AN EXPLORATORY STUDY REGARDING OPEN DATA IN SOME DEVELOPING COUNTRIES

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ABSTRACT

Nowadays, it is not only necessary to manage the data generated by the organization, but also to manage open external data that, through the analysis processes, helps to contribute to the decision-making based on "discovered" knowledge. Thus, we can say that the virtual world is now part of the real world of the organization, regardless of size or the domain area to which it corresponds. However, in countries where there is a lack of detailed metadata, this limits the valid communication between humans and machines. An exploratory analysis of several open data sites in Colombia, Ecuador, Mexico and Peru show the need - in spite of standardization efforts - for an integrated management system which will ensure the quality of metadata for published open data statistics.

Key words: Open Data; Metadata Management; Open Government; Information and Communication Technology.

INTRODUCTION

The relevance of data, and the knowledge that data can provide, is increasingly recognized by organizations (Baldwin, 2015; Experian, 2015). This is evidenced by the increase in the demand of analysts and staff employed in the management and analysis of data, now known as "data scientists" (McKinsey & Company, 2011; Chen, Chiang, & Storey, 2012). Traditionally, government organizations in certain countries have been maintained within a specific and closed context, but now there is growing realisation that they are also affected by external data. In this way, it is not only necessary to manage the data generated by the organization, but also the external data that through data processing allows for deeper analytical insights that can support the decision making and, thus, apply the managerial approach known as Business Intelligence (BI).

Governments hold data in many areas that are of direct interest for citizens or any kind of organization. Examples include population censuses, transport, public

health, environment, education, agricultural information, infrastructure and many more. Open data is, generally, official data that any person can use or share without legal or technical restrictions. Open data has financial value as it assists with better decision-making, optimized business operations (including processes and procurement) and maximizing the value obtained from existing and new infrastructure (Open Data Institute, 2015). However, this data for reuse by others can quickly become ineffective, if it fails to address the needs of data consumers and the access can be inefficient. The reasons why access is inefficient may, for example, be due to a number of reasons such as the late data delivery; inadequate legacy data formats; or the data is trapped in closed files. Data can also be ineffective because the metadata does not have the fields available which would facilitate the full description of all the characteristics in order to assess quality and allow the data to be useful in knowledge discovery and decision-making.

The process of cleaning up the open data and re-mapping it to a particular schema is not trivial and requires a deep understanding of all the data characteristics. However, the cleansing has to be completed for data to be useful and to yield positive impacts otherwise the lack of metadata becomes a serious limitation for using open data.

In the literature we found a series of standards proposed for the management metadata, like the Common Warehouse Metamodel (CWM), the Nordic Metamodel, the Generic Statistical Information Model (GSIM), the Data Documentation Initiative (DDI) standard, ISO/IEC 11179 and the Statistical Data and Metadata eXchange (SDMX) standard (Jimenez-Ramirez, Burke, & Rodríguez, 2017)).

According the above, our work presented here has focused on the entities or organizations of the official sector in developing countries and aims to present how the lack of metadata has negative effects, considering that now the entities assume new roles to comply with the regulations and policies of open government. In this paper we present an exploratory study of government web portals from Colombia, Ecuador, Mexico and Peru and discuss the ways in which these countries have adopted the standards in order to ensure the quality of their own open data.

OPEN GOVERNMENT DATA

 "Open Data" can be defined as follows:

   i. as data that any person can use or share, without legal, technical or financial barriers and is considered the input (the fuel) of innovation aimed at sustainable development" (Open Data Institute, n.d.)
   ii. according to the *Open definition v2.1*: "*Knowledge is open if anyone is free to access, use, modify, and share it — subject, at most, to measures that preserve provenance and openness*" (Open Knowledge International, n.d.)

Open Government Data (OGD) can also be defined as a "*set of policies that promotes transparency, accountability and value creation by making government data available to all*" (OECD, n.d.).

The functions of open data include:

i.   Transparency and democratic control.
ii. Participation.
iii. Empowerment.
iv. Improvement or creation of new products and services.
v.   Innovation.
vi. Improvement in the efficiency of the services offered by the government.
vii. Improvement in the effectiveness of the services offered by the government.
viii. Measuring the impact of policies.
ix. New knowledge from combined data sources and patterns in large volumes of data.

The "Data Spectrum" proposed by Open Data Institute (ODI) helps to understand and establish reference points between closed data and open data (Figure 1). For data to be considered "open", it must be accessible. This implies that the data must be accompanied by an open data license (Open Data Institute & Thomson Reuters, 2016).

Within our growing digital society, we continuously search for deep understanding of data and external information, and the official statistics that are presented to us as open data in web portals, catalogues or other forms of access to data, help to provide this understanding by offering open available free information. In the government sector, other sources of data are also available, which can be from the portals of government agencies such as the "Open Government Data" (OGD) catalogue.
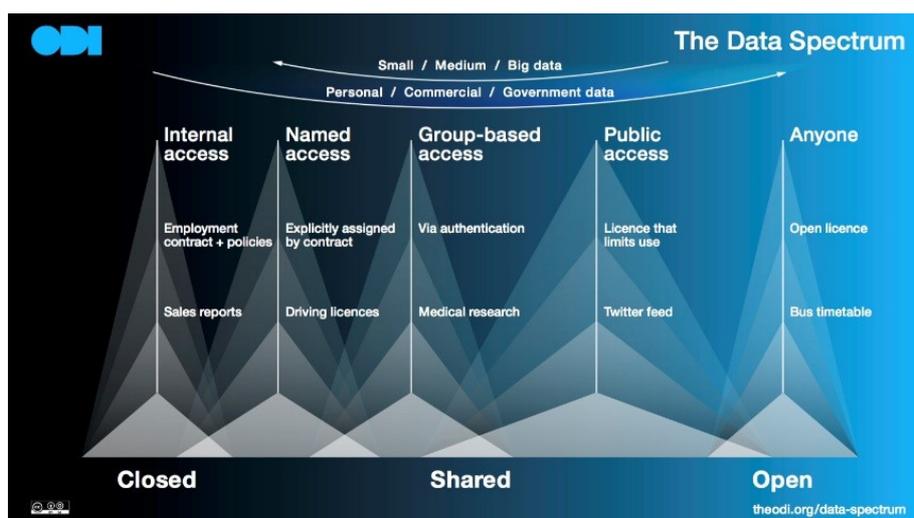

Figure 1: The Open Data Institute's Data Spectrum, Source: (Open Data Institute & Thomson Reuters, 2016)

Official statistics are intended for a wide range of users including governments (central and local), research institutions, professional statisticians, journalists and the media, businesses, educational institutions and the general public. There are three types of users: those with a general interest that use official open data in order to be informed on a particular topic or to observe trends. The second type of user category are those with business interests including decision makers that use open data as an important reference, providing information on the phenomena or circumstances of their own work by focusing on a particular research interest. Other users with research interests are universities and government agencies that have analytical purposes such as when open data is used for establishing and assessing government policies.

One common key point for all these users is their need to be able to trust the official information i.e. to hold firm belief that the results published are authoritative and unbiased. In this way, producers of official statistics must maintain a reputation of professionalism and independence. Unfortunately, we must still check the quality of open data because mistakes in open data are common. For instance, it is very strange that in a dataset from Colombia about violent deaths we found several people with 117 years, which we assume must be some kind of data error.

The public sector is a large supplier of open data and also one of the largest users and beneficiaries of open government data. The report '*The value of open data for the Government*' (2017), published on Datos.gob.es, outlines a large number of examples regarding ways in which the government could benefit in various areas. The report outlines how the government relies on their own published open data for feedback, cooperation, understanding, optimisation, and learning. (Datos.gob.es, 2017).

Some studies have found potential benefits amounting to 4.1% of global GDP of having open data across all sectors. These studies focused on the value of public sector open data and found that it is worth between 0.4% and 1.5% of an economy's GDP. Indeed, a UK study found that "we may actually underestimate the gains from lower prices of public sector information due to the difficulty in valuing the full effects of downstream and future activities" (Open Data Institute, 2015).

After consideration of a range of international organizations such as the United Nations, the World Bank, the United Nations Economic Commission for Europe (UNECE), the Economic Commission for Latin America and the Caribbean (ECLAC) and the Organisation for Economic Co-operation and Development (OECD), it was proposed to choose the National Statistical Offices (NSOs) as the protagonists of the "Data Revolution" in developing countries (PARIS21, 2015). However, it was emphasised that all open data must be of high quality. This is the primary reason why it is so important and necessary to ensure completeness of the metadata in order to evaluate the quality of open data and to be able to use it, with confidence, in analytical tasks.

DATA QUALITY AND METADATA

An organization's survival increasingly depends on its ability to extract the right information from data. Therefore, the quality of the data itself is becoming more important. However, data quality is not restricted to data correctness and consistency. EuroStat's definition of quality in statistics provides a set of six quality dimensions that originally defined statistical data, but can also be applied to many other types of data (Eurostat, 2003):

I.	**Relevance**	The degree to which statistics meet current and potential users' needs.
II.	**Accuracy and Reliability**	The degree to which data is free of errors arising from various factors; in the context of statistics, accuracy means the closeness of the estimated value to that of the true (unknown) value in the population.
III.	**Timeliness and Punctuality**	How soon the data is published relative to what is measured, and how closely data updates adhere to the intended publication schedule.
IV.	**Accessibility and Clarity**	The ease with which users can access the data and the degree of detail of the metadata description.
V.	**Comparability**	The degree to which data can be compared across time, regions or other domains.
VI.	**Coherence**	The degree to which data conforms to recognized definitions and methodologies.

Data quality involves a deep scrutiny on new data entrances in an organization. If the dataset is not valid, neither the descriptions nor the inferences made based on the data are likely to be correct which could lead to poor decisions that cause loss of time, money and credibility. Data analysis has little or no use if applied to data which is of low-quality.

Mistakes are frequent despite the care in the data capture by any transactional system or the data produced by official agencies. Thus, it is necessary to enrich the data in order to verify the quality of available data. For instance, we must verify that there are no values outside their domain. For discrete attributes, we need to know the set of possible values for checking problems of domain or referential integrity. Data can be enriched by increasing the precision of the metadata description – as metadata provides the fundamental "data about data".

Metadata also encompasses administrative facts about data (who has created the data and when); the definition of applied concepts and descriptions regarding how the data was collected and processed (prior to dissemination). Metadata facilitates sharing, querying and the understanding of statistical data over the lifetime of the data. There is, therefore, a strong relationship between metadata and quality. On the one hand, metadata describes the quality of the statistical information, yet, on the other hand, the metadata is itself a quality component, which also serves to improve the availability and accessibility of statistical data.

It is therefore, important to always ensure that the metadata is meticulously organised, complete and precise.

Nowadays, metadata is not restricted to a passive state (object documentation), but is also used more actively, to facilitate communication between users and data sources (Lundell, 2013). However, across many sources of open data, a lack of metadata is common, regardless of the country of origin. This lack of metadata, unfortunately, can limit the reuse of open data.

OPEN DATA IN DEVELOPING COUNTRIES UNDER STUDY

The exploratory study presented originated in our interest regarding the ways in which countries are ranked at a global level. These countries included Colombia, Ecuador, México and Peru as they are all developing countries with some characteristics in common, regarding their use of open government data. The main purpose of our research was to check if the datasets are accompanied by their relevant metadata sets in order to evaluate the quality and usefulness of the data. There are four different ways to evaluate data openness, according to the common open data assessment framework (devised by the World Wide Web Foundation and the Governance Lab at NYU) (World Wide Web Foundation, 2014):

i) **Context/Environment:** The context within which open data is provided. This might be the national context, as in the case of central Open Government Data, or might be the context in a particular sector.
ii) **Data (supply):** the nature and qualities of open datasets. This includes the legal, technical, practical and social openness of data, as well as issues of data relevance and quality.
iii) **Use:** the context of use of the open dataset.
iv) **Impact:** the benefits to be gained from using the open dataset.

After consideration of these forms of assessment of data openness, we focused on the second point. Thus, we made a direct exploration of official open data catalogues (portals created by governments to promote the production and use of open data) of the four countries of interest.

Several indexes have been proposed for assessing open government data, of which 3 were chosen for use in this study: The Open Data Barometer (ODB), Global Open Data Index (GODI) and Open Data Inventory (ODIN). These indexes were selected, first, because they allow for monitoring at country level and include those aspects of interest in this work. Second, they are focused on national governments and their latest report is updated to the year of 2017.

Table 1 summarizes certain aspects related to the openness of the data considered by the three selected indexes. The assessment methodologies are based on the "International Open Data Charter Principles". In practical terms, the tools have mostly operationalized the open data according to the *Open definition v2.1* (Open Knowledge International, n.d.).

Table 1: Indexes Selected For Comparisons of Open Government Data in Developing Countries

Index	What are they measuring?	Responsible organization	Data collection and Report (year)	Criteria to assess Openness (dataset)
The Open Data Barometer (ODB)[1]	National Governments Level: Country	World Wide Web Foundation	Data collection: 2016 Report: 2017 Data categories: 15	- data existence - available: online - machine-readable and reusable formats - free of charge - openly licensed - up to date - kept regularly updated - easy to find information - (linked) data URIs provided
Global Open Data Index (GODI)[2]	National Governments Level: Country	Open Knowledge International	Data collection: 2016 Report: 2017 Data categories: 15	- openly licensed - machine-readable format - downloadable once - up to date - available: publicly - free of charge
Open Data Inventory (ODIN)[3]	National Governments Level: Country Statistical Offices (NSOs)	Open Data Watch	Data collection: 2016 Report: 2017 Data categories: 20	- Machine Readable - Non-proprietary - Download Options - Metadata Available - Terms of Use

As is to be expected, the ranking of a country may vary according to the indexes due to the different methods used to calculate them. However, in the measurements, Mexico has the highest value, no matter the index, as shown in Table 2. It should be noted that of the three indexes, ODIN is oriented to evaluate only the datasets of the National Statistical Offices (NSOs) and is the only one that explicitly contains the "Metadata Available" criterion for the ranking of countries.

The Open Data Barometer (ODB) aims to uncover the true prevalence and impact of open data initiatives around the world. It analyses global trends, and provides comparative data on countries and regions using an in-depth methodology that combines contextual data, technical assessments and secondary indicators. The 4th edition of the ODB covers 115 jurisdictions and, the Barometer ranks governments are the following factors: Readiness for open data initiatives, Implementation of open data programmes and Impact that open data is having on business, politics and civil society (World Wide Web Foundation, n.d.).

Table 2: Scores and ranking for the countries under study in 2016.

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[1] www.opendatabarometer.org

[2] https://index.okfn.org/

[3] http://odin.opendatawatch.com/

Country	Open Data Barometer index (ODB)	Global Open Data Index (GODI)	Open Data (ODIN)
Mexico	Score (%): 73,45 Ranking: 11	Score (%): 65 Ranking: 11	Score (%): 67 Ranking: 16
Colombia	Score (%): 51,65 Ranking: 24	Score (%): 64 Ranking: 14	Score (%): 41 Ranking: 71
Peru	Score (%): 33,33 Ranking: 48	Score (%): 29 Ranking: 55	Score (%): 36 Ranking: 97
Ecuador	Score (%): 21,62 Ranking: 67	* Data not available	Score (%): 56 Ranking: 31

For a better comprehension of the scores obtained by the four developing countries under study, we created Table 3 which presents the scores concerning the implementation of open data programmes. Within that table, we highlighted the lowest scores, that coincidentally were the same, for the all the countries under study. The land ownership data and detailed data on government spend were the aspects with the lowest scores for open data in these countries. This is not so surprising because these countries have capitalist economies where a few are the owners of the land and are also characterized by their high degree of corruption. Although there are transparency laws for public administration, these are not met and hence the low score for government spending.

Table 3: Implementation Scores by Open Data Barometer. 2016.

Implementation programmes \ Country	Mexico	Colombia	Peru	Ecuador
Map Data	80	60	5	50
Land ownership data	5	5	5	5
Detailed census data	80	65	60	15
Detailed government budget	95	65	65	15
Detailed data on government spend	5	5	5	5
Company register	65	15	5	65
Legislation	15	15	15	15
Public transport timetables	55	5	5	5
International trade data	15	65	75	15
Health sector performance	80	60	55	15
Primary or secondary education performance data	65	65	65	60
Crime statistics	60	60	45	80
National environment statistics	60	15	65	15
National election results	65	65	95	65
Public contracts	80	65	5	15
Average score (%)	55	42	38	29
Global rank	11	24	48	67

In the portal of The Open Data Barometer, we also present the score evolution for the four editions (publications) of the measurements. Figure 2 presents the

evolution trends of Mexico, Colombia, Peru and Ecuador. This graph clearly evidences the positive changes for Mexico and Colombia during the years 2013; 2014; 2015 and 2016.
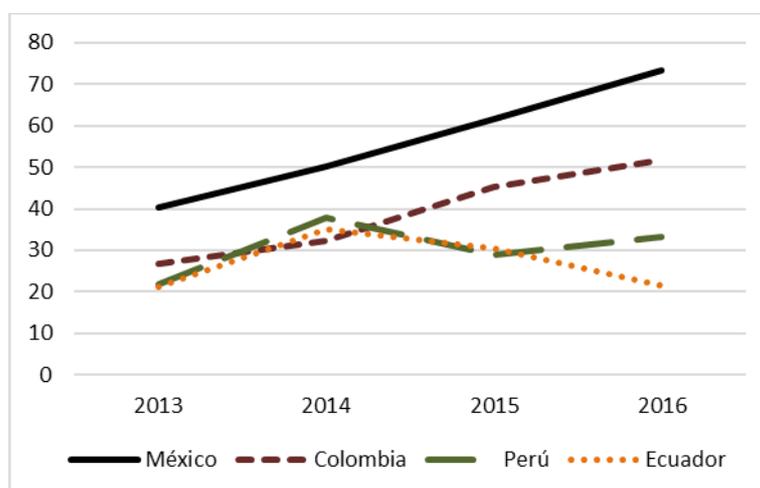

Figure 2: Score trends over past editions according ODB index.

However, in order to find if the open datasets are accompanied by their respective metadata, we visited the Country-level open data catalogues from Mexico, Colombia, Peru and Ecuador. We began with Mexico because this country has the highest score in data openness, of the countries chosen for this study. The URL of the web portal is https://datos.gob.mx. In this portal, the Mexican government offer open datasets about eleven themes including "Culture and Tourism" which was chosen as our example. After selecting that option, three kinds of open data appear to be available, namely: "*recommended*", "*more recent*", and "*most downloaded datasets*". We choose, from among the most recommended datasets, the "*Mexico City free Internet connection dataset*", interesting information for any tourist.

Figure 3: Open data from Mexico, Source:
https://datos.gob.mx/busca/dataset/puntos-mexico-conectado-con-acceso-
gratuito-a-internet

Figure 3 shows the page for downloading the dataset that contains the points of Mexico City with free Internet connection. As can be observed in this figure, the portal does offer some metadata such as the source, the publisher's name, the language, the last edition date and the publication date. The dataset has a CSV format to make it easily accessible. Figure 4, has two fragments, one of the datasets is called "total_sitios_cdmx_2017-09-09.csv" and the other dataset concerns a census of this country.

We can observe in Figure 4, in the highlighted fragment, that the dataset regarding Internet connections appears with many strange characters in the place where there should be a letter with a title. For instance, the word "NÃšMERO" is not correct and must be changed for "Número" (number, in English). Therefore this dataset is not ready to be understood and used, especially by a tourist. We also noticed in the open datasets, many abbreviations for specifying the column names and many of them are not mnemonic, for example this happens in the inferior fragment of Figure 4, corresponding to the Mexican Census.

The Colombian open data URL is https://datos.gov.co and contains 6660 open datasets. The metadata for Colombian datasets are restricted to administrative ones like the Mexican datasets. The lack of metadata and poor quality data are common problems also for other countries including those in a more positive position than Mexico. The web portals of Ecuador and Peru are in http://www.datosabiertos.gob.ec/ and http://datosabiertos.mef.gob.pe, respectively.

Figure 4: Fragments of Mexican datasets.

Although both ODB and GODI methodologies do not include an explicit criterion about metadata, the lack of metadata is discussed in the key findings and recommendations of ways to improve the openness of the data within the 2017 reports published by ODB (World Wide Web Foundation, 2017) and GODI (Lämmerhirt, Rubinstein, & Montie, 2017). However, ODIN methodology

evaluates the availability of metadata, which mainly informs the user about the data collection methodologies. According to the scores given by ODIN, the datasets published by the National Statistical Offices (NSOs) mostly have metadata (Open Data Watch-Open Data Inventory, 2017).

Another relevant aspect for open data is the quality of the data; which is not measured directly by the ODB, GODI and ODIN tools. However, the 2017 reports published by the three indexes acknowledge that poor quality makes open government data difficult to use with confidence. For instance, we can view the second key finding of the "Global Report - Open Data Barometer 4th Edition", which states: "*Government data is typically incomplete and low quality*". Furthermore "*Data is hard to use because there is no metadata or guidance documentation available*" (World Wide Web Foundation, 2017).

Official catalogs of open data

To complement the previous section of the study, this part of the exploration focuses on the technical aspects that have been directly observed in the web portals of the National Statistical Offices (NSOs) and in the official catalogs of open data (web portals created by governments to promote the production and use of open data) from the four countries under study: Colombia, Ecuador, México y Peru (Table 4).

Table 4: Web portals of the National Statistical Offices (NSOs) and official catalogs of open data

Country	National Statistical Offices (NSO) National Statistical Systems (NSS)		Open data catalogs of the government
	Official Statistics	**Open Data Catalogue**	
Colombia	*Platform:* Portal Web[4] *Formats*: XLS, PDF	*Platform:* NADA *Metadata standards*: DDI, Dublin Core RDF *Microdata*: CSV	*Platform:* SOCRATA[5] *Formats*: CSV, XLS, JSON, XML, RDF
Ecuador	*Platform:* Portal Web[6] *Formats*: *Microdata:* SAV, CSV *Macrodata:* XLS, PDF	*Platform:* NADA *Metadata standards*: DDI, Dublin Core RDF *Microdata*: SAV, CSV	*Platform:* CKAN[7] *Formats*: CSV, XLS, JSON
México	*Platform:* Portal Web[8] *Formats*: *Microdata:* DBF, CSV, DTA, SAV, SAS	*Platform:* NADA *Metadata standards*: DDI, Dublin Core RDF *Microdata*: DBF, CSV, DTA, SAV, SAS	*Platform:* CKAN[9] *Formats*: CSV, JSON

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[4] http://www.dane.gov.co/index.php/sistema-estadistico-nacional-sen

[5] https://www.datos.gov.co/

[6] http://www.ecuadorencifras.gob.ec/institucional/home/

[7] http://catalogo.datosabiertos.gob.ec/

[8] http://www.inegi.org.mx/

[9] https://datos.gob.mx/

Perú	Platform: Portal Web[10] Formats: SAV, DBF Macrodata: XLS, PDF	Platform: NADA Metadata standards: DDI, Dublin Core in RDF Microdata: SAV, DBF	Platform: Portal Web[11] Metadata standards: Dublin Core. Formats: CSV, JSON, RDF

Source: (Rodríguez & Jimenez-Ramirez, 2017)

The National Statistical Systems (NSS) of the four countries consists mainly of two platforms, one of them is a web portal owned by the NSO and dedicated to the dissemination of official statistics (maps, tables, and charts, among others). And the other platform (provided by third parties) is the tool for National Data Archive (NADA) dedicated to the dissemination and presentation of dataset (metadata and microdata).

NADA is open-source software developed by the International Household Survey Network (IHSN) with the support of the World Bank; its application domain is specific to NSOs. The metadata file, according to the standard Data Documentation Initiative (DDI), describes the important characteristics of microdata. Whereas, the other file with elements of the Dublin Core standard, describes the resources and that format is Resource Description Frame (RDF). Additionally, both DDI and Dublin Core use the eXtensible Markup Language (XML) (International Household Survey Network-NADA, n.d.).

The web portal owned by the NSO publishes the indicators (macrodata) with XLS and PDF download formats as the most common; but these datasets do not contain metadata that helps users understand the data. Also, these portals share microdata and the common format used corresponds to the commercial statistical software SPSS (SAV format), and they do not offer additional support metadata either.

CONCLUSIONS

In today's digital age, it is essential that all organizations and citizens have confidence in the validity of published data – and we need to ensure that government portals contain accurate information. Yet, for open data to have impact and value, it must be comprehensive and of the highest quality. These two characteristics make the data usable and thus understandable. Hence, making data usable can be seen as one of the core components of a successful open data initiative. Yet in order to ensure this full "usability" it is essential that the data should contain fully complete metadata.

The lack of metadata about microdata, which refers to the objects of study contained in the datasets outlined in this paper, is a generalized problem, which affects both developing and developed countries. Therefore, we recommend that in order to improve the openness of the data in future there is a need to add more precise metadata descriptions for all government open datasets.

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