review*, Vol. ahead-of-print No. ahead-of-print. https://doi.org/10.1108/OIR-05-2020-0204

Máchová, R., Hub, M., and Lněnička, M. (2018), "Usability evaluation of open data portals: Evaluating data discoverability, accessibility, and reusability from a stakeholders' perspective", *Aslib Journal of Information Management*, Vol. 70 No. 3, pp. 252–268. https://doi.org/10.1108/ajim-02-2018-0026

Máchová, R., and Lněnička, M. (2017), "Evaluating the quality of open data portals on the national level", *Journal of Theoretical and Applied Electronic Commerce Research*, Vol. 12 No. 1, pp. 21–41. https://doi.org/10.4067/S0718-18762017000100003

Martin, C. (2014), "Barriers to the open government data agenda: Taking a multi-level perspective", *Policy & Internet*, Vol. 6 No. 3, pp. 217–240. https://doi.org/10.1002/1944-2866.POI367

Meijer, A., and Bolívar, M. P. R. (2016), "Governing the smart city: a review of the literature on smart urban governance", *International Review of Administrative Sciences*, Vol. 82 No. 2, pp. 392–408. https://doi.org/10.1177/0020852314564308

Neves, F. T., de Castro Neto, M., and Aparicio, M. (2020), "The impacts of open data initiatives on smart cities: A framework for evaluation and monitoring", *Cities*, Vol. 106, https://doi.org/10.1016/j.cities.2020.102860

Nugroho, R. P., Zuiderwijk, A., Janssen, M., and de Jong, M. (2015), "A comparison of national open data policies: Lessons learned", *Transforming Government: People, Process and Policy*, Vol. 9 No. 3, pp. 286–308. https://doi.org/10.1108/TG-03-2014-0008

Ojo, A., Curry, E., and Zeleti, F. A. (2015), "A tale of open data innovations in five smart cities", In *2015 48th Hawaii International Conference on System Sciences* (pp. 2326–2335). IEEE. https://doi.org/10.1109/HICSS.2015.280

Pereira, G. V., Macadar, M. A., Luciano, E. M., and Testa, M. G. (2017), "Delivering public value through open government data initiatives in a Smart City context", *Information Systems Frontiers*, Vol. 19 No. 2, pp. 213–229. https://doi.org/10.1007/s10796-016-9673-7

PWC (2021), "Creating the smart cities of the future", Available at: https://www.pwc.in/industries/smart-cities.html, accessed on 23rd February, 2021.

Saxena, S. (2017a), "Significance of open government data in the GCC countries", *Digital Policy, Regulation and Governance*, Vol. 19 No. 3, pp. 251–263. https://doi.org/10.1108/DPRG-02-2017-0005

Saxena, S. (2017b), "Prospects of open government data (OGD) in facilitating the economic diversification of GCC region", *Information and Learning Science*, Vol. 118 No. 5/6, pp. 214–234. https://doi.org/10.1108/ILS-04-2017-0023

Saxena, S. (2018), "Open government data (OGD) in six Middle East countries: an evaluation of the national open data portals", *Digital Policy, Regulation and Governance*, Vol. 20 No. 4, pp. 310–322. https://doi.org/10.1108/DPRG-10-2017-0055

Saxena, S., and Janssen, M. (2017), "Examining open government data (OGD) usage in India through UTAUT framework", *Foresight*, Vol. 19 No. 4, pp. 421–436. https://doi.org/10.1108/FS-02-2017-0003

Sieber, R. E., and Johnson, P. A. (2015), "Civic open data at a crossroads: Dominant models and current challenges", *Government Information Quarterly*, Vol. 32 No. 3, pp. 308–315. https://doi.org/10.1016/j.giq.2015.05.003

Sharifi, A. (2020), "A typology of smart city assessment tools and indicator sets", *Sustainable Cities and Society*, Vol. 53, https://doi.org/10.1016/j.scs.2019.101936

Ubaldi, B. (2013), "Open government data: Towards empirical analysis of open government data initiatives", *OECD Working Papers on Public Governance*, No. 22, OECD Publishing. https://doi.org/10.1787/5k46bj4f03s7-en

United Nations, (2016), "United Nations e-Government Survey 2016: E-Government in Support of Sustainable Development", New York: UN Publishing Section.

United Nations. (2018), "United Nations e-Government Survey 2018: Gearing E-Government to support transformation towards sustainable and resilient societies", New York: UN Publishing Section.

United Nations. (2020), "United Nations e-Government Survey 2020: Digital Government in the Decade of Action for Sustainable Development", New York: UN Publishing Section.

Wirtz, B. W., and Birkmeyer, S. (2015), "Open government: Origin, development, and conceptual perspectives", *International Journal of Public Administration*, Vol. 38 No. 5, pp. 381–396. https://doi.org/10.1080/01900692.2014.942735

Zuiderwijk, A., Janssen, M., and Dwivedi, Y. K. (2015), "Acceptance and use predictors of open data technologies: Drawing upon the unified theory of acceptance and use of technology", *Government Information Quarterly*, Vol. 32 No. 1, pp. 429–440. https://doi.org/10.1016/j.giq.2015.09.005