QODA – Methodology and Legislative Background for Assessment of Open Government Datasets Quality

Žaklina Spalević[1], Nataša Veljković[2] & Petar Milić[3]*

[1]Singidunum University, Danijelova 32, 11000 Belgrade, Serbia

[2]University of Niš, Faculty of Electronic Engineering, Aleksandra Medvedeva 14, 18000Niš

[3]University of Pristina – Kosovska Mitrovica, Faculty of Technical Sciences, Knjaza Miloša 7, 38220 Kosovska Mitrovica, Serbia

In last few years, many open government data portals have been emerging in the world. These portals publish open government datasets which can be accessed and used by everyone for their own needs. In this paper, we propose methodology named QODA (Quality of Open government DAtasets) for assessment of quality of published datasets via two aspects. First one is assessment of quality of pure open government datasets, and second is assessment of quality features on the platforms which contributes to the publication of quality datasets. It provides a step-by-step dataset analysis guidance and summarization of results. Research presented in this paper shows that open government dataset quality depends on data provider as well as proper definition of metadata behind datasets. Our findings result in recommendations to open government data (OGD) publishers, to constantly supervise the use of published datasets, with aim to have timely and punctual information on OGD portals, with special attention on quality features.

Introduction

Public sector is under increasing pressure to supply more transparent and open data. This, forced governments to launch open data platforms to ensure that academia, citizens, business and other interested parties are aware of open government data (OGD). They are important prerequisites for unlocking the potential of OGD and are accompanied by appropriate legislations.[1,2] Equipped with metadata and organized into a searchable catalogue, OGD platforms enable provision of information about published datasets. Facilitation of public access and exploitation of OGD is achieved by browsing datasets by categories, tags, organizations, formats but also using some extra features such as API or SPARQL endpoints. Moreover, OGD platforms can offer the list of applications developed based on OGD data, discussion and commenting, visualization etc. End users will appreciate accessibility, reusability and easy processing of OGD.[3] Governments are more interested into releasing of data through OGD platforms rather than transforming it into the reports and applications which represent a faster way for achieving openness and transparency. This must be accompanied by legislation as a framework for sustainable development goals. Legislation on open government data secures the provision of automatic dissemination of information.[4] Furthermore, they facilitate understanding, management and exploitation of OGD by provision of information about meaning of OGD.[5]

The real value of OGD is generated by their use[6,7], therefore we should focus on identifying and solving challenges and barriers in open data adoption. Most of the challenges are related with users' ability to reuse OGD. Therefore, the OGD platforms should outweigh the positive effect and impact of OGD. Keeping in mind that OGD are published on OGD platforms, better usability of data and possibility to reuse data is in a relation with usability of OGD platforms. This claim is supported by research of Nikiforova[8], that states how users will not find OGD platforms usable and fit to their needs if they are faced with any concern related with OGD. In order to avoid these issues, data publishers should pay special attention to adequate level of OGD quality and focus more on user-friendliness of OGD platforms. Any deficiencies related with usability of OGD portals should be properly addressed through OGD quality in regard with accessibility, discoverability and reusability issues from users' perspective. As more and more open data are rapidly published, it becomes

*Author for Correspondence
E-mail: petar.milic@pr.ac.rs

clear why the quality of OGD on platforms is of great importance. Not to forget the government impediments for OGD reuse, which mostly are related with technical know-how, low data quality, confidentiality of personnel data, as well as, missing motivation and no understanding of OGD benefits.

Attard *et al.*[9] claim that usability context is the most common quality criteria, which refers to how facilely we can use OGD. Their study is aligned with research made by Lourenco *et al.* who assessed how structure of OGD platforms affects their usability.[10] Background structure of OGD platforms plays crucial role in achieving high quality OGD, apart from user interface aspect of OGD consumption. It is related with proper definition and publication of dataset's metadata on OGD platforms. Metadata are essential for achievement of a certain level of OGD quality and crucial for their use, while by opinion of Máchová and Lněnička[11] they represent a serious peril that could hinder the open data movement. Our previous research[5] on utilization of metadata for OGD consumption showed that diversity of metadata leads to writing different data providers for processing various elements of metadata with possible same meaning.

Open government data is an asset and a strategic tool for governments. Therefore, it is rational to establish a continuous focus on OGD quality measurement. High quality data better represents underlaying real-world phenomena and ensures optimal decision making. Furthermore, that leads to trusty relationship between government as data provider and various data stakeholders and accelerates data utilization.

In this paper we analysed OGD metadata to evaluate and assess OGD quality. For that purpose, we introduced QODA methodology with a set of indicators covering different ODG quality aspects. The methodology is flexible and generalized for application on different OGD portals. Also, in line with assessing of elements necessary for implementation of OGD quality, we additionally focused on detecting shortages which are of specific importance for achieving high quality levels. Based on the need for maintaining quality of OGD at high level, we got an idea to explore metadata structure of OGD datasets and try to find possible relations between quality and published metadata. Our approach goes toward establishment of metrics for OGD quality. As a proof of concept, we evaluate our methodology regarding multiple instances of OGD platforms. Furthermore, we analysed applicability of

the methodology, its pros and cons, and gave recommendations for definition of dataset's metadata.

Related Work

Data quality is cross-disciplinary concept, and for its adequate application in the light of open government, several characteristics should be encompassed. The inevitable companion of open government movement is open government data, and then the quality of data becomes even more important.[10] Albeit governments publish OGD, if they do not implement high quality standards with regards to its consumers, exploitation of its full potential can be questioned.[9] Moreover, the trust in government institutions is irrevocably lost if low quality OGD is disclosed. The research of Gonzálvez-Gallego and Nieto-Torrejòn also goes in this direction, where they assessed how and whether OGD, as a strategy of governance, can do one's bit to the trust in government institutions and contentment with public outcomes.[12] The authors encouraged public officers to exploit and utilize the open data strategies in order to attract young people to government institutions. Lněnička *et al.*[13]conducted a study on adoption of OGD and OGD portals among students. It has revealed that this group of stakeholders of OGD can bring a valuable insight and recommendations. Study gives good guidelines for achieving high SGD quality. Their findings emphasized the importance of proper quality management of OGD portals, in current OGD ecosystems. In this way, possible OGD barriers of legal, institutional and technical level for unrestricted access and reusability of OGD will be bridged.[14,15]

Bicevskis *et al.* suggests specification of OGD quality evaluation according to the concepts of data objects[16] which allows descriptions of data quality dimensions apart from the information system that collects them. They reported that, the same data might have good quality, for one application, and poor for others. Similarly, OGD quality modelling should go in two directions: platform independent modelling and platform specific modelling. Such modelling should resolve the issues of awareness of the needs between open data publishers and users.[11] Regards to this aspect of OGD quality will be addressed to some extent. Mostly this is related to accuracy, completeness, consistency and timeliness aspects of OGD quality. Simply relating OGD quality with accuracy might not be enough to consider essentially good data as high-quality data.[10] Furthermore, all the mentioned aspects of OGD quality are key characteristics of desired data disclosure. The frameworks for evaluation of OGD developed in recent

years, showed starting quality of OGD based on aforementioned characteristics. The research conducted in this direction, formed the metrics with purpose to assess the OGD.

Metrics for assessment of the OGD are in great number of cases available through established frameworks and are of very heterogeneous points of view. According to the Vetro *et al.*[17], these frameworks are comprehensive approach for assessment of OGD quality, but at the same time, they are at high-level due to the fact that they are proposed at the portal level. Tang & Jiang[18] contributes to this by recommending how open data should be published in order to articulate needed standards for achievement of crucial components of OGD quality. The importance of OGD containing adequate metadata that describes them, is a step forward in provisioning high quality OGD. Assessment of OGD, by using Likert scale, as proposed by Nikiforova[19], and in the light of OGD specification, feedback and requests, can reveal potential gaps in definition of OGD, which consequently affects their quality. This assessment was carried out on 42 national open data portals and tried to reveal main challenges that could have negative impact on users' participation in OGD consumption. In most cases it is related to the quality of OGD. High-quality of OGD is key enabler of user participation in consumption of OGD which is a prerequisite for establishing an active open data ecosystem. In this direction, it is important to have suitable information about OGD. It is responsibility of the publisher. It becomes obvious that usability of OGD portals is very important. According to the Máchová *et al.*[20] measurement of usability, from the ordinary citizen's point of view, contributes to the better characterization of the basic requirements regarding the OGD portals features that improves their usability, accessibility and discoverability. Moreover, governments should enable facilitation of the both OGD portals in general, and datasets of interest in particular.[21]

Facilitation of factors for both of aforementioned cases is ensured with proper handling of metadata information on OGD portals. Provision of adequate metadata about OGD attributes to the quality, simplifies the process of OGD reuse and can serve as a monitor of OGD progress. Our previous work[5] indicates that quality aspects of OGD such as completeness, timeliness, primary, categorization, licensing and linking along with access, rating and discussion goes toward utilization of OGD and reveals the government's commitment for achieving openness and transparency. Lněnička *et al.*[22] also contributes to this topic by benchmarking quality of

OGD through metadata that complies with DCAT-AP standard and propose a set of metrics suitable for tracking the quality of OGD. They claim that this metrics can be used as valuable input for decision-making as well as the definition of future actions significant for increasing the rank of country on various indices and rankings. As open data are usually consumed without checking whether they are of adequate level of quality and assuming that they are already checked by data suppliers[23], it becomes clear why it is important for OGD to be of high quality and trustable. Nikiforova[24] emphasizes that ratio of OGD quality opposed to the whole data quality analysis is ~0.2% which is unreasonably small despite the new challenges that arose from their nature.

Our study contributes to the quality analysis and assessment by identifying two important attributes of OGD quality. They are dataset quality from one side, and prerequisites of quality from OGD portal perspective. By evaluating OGD we will confirm this assumption and show that data providers play an important role in definition of OGD quality features. We will provide specification of OGD quality requirements which should be addressed from the level of OGD metadata. Also, we will examine orientation of OGD portals towards availability of information assets needed for effective consumption of OGD. The work presented in this paper represents the extension of our research published in Milić *et al.*[5] with up-to-date assessment of OGD quality by inclusion of contemporary directions in this area.

Materials and Methods

Open Government Data Platforms

OGD platforms are devoted to the OGD management, cataloguing, publishing and visualization of OGD to the public. They are equipped with various features that facilitate use of published data, with aim of improving quality and qualitative descriptions of OGD[5]. Metadata are prerequisite for effective utilization of OGD for consumption, evaluation and assessment purposes. All of this is mostly achieved through the metadata schemes available via API which are of high significance for adoption of the OGD. Metadata schemes on OGD platforms are not standardized and therefore the process of evaluation and assessment of OGD for different purposes is difficult. Assaf *et al.*[25] indicates this fact and suggest standardization approach based on harmonization of OGD dataset model by detailed comparison and mapping of several models of metadata and their fields. These and similar approaches[26–28] should facilitate

measurement and assessment of OGD on platforms which will increase positive impact on them and will go toward higher standards of quality and government openness.

Automatic evaluation and assessment of OGD on platforms can be achieved by using open data platform's APIs. Their aim is to serve as machine accessible and readable source of information. They can be examined in order to check whether exposed information is conforming to defined quality levels.

Monitoring and analysing user behaviour, while exploiting OGD platforms, can have twofold advantage for platform managers. From one side, valuable information on utilized metadata of OGD datasets can be observed and potential black holes in their definition identified, while on the other side, empirical evidence of relations between of quality and OGD usage[29] can be obtained. Furthermore, OGD platforms should comply with FAIR principles (Findability, Accessibility, Interoperability and Reusability). Exhaustive OGD usage assessment, particularly in the form of pools, could be performed to reveal the impact on OGD adoption of contextual aspects, such as users' needs and competencies, as well as research of the role and influence of mediate OGD usage modes.

QODA Methodology

QODA (Quality of Open government DAtasets) methodology analyses two aspects: OGD Quality and OGD Portal Quality (depicted in Fig. 1). The proposed methodology is continuation of our research[5] considering current trends and state-of-the art in this area.

We have identified the need to address the quality of platform on which OGD are published, and that is the reason why in our methodology OGD platform is important constituent. QODA methodology enables evaluation of OGD quality, against predefined set of measures, which will be described in details in the following paragraphs

OGD quality aspect (OQA) in QODA methodology consists of 7 parts:

Complete – with this sub aspect we seek to ensure that each OGD dataset is equipped with metadata for description, whether they are machine readable, downloadable and eventually linked with other data (Eq. 1). According to this feature, complete is calculated and taken into account when OQA is determined. Keeping in mind that on some OGD platforms, description of the dataset is separated of the description of the dataset resource, we decided to scale description measure of complete aspect in the way that description of dataset takes 80% of the measure, while 20% goes to the description of the dataset (Eq. 2).

$$complete = description + download + machineReadable + linked \quad \dots (1)$$

$$complete["description"] = 0.8 * datasetDescription + 0.2 * resourceDescription \quad \dots (2)$$

Timely– under this aspect we consider if the data are actual, updated on time, how often they are updated, validity period and when was the last update. Previously mentioned information is equally important for both datasets in general and dataset resources, and that is the reason why they are equally weighted in the final score (Eq. 3).

$$timely = 0.5 * datasetTimellines + 0.5 * resourceTimellines \quad \dots (3)$$

Primary – by this we mean their publication in original format, without aggregation and modification, directly from source of origination. In that form, they ensure the subtle level of granularity that is satisfactory from the aspect of legislation and other requirements[5].

Categorized– by grouping, or classification of OGD, by some established criteria, data availability and discoverability is increased. Moreover, categorized
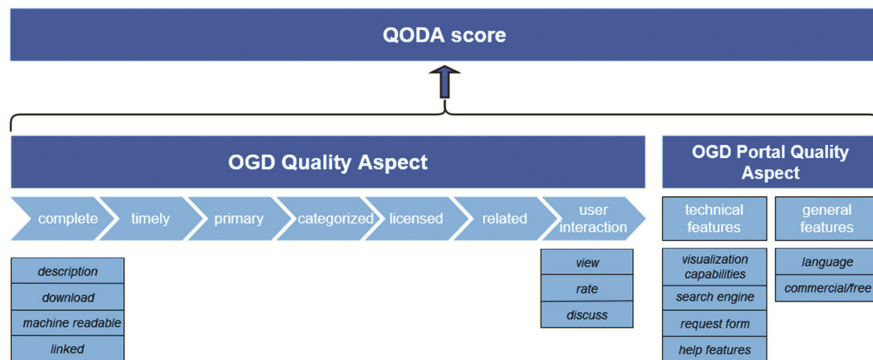

Fig. 1 — QODA methodology – Building blocks

OGD datasets make it easier to obtain desired information. For these purposes, the advantage of metadata accompanying dataset is utilized and thus contributes to the overall quality of OGD.

Licensed– by checking this sub aspect, we review whether OGD is truly open or available per request. Mostly, OGD are license free and available without any restrictions.

Related – relation of OGD with other data, especially with those on the same platform is important in searching for information of interest. Furthermore, relation of OGD datasets by exploiting semantic interlinking between datasets contributes to the established aim of our paper.

User interaction– by utilization of this sub aspect of OQA measure, we are checking user contribution in OGD promotion and reuse, by exploiting whether end users are using OGD datasets, whether user expresses their satisfaction with published data by rating them and whether they contribute to the forming of the discussion. This will guide and direct the OGD publishers to the valuable source of information for further improvements of the platform and OGD itself.

OGD portal quality aspect (OPQA) in QODA methodology consists of two parts:

Technical features – features of the OGD platform such as visualization capabilities, search engine capability, request form for seeking of datasets and help documentation represent the basic prerequisites for achieving quality[3,9] and fitness for use, from the technical point of view.

General features– availability of language change and information whether OGD platform is license free, or commercial, are constituent for successful user consumption of OGD data in modern applications.

$$opqa = 0.7 * technical\ Features + 0.3 * general\ Features \qquad \dots (4)$$

As both OQA and OPQA values contribute to the final QODA score. Its calculation is performed according to the Eq. 5.

$$QODA\ score = 0.7 * oqa + 0.3 * opqa \qquad \dots (5)$$

QODA methodology reflects the requirements and experiences of the data consumers and balance metadata functionality against applicable constraints, in order to extract, as much as possible, information from OGD, which can be of the great potential for assessing the OGD quality.

To calculate QODA score, we seek for metadata elements on OGD platforms for the purposes of denoting presence or absence of such elements, along with checking whether the element is filled with data, as well as, if data are of some kind.[8] We examine metadata elements shown in Table 1.

Table 1 — Examined metadata for OGD quality — (*Contd.*)

platform	quality aspect		parameter	metadata field
CKAN	OGD Quality Aspect	complete	description	[notes], resources → [description]
			download	resources → [url]
			machine readable	resources → [format], {csv, json, xml...}, resources → [mimetype]
			linked	[relationship_as_object], [relationships_as_subject]
		timely		[metadata_created], [metadata_modified], extras → [temporal_coverage_from], extras → [temporal_coverage_to], extras → [frequency-of-update], extras → [date_updated], resources → [created], resources → [last_modified]
		primary		resources → [format]
		categorized		[tags], [groups], extras → [categories]
		licensed		[is_open], [private], [license_title], [license_id], [license_url]
		related		[relationship_as_object], [relationships_as_subject]
		user interaction	view	tracking_summary → [recent], tracking_summary → [total]
			rate	[rating_count], [rating_average]
			discuss	
	OGD Portal Quality Aspect	technical features	visualisation capabilites	
			search engine	
			request form	
			help features	
		general features	language	
			commercial/free	

Table 1 — Examined metadata for OGD quality — (*Contd.*)

platform	quality aspect		parameter	metadata field
DKAN	OGD Quality Aspect	complete	description	[notes], resources→[description]
			download	resources → [url]
			machine readable	resources → [format], {csv, json, xml...}, resources → [mimetype]
			linked	[relationship_as_object], [relationships_as_subject]
		timely		[metadata_created], [metadata_modified], extras → [temporal_coverage_from], extras → [temporal_coverage_to], extras → [frequency-of-update], extras → [date_updated], resources → [created], resources → [last_modified]
		primary		resources → [format]
		categorized		[tags], [groups], extras → [categories]
		licensed		[is_open], [private], [license_title], [license_id], [license_url]
		related		[relationship_as_object], [relationships_as_subject]
	OGD Portal Quality Aspect	user interaction	view	tracking_summary → [recent], tracking_summary → [total]
			rate	[rating_count], [rating_average]
			discuss	
		technical features	visualisation capabilites	
			search engine	
			request form	
			help features	
		general features	language	
			commercial/free	
Socrata	OGD Quality Aspect	complete	description	[description]
			download	[download Count]
			machine readable	[columns]*
			linked	
		timely		[created At], [publication Date], [rows UpdatedAt], metadata → custom fields → 'Time Frame' → [Date Created], metadata → custom fields → 'Time Frame' → [Period of Coverage], metadata → custom fields → 'Time Frame' → [Update Frequency]
		primary		[columns]*
		categorized		[tags], [category]
		licensed		license → [name], [rights], grants → [flags]
		related		
	OGD Portal Quality Aspect	user interaction	view	[viewCount], [viewLastModified]
			rate	[average Rating], [totalTimesRated]
			discuss	[number Of Comments]
		technical features	visualisation capabilites	
			search engine	
			request form	
			help features	
		general features	language	
			commercial/free	
		complete	description	metas → default → [description]
			download	
			machine readable	[fields]*
			linked	metas → default → [references]
Open Data Soft	OGD Quality Aspect	timely		metas → default → [modified], metas → default → [metadata_processed], metas → default → [data_processed], metas → dcat → [temporal_coverage_start], metas → dcat → [temporal_coverage_end]

(*Contd.*)

Table 1 — Examined metadata for OGD quality — (*Contd.*)

platform	quality aspect	parameter		metadata field
Open Data Soft	OGD Quality Aspect	primary		[fields]*
		categorized		metas → default → [keyword]
		licensed		metas → default → [license], metas → default → [license_url]
		related		metas → default → [references]
	OGD Portal Quality Aspect	user interaction	view	
			rate	
			discuss	
		technical features	visualisation capabilites	
			search engine	
			request form	
			help features	
		general features	language	
			commercial/free	
U Data	OGD Quality Aspect	complete	description	[description], resources→[description]
			download	resources → [url]
			machine readable	resources → [format], {csv, json, xml...}, resources → [mimetype]
			linked	
		timely		[createdAt], [frequency], [frequency_date], [last_modified], [last_update], [temporal_coverage], resources → [last_modified], resources → [latest], resources → [published]
		primary		resources → [format], resources → [mime]
		categorized		[tags]
		licensed		[private]
		related		
	OGD Portal Quality Aspect	user interaction	view	metrics → [views], metrics → [reuses], metrics → [followers]
			rate	metrics → [issues]
			discuss	metrics → [discuss]
		technical features	visualisation capabilites	
			search engine	
			request form	
			help features	
		general features	language	
			commercial/free	

Condition used in all cases: 1 - defined, 0 - undefined

As it can be seen from Table 1, evaluation of *complete* sub aspect is done through four parts where each part is examined by separate metadata fields on OGD platform. These metadata fields are different from platform to platform, and they are not unique for all. For example, CKAN and DKAN platforms are same in general, and they share almost all fields. Moreover, in analysis of machine readable feature, we assess dataset format in order to check whether indeed they are machine-readable or not. OQA aspect can be calculated automatically, while OPQA must be done manually. This is the reason, why in Table 1 general and technical features are empty for metadata fields.

For some sub aspect of OQA there are more than one metadata fields to be examined and all of them should be considered.

For some sub aspects of OQA there are no adequate metadata fields (*related* sub aspect of OQA for Socrata, OpenDataSoft and uData) to be examined, and thus they obtain 0 value. Metadata fields marked with '*' means that they have separated API for access and consumption of that data. Consequently, this means that such data are machine-readable by default. Moreover, some platforms such as Socrata and OpenDataSoft have separate API for download of OGD datasets and they are marked in that manner.

Results and Discussion

Evaluation of QODA Methodology — Usecase Approach

In order to perform preliminary check of chosen OGD portals, we have selected portals from the official websites of the CKAN (https://ckan.org), DKAN (https://getdkan.org), SOCRATA (https://dev.socrata.com), Open Data Soft (https://www.opendatasoft.com) and uData (https://github.com/opendatateam/udata) platform. For each platform we have selected up to 15 portals, with exception for the uData platform which is relatively new and there are just 4 portals running on it. For selected OGD portals, we examined how many datasets are published, average number of complete metadata fields per dataset and average number of machine readable formats per dataset. Results of these assessments are presented in Table 2.

What we see from Table 2 conforms to expectations that CKAN platform has most published datasets per portal, but the level of complete metadata fields and machine-readable formats is not very high. In this regard, DKAN platform has better results, as DKAN is OGD platform very similar to the CKAN. Also, it can be noticed that SOCRATA and Open Data Soft OGD platforms have best results for the level of average number of machine-readable formats per dataset. This is because these platforms have separate API calls for accessing published data. More precisely, SOCRATA and OpenDataSoft publish data only in tabular format, and offer possibility to export them in various machine-readable formats such as, CSV, JSON, XML, RDF etc. Furthermore, among all tested portals, only SOCRATA powered OGD portals

Table 2 — Statistical analysis of examined OGD portal

Platform	Portal	Number of datasets	AVG number of complete metadata fields per dataset	AVG number of machine-readable formats per dataset
uData	https://data.gov.rs/api/1/datasets	1822	64%	67%
	https://dados.gov.pt/api/1/datasets	4910	65%	39%
	https://data.public.lu/api/1/datasets/	1600	63%	13%
	https://www.data.gouv.fr/api/1/datasets/	41037	66%	40%
CKAN	https://ckan.publishing.service.gov.uk/api/3/action/package_list	52448	68%	30%
	https://open.canada.ca/data/api/3/action/package_list	31755	63%	29%
	https://ckan.opendata.swiss/api/3/action/package_list	6963	74%	13%
	https://datos.gob.mx/busca/api/3/action/package_list	9287	60%	14%
	https://data.go.th/api/action/package_list	5898	74%	45%
	https://data.gov.au/api/3/action/package_list	13376	72%	13%
	https://www.govdata.de/ckan/api/3/action/package_list	49571	64%	5%
	https://open.africa/api/3/action/package_list	6490	64%	45%
	https://data.gov.ie/api/3/action/package_list	13373	75%	36%
	https://data.humdata.org/api/3/action/package_list	31796	71%	39%
	https://data.gov.ro/api/3/action/package_list	2691	69%	78%
	https://data.gov.sk/api/3/action/package_list	2841	72%	60%
	https://dados.gov.br/api/3/action/package_list	11029	75%	56%
	https://data.buenosaires.gob.ar/api/3/action/package_list	423	78%	46%
	http://opendata.hu/api/3/action/package_list	67	60%	21%
DKAN	https://data.gov.gh/api/3/action/package_list	315	100%	90%
	https://data.city.kyoto.lg.jp/api/3/action/package_list	606	100%	78%
	https://data.gov.jm/api/3/action/package_list	32	100%	83%
	https://dadesobertes.diba.cat/api/3/action/package_list	76	90%	81%
	https://opendata.by/api/3/action/package_list	229	100%	49%
	http://data.mmr.cz/api/3/action/package_list	43	73%	100%
	https://dati.gov.it/opendata/api/3/action/package_list	52519	72%	82%
	https://data.cambridgeshireinsight.org.uk/api/3/action/package_list	235	72%	65%
	https://opendata.transport.nsw.gov.au/api/3/action/package_list	206	60%	5%
	https://datosabiertos.rosario.gob.ar/api/3/action/package_list	245	100%	78%
	https://data.nicva.org/api/3/action/package_list	164	100%	80%
	https://opendata.bonn.de/api/3/action/package_list	327	100%	82%
	https://dati.comune.genova.it/api/3/action/package_list	138	100%	81%
	https://data.louisvilleky.gov/api/3/action/package_list	280	100%	53%
	https://data.gov.sa/Data/en/api/3/action/package_list	6442	100%	75%

(*Contd.*)

Table 2 — Statistical analysis of examined OGD portal

Platform	Portal	Number of datasets	AVG number of complete metadata fields per dataset	AVG number of machine-readable formats per dataset
	https://data.edmonton.ca/api/catalog/v1	2519	100%	100%
	https://data.cityofnewyork.us/api/catalog/v1	3516	100%	100%
	https://www.dati.lombardia.it/api/catalog/v1	5432	100%	100%
	https://data.texas.gov/api/catalog/v1	1284	100%	100%
	https://data.honolulu.gov/api/catalog/v1	306	100%	100%
	https://cohesiondata.ec.europa.eu/api/catalog/v1	1139	100%	100%
	http://www.datos.gov.co/api/catalog/v1	28964	100%	100%
SOCRATA	https://healthdata.gov/api/catalog/v1	4308	100%	100%
	http://www.pivcide.pr/api/catalog/v1	70	100%	100%
	http://data.usaid.gov/api/catalog/v1	1510	100%	100%
	http://data.sfgov.org/api/catalog/v1	1087	100%	100%
	http://citydata.mesaaz.gov/api/catalog/v1	930	100%	100%
	http://data.cincinnati-oh.gov/api/catalog/v1	156	100%	100%
	http://data.novascotia.ca/api/catalog/v1	1113	100%	100%
	http://www.data.act.gov.au/api/catalog/v1	1127	100%	100%
	https://public.opendatasoft.com/api/v2/catalog/datasets	623	50%	100%
	https://data.explore.star.fr/api/v2/catalog/datasets	42	57%	100%
	https://data.laregion.fr/api/v2/catalog/datasets	1711	46%	100%
	https://www.data.corsica/api/v2/catalog/datasets	502	56%	100%
	https://opendata.vancouver.ca/api/v2/catalog/datasets	177	36%	100%
	https://ressources.data.sncf.com/api/v2/catalog/datasets	216	51%	100%
	https://opendata.wuerzburg.de/api/v2/catalog/datasets	107	62%	100%
OpenDataSoft	https://opendata.comune.bologna.it/api/v2/catalog/datasets	425	53%	100%
	https://data.gouv.nc/api/v2/catalog/datasets	153	49%	100%
	https://transparencia.sns.gov.pt/api/v2/catalog/datasets	148	58%	100%
	https://data.education.gouv.fr/api/v2/catalog/datasets	92	50%	100%
	https://opendata.bristol.gov.uk/api/v2/catalog/datasets	221	64%	100%
	https://data.leicester.gov.uk/api/v2/catalog/datasets	181	66%	100%
	https://data.montreuil.fr/api/v2/catalog/datasets	152	66%	100%
	https://data.bs.ch/api/v2/catalog/datasets	152	54%	100%

has all complete metadata fields, i.e. all metadata defined. Some of the analysed OGD portals has lower than 50% (or near that value) the level of complete metadata fields per dataset on OGD portals, which may throttle the power of OGD. These portals should address this issue, as more detailed metadata for each dataset on portal, contributes to the overall quality of OGD, which consequently improves application processing.[5]

By observing the data for the number of the OGD datasets per portal, we came to conclusion that would be time consuming to test all of them, and therefore we decided to apply statistical sampling of the datasets in order to perform tests needed for checking whether the proposed methodology for determining the quality of OGD is applicable. For this purpose, we need to select a relevant subset of the datasets on each OGD portal. This can be achieved by using statistical approach which can ensure a reliable method for sample size calculation with given constraints[30] as shown in Eq. (6). Included constraints were confidence level (Z), margin of error (c) and accuracy (p).

$$S = \frac{Z^2 * p * (1-p)}{c^2} \quad \dots (6)$$

$$S = \frac{S}{1 + \frac{S-1}{P}} \quad \dots (7)$$

c describes the precision of a chosen sample and deviation of expected results. For the purposes of our assessment, it was valued at 10. Z is in the form of percentage, and helps to check whether sampled data meet the required feature and whether they are inside of the confidence interval. In our assessment, we choose confidence level of 95%, for which Z will take the value of 1.65 as per table of standard normal curve. p stand for accuracy. Reliable prediction of this percentage is not feasible, which is the reason why we have chosen 50% for p parameter. Taking into account whole assessed population denoted by P, by Eq. (7) we obtain necessary sample size.

In assessment of OGD portals against QODA methodology described throughout this paper, we apply

use case study approach. Assessment was performed on the OGD portals as listed in Table 2 for aspects defined in Table 1. Assessed OGD portals are of country or city level. Each metadata is tested, to see whether it is defined or not, and if it is defined it receives value 1, otherwise 0. Then we summarize the values for each sub aspect and calculate the mean value. Further, values for each sub aspect are added and divided by total number of sub aspects obtaining thus the final value for OQA aspect of QODA methodology. The OPQA aspect of QODA methodology is calculated manually. This manual calculation is done in that manner that for each portal we

examine whether the proposed characteristic is defined or not (consequently obtaining 1 or 0), then sum the values and divide it with total number of characteristics. In Table 3 we present results of assessment.

The best results has OGD portal in Portugal with value 0.7131. This portal is powered by uData OGD platform. The newly established uData OGD platform solves some shortcomings of existing platforms, both open source and commercial, among which is performance issues, easy interface and better API support. Closer to the Portugal national OGD portal is Basel (Switzerland) OGD portal, a city level portal, with QODA score of

Table 3 — Results of assessment by QODA methodology — (*Contd.*)

platform	portal	OQA value	OPQA value	QODA score
uData	https://data.gov.rs/api/1/datasets	0.5775	0.5000	0.5543
	https://dados.gov.pt/api/1/datasets	0.5902	1.0000	0.7131
	https://data.public.lu/api/1/datasets/	0.5920	0.8750	0.6769
	https://www.data.gouv.fr/api/1/datasets/	0.5678	0.6250	0.5850
CKAN	https://ckan.publishing.service.gov.uk/api/3/action/package_list	0.3927	0.4500	0.4099
	https://open.canada.ca/data/api/3/action/package_list	0.4028	0.8750	0.5445
	https://ckan.opendata.swiss/api/3/action/package_list	0.3628	0.7500	0.4790
	https://datos.gob.mx/busca/api/3/action/package_list	0.4765	0.6250	0.5211
	https://data.go.th/api/action/package_list	0.4797	0.6250	0.5233
	https://data.gov.au/api/3/action/package_list	0.4824	0.6250	0.5252
	https://www.govdata.de/ckan/api/3/action/package_list	0.4887	0.5000	0.4921
	https://open.africa/api/3/action/package_list	0.4579	0.8750	0.5830
	https://data.gov.ie/api/3/action/package_list	0.4704	0.8750	0.5918
	https://data.humdata.org/api/3/action/package_list	0.4713	0.6250	0.5174
	https://data.gov.ro/api/3/action/package_list	0.4574	1.0000	0.6202
	https://data.gov.sk/api/3/action/package_list	0.5115	0.7500	0.5831
	https://dados.gov.br/api/3/action/package_list	0.4879	0.5000	0.4915
	https://data.buenosaires.gob.ar/api/3/action/package_list	0.4228	0.3750	0.4085
	http://opendata.hu/api/3/action/package_list	0.4602	0.7500	0.5471
DKAN	https://data.gov.gh/api/3/action/package_list	0.5087	0.5000	0.5061
	https://data.city.kyoto.lg.jp/api/3/action/package_list	0.3364	0.5000	0.3855
	https://data.gov.jm/api/3/action/package_list	0.4985	0.3750	0.4615
	https://dadesobertes.diba.cat/api/3/action/package_list	0.4871	0.6250	0.5285
	https://opendata.by/api/3/action/package_list	0.4949	0.6250	0.5339
	http://data.mmr.cz/api/3/action/package_list	0.4979	0.8750	0.6110
	https://dati.gov.it/opendata/api/3/action/package_list	0.4499	0.5000	0.4649
	https://data.cambridgeshireinsight.org.uk/api/3/action/package_list	0.4960	0.6250	0.5347
	https://opendata.transport.nsw.gov.au/api/3/action/package_list	0.4722	0.5000	0.4805
	https://datosabiertos.rosario.gob.ar/api/3/action/package_list	0.4930	0.5000	0.4951
	https://data.nicva.org/api/3/action/package_list	0.4894	0.6250	0.5301
	https://opendata.bonn.de/api/3/action/package_list	0.4837	0.6250	0.5261
	https://dati.comune.genova.it/api/3/action/package_list	0.4877	0.5000	0.4914
	https://data.louisvilleky.gov/api/3/action/package_list	0.4134	0.7500	0.5144
	https://data.gov.sa/Data/en/api/3/action/package_list	0.3540	1.0000	0.5478
SOCRATA	https://data.edmonton.ca/api/views	0.6733	0.5000	0.6213
	https://data.cityofnewyork.us/api/views	0.6379	0.3750	0.5590
	https://www.dati.lombardia.it/api/views	0.6452	0.5000	0.6016
	https://data.texas.gov/api/views	0.5964	0.5000	0.5675
	https://data.honolulu.gov/api/views	0.6188	0.5000	0.5832
	https://cohesiondata.ec.europa.eu/api/views	0.5987	0.3750	0.5316
	http://www.datos.gov.co/api/views	0.5609	0.6250	0.5801
	https://healthdata.gov/api/views	0.6140	0.3750	0.5423

(*Contd.*)

Table 3 — Results of assessment by QODA methodology

| platform	portal	OQA value	OPQA value	QODA score
	http://www.pivcide.pr/api/views	0.6536	0.3750	0.5700
	http://data.usaid.gov/api/views	0.6536	0.5000	0.6075
	http://data.sfgov.org/api/views	0.6300	0.3750	0.5535
	http://citydata.mesaaz.gov/api/views	0.5952	0.3750	0.5291
	http://data.cincinnati-oh.gov/api/views	0.6274	0.3750	0.5517
	http://data.novascotia.ca/api/views	0.6522	0.3750	0.5690
	http://www.data.act.gov.au/api/views	0.5991	0.3750	0.5319
	https://public.opendatasoft.com/api/v2/catalog/datasets	0.7342	0.3750	0.6264
	https://data.explore.star.fr/api/v2/catalog/datasets	0.6178	0.3750	0.5450
	https://data.laregion.fr/api/v2/catalog/datasets	0.5239	0.3750	0.4792
	https://www.data.corsica/api/v2/catalog/datasets	0.6986	0.3750	0.6015
	https://opendata.vancouver.ca/api/v2/catalog/datasets	0.4871	0.5000	0.4910
	https://ressources.data.sncf.com/api/v2/catalog/datasets	0.6214	0.3750	0.5475
	https://opendata.wuerzburg.de/api/v2/catalog/datasets	0.5633	0.3750	0.5068
Open Data Soft	https://opendata.comune.bologna.it/api/v2/catalog/datasets	0.5517	0.3750	0.4987
	https://data.gouv.nc/api/v2/catalog/datasets	0.7991	0.3750	0.6719
	https://transparencia.sns.gov.pt/api/v2/catalog/datasets	0.4768	0.3750	0.4463
	https://data.education.gouv.fr/api/v2/catalog/datasets	0.6435	0.3750	0.5630
	https://opendata.bristol.gov.uk/api/v2/catalog/datasets	0.6436	0.3750	0.5630
	https://data.leicester.gov.uk/api/v2/catalog/datasets	0.6214	0.3750	0.5475
	https://data.montreuil.fr/api/v2/catalog/datasets	0.7144	0.3750	0.6126
	https://data.bs.ch/api/v2/catalog/datasets	0.7504	0.6250	0.7128
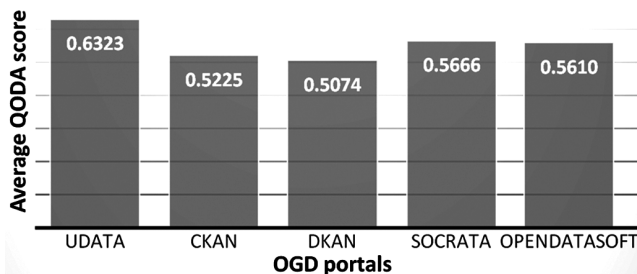
Fig. 2 — Overall quality of OGD portals for each platform shows average QODA score per each platform of analysed OGD portals

0.7128. Lowest results were noticed for city portal of Kyoto with value of 0.3855, powered by DKAN.

Furthermore, it can be noticed, that only few portals have highest score for OPQA aspect, and similarly, more than a half of assessed portals have a value lower than 0.5. From the user point of view, this aspect of QODA methodology is important for their perception of usage of OGD platform, enabling thus availability of tools and methods for fast data analysis and preview.[13,26,29] Moreover, this confirms our assumption that quality features of the OGD platforms must be considered in determining the quality of OGD in a whole as OGD platforms makes OGD available to all, whether they are developers or ordinary users.

It can be seen that Fig. 2 shows average QODA score per each platform of analysed OGD portals. uData has a great potential to be a leader in this area, while the other platforms can improve their rating. SOCRATA and OpenDataSoft goes toward this, as they offer machine processing of published OGD data, boosting in this manner the availability of OGD in applications, while for others these should be recommendation.

Conclusions

As OGD platforms represent the bridge between the government and users of OGD, governments need to pay more attention to OGD quality maintenance. The QODA methodology presented in this paper is the resumption of research we have referenced before. Here we have proven that OGD quality depends on data provider, but nevertheless, either national or city level data publishers may have data quality problems. Quality of OGD must be continually monitored and potential quality problems need to be detected, explored and solved. Consequently, this will affect the usability of OGD by end users, as well as the success of the initiative in general.

Our QODA methodology contributes to the identification of potential issues in OGD quality that can affect its consumption in applications and provide the specification of OGD quality requirements that should be addressed for achievement of the better quality of data. Also, QODA methodology can be utilized for identification of places in metadata structure of OGD platform that need to be improved upon. From practical point of view and based on findings of applied use case

study approach, it is recommended to OGD publishers to constantly track the exploitation of published OGD datasets with aim to have timely and punctual information on OGD portals with special attention on quality features.

Further research should be done towards fine grained adjustment of QODA coefficients which will reflect in more accurate and precise information about quality of OGD. In this regards an in-depth check of appropriateness of targeted quality features in the light of provided metadata values can help. Also, checking whether metadata values that are part of quality features check correspond to what is annotated is helpful. If the OGD quality is not high enough, potential users may not see a positive impact and will find portals unusable and not fitting their purposes. The quality of OGD has direct impact on trust and indirect on the user satisfaction.

References

1 Law on Electronic Administration, *The Official Gazette of the Republic of Serbia*, No. 27/2018.

2 Directive (EU) 2019/1024 of the European Parliament and of the Council of 20 June 2019 on open data and the re-use of public sector information, *J Euro Union* L 172/56.

3 Veljković N, Milić P, Stoimenov L & Kuk K, Production of linked government datasets using enhanced LIRE architecture, *Comput Sci Info Syst*, **17(2)** (2020) 599–617.

4 Sallami K, Idlebi N & Nahar M, Legal aspects of open government and open data, *Eco Soc Commission Westn Asia (ESCWA)* (United Nations, Beirut) 2020, .

5 Milić P, Veljković N & Stoimenov L, Comparative analysis of metadata models on e-government open data platforms, *IEEE Trans Emerg Top Comput*, **9(1)** (2021) 119–130.

6 Charalabidis Y, Zuiderwijk A, Alexopoulos C, Janssen M, Lampoltshammer T & Ferro E, The open data landscape, in *The World of Open Data, Public Administration and Information Technology*, vol 28, (Springer Cham) 2018, https://doi.org/10.1007/978-3-319-90850-2_1.

7 McBride K, Toots M, Kalvet T & Krimmer R, Open government data driven co-creation: Moving towards citizen-government collaboration, *Proc 17th Int Conf Electron Govt* () 2018, 184–195.

8 Nikiforova A, Assessment of the usability of Latvia's open data portal or how close are we to gaining benefits from open data, *Proc 14th Int Conf Interfaces Human Comput Inter* () 2020, 51–58.

9 Attard J, Orlandi F, Scerri S & Auer S, A systematic review of open government data initiatives, *Govt Info Qua*, **32(4)** (2015) 399–418.

10 Lourenço R P, An analysis of open government portals: A perspective of transparency for accountability, *Govt Info Quarterly*, **32(3)** (2015) 323–332.

11 Máchová R & Lněnička M, Evaluating the quality of open data portals on the national level, *J Theor Appl Electron Commer Res*, **12(1)** (2017) 21–41.

12 Gonzálvez-Gallego N & Nieto-Torrejòn L, Can open data increase younger generations' trust in democratic institutions? A study in the European Union, *PLoS ONE*, **16(1)** (2021) 1–14.

13 Lněnička M, Nikiforova A, Saxsena S & Singh P, Investigation into the adoption of open government data among students: the behavioural intention-based comparative analysis of three countries, *Aslib J Info Manag*, (2021) Preprint, https://doi.org/10.1108/AJIM-08-2021-0249.

14 Crusoe J & Melin U, Investigating open government data barriers, *Proc 17th Int Conf Electron Govt* (Austria, Krems) (2018), 169–183.

15 Dulong de Rosnay M & Janssen M, Legal and institutional challenges for opening data across public sectors: Towards common policy solutions, *J Theor Appl Electron Commer Res*, **9(3)** (2014) 21–41.

16 Bicevskis J, Bicevska Z, Nikiforova A & Oditis A, An approach to data quality evaluation, *Proc 5th Int Conf Social Netw Analy, Manage Secu* (Spain, Valencia) 2018, 196–201.

17 Vetro A, Canova L, Torchiano M, Orozco Minotas C, Iemma R & Morando F, Open data quality measurement framework: Definition and application to open government data, *Govt Info Quarterly*, **33(2)** (2016) 325–337.

18 Tang R& Jiang J, Characteristics of open government data (OGD) around the world: A country-based comparative meta-analysis, *Data Inf Manag*, **5(1)** (2020) 11–26.

19 Nikiforova A, Comparative analysis of national open data portals or whether your portal is ready to bring benefits from open data, *Proc IADIS Conf ICT, Society and Human Beings* (Portugal, Lisbon) 2020, 1–9.

20 Máchová R, Hub M & Lněnička M, Usability evaluation of open data portals: Evaluating data discoverability, accessibility, and reusability from a stakeholders' perspective, *Aslib J Info Manag*, **70(3)** (2018) 252–268.

21 Nikiforova A, Smarter open government data for society 5.0: Are your open data smart enough?, *Sensors*, **21(21)** (2021) 1–30.

22 Lněnička M, Luterek M & Nikiforova A, Benchmarking open data efforts through indices and rankings: Assessing development and contexts of use, *Telemat Inform*, **66** (2022) 1–25.

23 Nikiforova A, Open data quality evaluation: A comparative analysis of open data in Latvia, *Baltic J Modern Comput*, **6(4)** (2018) 363–386.

24 Nikiforova A, Definition and evaluation of data quality: User-oriented data object-driven approach to data quality assessment, *Baltic J Modern Comput*, **8(3)** (2020) 391–432.

25 Assaf A, Troncy R & Senart A, HDL - towards a harmonized dataset model, *Proc 2nd Int Works on Dataset Profiling Federated Search on Linked Data* (France, Sophia Antipolis) 2015, 62–74.

26 Zuiderwijk A, Janssen M & Susha I, Improving the speed and ease of open data use through metadata, interaction mechanisms, and quality indicators, *J Organ Comput Electron Commer*, **26(1-2)** (2016) 116–146.

27 Mohamad A, Sylvester A & Campbell-Meier J, Towards a taxonomy of emerging topics in open government data: a bibliometric mapping approach, *Proc 55th Hawaii Int Conf Sys* () (2022) 2553–2562.

28 Hossain M A, Rahman S, Quaddus M, Hooi E & Olanrewaju A S, Factors affecting performance of open government data initiatives: A multi-method approach using sem and FSQCA, *J Organ Comput Electron Commer*, **34(1)** (2022) 1–20.

29 Quaraty A, Open government data: Usage trends and metadata quality, *J Inf Sci*, **24(2)** (2021) 1 – 24.

30 Sematech N I S T, e-Handbook of statistical methods, http://www.itl.nist.gov/div898/handbook (accessed 6 June 2022).