

# Realizing the Innovation Potentials from Open Data: Stakeholders' Perspectives on the Desired Affordances of Open Data Environment

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**Abstract.** The increasing volumes of datasets published on open data platforms have had little impact on the public use of open data and perceived transparency of respective governments. At the same time, the innovation potentials of these datasets are far from realized due to many factors including poor quality of datasets. While past studies have attempted to catalog barriers to open data exploitation and use; few studies have focused on the role of the available open data platforms in tackling this problem. In addressing this gap, this paper examines the problems associated with the use of current generation of open data platforms and perspectives of stakeholders on desirable features and affordances. Results show barriers to effective open data use based on stakeholders' perspective. Findings also provide insights into three categories of platform affordances that could spur greater use of open data published on these platforms and enhanced transparency of respective governments.

**Keywords:** Open Data, Transparency, Open Data Platforms.

## 1 Introduction

In response to the European Public Sector Information (PSI) Directive, many European Union (EU) member states have launched their Open Data initiatives (Colpaert et al. 2014) with over 8,000 datasets available on the EU Open Data Portal (Union n.d.). However, due to barriers such as limited access to and use of open data by citizens and third-parties; and limited resources on the part of government agencies to sustainably publish datasets of high value (Janssen, Charalabidis, and Zuiderwijk 2012), the innovation and transparency potentials of open data are far from achieved. Specifically, while opening up data on processes and decisions of governments are in general expected to improve transparency, recent studies have shown high-quality transparency depends not only on how visible information is made but also on how well it lends itself to accurate inference. Few studies like (Peled 2012) have highlighted the centrality of open data platforms in enabling greater transparency through features for accessing, using and interaction around open data. In our opinion, the innovation potentials of open data is significantly impacted by the transparency-related affordances of the underlying open data platforms. Thus, a thorough understanding of both the limitations and required transparency-related affordances of open data platforms is imperative to effectively harness the open data resources they hold. While there are some existing studies on Open Data Platforms (Group 2014), none of these studies explicitly address the affordances of these platforms on their explicit support for both data and organizational transparency. Our study reported in this paper addresses this gap by first describing the features of existing open data platforms from in the transparency context. Eleven platforms were reviewed and evaluated in this study including: CKAN (Foundation n.d.), DKAN (NuCivic n.d.), Socrata (Socrata n.d.), PublishMyData (Swirll n.d.), Information Workbench (FluidOps n.d.), Enigma (Enigma n.d.), Junar (Junar n.d.), OpenDataSoft (OpenDataSoft n.d.), Callimachus (Project n.d.), DataTank (IMinds n.d.) and Semantic MediaWiki (Community n.d.). Next, the paper describes findings from the expert interviews and collective intelligence session organized in collaboration with the Dublin City Council to identify perceived shortcomings of current generation open data platform and the desired affordances from next generation open data platform from different categories of open data stakeholders. The rest paper is organized as follows: Section 2 provides an extensive review of existing platforms, Section 3 presents the methodology for the review and evaluation while Section 4 reviews the findings from the study, Section 5 discusses our findings, while concluding remarks are given in Section 6.

## 2 Review of existing platforms

The term Open Data Platform (ODP) does not have a universal definition. However, the term “Platform” has a consistent meaning across many different domains. The concept represents a system defined by three aspects: (1) a stable, low-variety "core", (2) a changeable, high-variety set of "complements", and (3) the interfaces which allow core and complements to operate as a single system (Baldwin and Woodard 2008).

In the context of our study, Open Data Platform (ODP) is understood as a technology infrastructure comprising of a software ecosystem that supports different end-user interactions with open data including search and discovery, publishing, analysis and visualization as well as sharing and development of stories from data. As background to our work, we reviewed 11 open data platforms based on some features which we considered pertinent for transparency. These platforms were selected based on their popularity on their installed bases. Description of the features and our observations are explained as follows:

*Metadata Schema and Data File Formats:* open data platforms supports different metadata schema and standards as well as a variety of data file formats. The metadata information refers to information about the dataset including descriptive information like the title, author, subjects, keywords; provenance information including publisher, revision history, changes, the source of data; and the structure of the data such as keys, indexes, columns. These information enables greater search capabilities and permits interoperability between different systems. Several file formats are associated with the datasets managed on the platform. Our review showed that formats supported include XML, CSV, JSON, XLS, RDF, PDF and HTML.

*Flexible search facility for datasets:* contemporary platforms provide keyword-based search capability on metadata associated with the dataset (with result filtering); emerging platforms such as Enigma offer search at record level and data filtering at multiple levels; indexing provides more efficient (faster) searching.

*Social Media, Collaboration and Social Sharing tools:* a collection of mechanisms that allow interaction between users; this includes social media tools to communicate & collaborate, to comment, to share, review and rate the datasets,

*Dataset Publishing Workflow:* features and tools supporting publication process, including data refinement, separation of public/private datasets, files upload via web UI, API or linked to an existing file on the web as well as the access control & addition of metadata to the workflow for data upload.

*Harvesting, Federation and Cataloguing:* Federation allows data replication across different instances, and provides seamless integration between the various independent portal instances – i.e. by performing a search across multiple instances of the platform; harvesting allows automated extraction of data from the open data portals; catalogue describes the implemented mechanism for the datasets navigation.

*Extensibility mechanisms:* some features are provided on the platforms to enable adaptation and extension (i.e. provision of APIs and libraries, support for website branding, and connectors, plugins and extensions).

*Data Analysis tools:* basic analysis features are included in most of the platforms; advanced features (rare) include statistical operations, OLAP, dashboards and analysis widgets including the R programming language extensions.

*Visualisation tools:* basic visualizations such as maps and charts available on platforms make use of existing maps services such as OpenStreetMaps, Google and Bing maps etc; and library such as D3.js and recline.js

*Personalization tools:* include features that allows: (1) modify the portal look and feel by portal administrators (i.e. branding, logo, colours), (2) customise the portal view to the users (i.e. personalised sorting, auto filtering, proffered view)

*Customization tools:* include features that allow the portal administrators to define the metadata standards, portal rules, enable tools and features as well as to configure the data store and limits.

*Dataset licensing service:* some platform enable the licensing information to be added to the dataset one of the metadata information.

*Accessibility:* access the data through application program interface (API). These APIs comprise routines, protocols, and tools for building software applications; provides clear specifications for external requests for interaction with the services offered by the platform; usually REST (Representational State Transfer) or SOAP (Simple Object Access protocol) services.

*Technical Environment:* describes the programming environment of the open data platform; a vital information for extension of platforms.

*Others:* All the additional features (i.e. data consumption statistics, overall performance, contextualisation tools etc.).

Table 2 presents the summary of features for each of the 11 platforms that were reviewed. Features marked as “Limited” are features that are partially supported by a platform. These features are discussed in Section 4.

**Table 2: Summary of Platform Features**

FEATURES	CKAN	DKAN	SOCRATA	PUBLISH MY DATA	INFO WKBENCH	ENIGMA	JUNAR	ODS	CALLIM	DATATK	SMWIKI
DATA, METADATA & FILE FORMAT STANDARDS	●	●	●	●	●	●	●	●	●	●	●
SEARCH & INDEXING	●	●	●	●	X	●	●	●	X	●	●
SOCIAL MEDIA, SHARING &	●	●	●	●	●	X	●	●	●	X	●
PUBLISHING WORKFLOW	●	●	●	●	●	●	●	●	●	●	●
HARVESTING, FEDERATION &	●	●	●	●	X	X	●	●	●	X	●
DATA ANALYSIS	●	●	●	X	●	●	●	●	X	●	X
VISUALISATION	●	●	●	X	●	X	●	●	X	X	●
PERSONALISATION	●	●	●	●	●	X	●	●	●	●	●
CUSTOMISATION	●	●	●	●	●	NA	●	●	●	●	●
LICENSING FOR DATASET	●	●	●	●	X	X	X	●	X	X	●
ACCESSIBILITY	●	●	●	●	●	NA	●	●	●	●	●
EXTENSIBILITY	●	●	●	●	●	●	●	●	●	●	●
TECHNICAL ENVIRONMENT	Python	PHP, Drupal	Scala	Ruby on rails	Java & Web apps	NA	Java & Python	NA	Java	PHP	PHP
<b>OTHERS</b>	Good manual Simple to use	Easy to use platform	Tracking & Measure of performance	Flexible, cloud-based, easy to use	R stat, support transparency, linked data	Reliable, scalable, large OD Analyses	Track & measures user impact on OD	Remote web services; easy deployment	Guides, videos, tutorial. Linked data	Deal with fraud, aids transparency	None

● denotes full-fledged solution, ● denotes limited solution, x denotes that solution is not provided, NA denotes information not available

## 3 Methodology

### 3.1 Research Objectives

The aim of the study is to evaluate existing open data platforms to identify the barriers to adoption and use of open data as well as desirable affordances of next-generation transparency enhancing open data platform. The study explicitly sets to answer the following questions:

Q1) *How available are data transparency-enhancing features on the platforms-* to answer this question, the platforms were evaluated based on a set of criteria that enable direct and indirect support for dataset transparency and socialisation on datasets. These criteria were partly derived from past studies. Other platform features that could impact data and organizational transparency were identified iteratively during the review. The following 12 criteria described above in Section 2; were obtained: 1) Metadata, Data and File Format Standards and Schemas, 2) Flexible search facility for datasets, 3) Social Media, Collaboration and Social Sharing tools, 4) Dataset Publishing workshop, 5) Harvesting, Federation and Cataloguing, 6) Data Analysis tools, 7) Visualisation tools, 8) Personalisation tools and 9) Customisation tools, 10) Dataset licensing service, 11) Accessibility and 12) Extensibility mechanisms. We also reviewed extant literature on open data platforms.

Q2) *What are the perceived shortcomings of open data platforms?* To answer this question, we analysed the barriers contributed by stakeholders that are related to data transparency and organizational transparency. These barriers are associated with specific stakeholder categories that identified them as well as the nature of transparency quality impacted by the barrier. The analytical model for the transparency qualities is discussed in Section 3.2.

Q3) *What specific platform features suggested by Stakeholders?* We analysed the features and solutions to identified barriers and shortcomings of open data platforms that were suggested by stakeholders during interviews and workshop sessions. The specific features were organized under three categories including a) information needs of stakeholders – what kinds of datasets do stakeholders highlight as important for them? b) social and collaboration needs – what features relate how stakeholders wish to interact and collaboratively make sense of the published data? c) understandability, usability, and decision making needs – what platform features do stakeholders desire to be able to carry out inferences on datasets, enable easy sense-making of data and make decisions based on available data.

### 3.2 Analytical Framework

Our study is grounded in computer-mediated transparency characterized by Meijer in (Meijer 2009) as: unidirectional or one-way regarding communication between parties involved in the transparency relationship or act and decontextualized in terms of information being shared. As a necessary condition for any form of transparency, computer-mediated transparency should ensure that external or receiving parties are capable of processing the information that has been made available (Heald 2006). Thus, in our study, we argue, that open data platforms features should explicitly mediate effective transparency. In particular, our study conceptualizes transparency as a *quality* which should be “satisfied” by an open data platform (Cappelli et al. 2013). Specifically, we adopt the deconstruction of the transparency construct presented in (Cappelli et al. 2013) as shown in Figure 1 to underpin our analysis of pathologies and platform-related barriers.

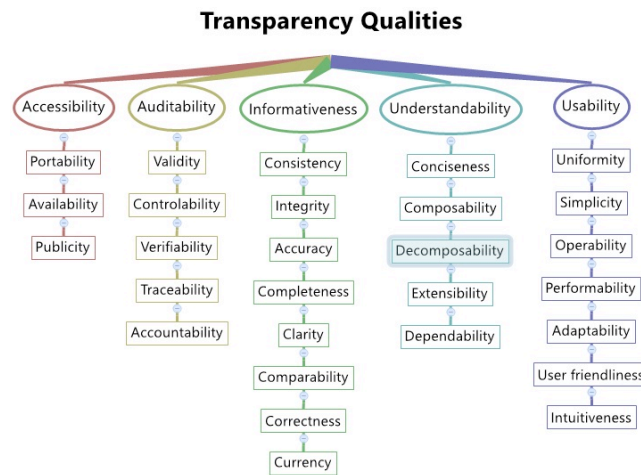


Figure 1: Transparency Qualities and Sub-Qualities (Cappelli et al. 2013)

### 3.3 Data Gathering

Four data gathering methods were adopted in the study: 1) extant literature on open data platforms, 2) a survey of selected open data platforms through hands-on use of these platforms and review of accompanying documentations, 3) expert interviews, 4) open data stakeholders interviews (publisher, data intermediaries or wrangler, platform developer and end-user) through a Collective Intelligence Workshop.

The workshop was organized in collaboration with Dublin City Council in April 2015 to discuss perceived barriers and problems with using the current set of open data platforms and desired features in future platforms. There were about 10 participants in the CI workshop from different stakeholders' categories – data consumers, suppliers, mediators or intermediaries and Enablers. Data consumers are end-users of open data as the general public or apps developers. Data suppliers include all entities involved in the publishing of datasets, Non-Governmental organizations or private sector entities.

## 4 Results

### 4.1 Features of existing platforms

We investigated the features available on the platforms by analysing contents from scholarly literature and documents describing the platforms and also based on our systematic exploration of selected instances of these platforms. Socrata, CKAN, DKAN and Semantic MediaWiki stand out as providing full-fledged features that support at least 9 of the 12 criteria used in evaluating the platforms (see Table 2). Other platforms support between 1 and 7 fully-fledged features. Overall, while the use of social media channels, customisation and personalisation of platform features are the common place in state-of-the-art platforms, support for metadata schema adaptation, options for Visualisation of datasets and accessibility (including at granular level) to datasets are limited. Features like availability of publishing pipelines or workflows are still relatively limited

on existing platforms. Whereas, personalisation and customisation feature are very common features of platforms. However, regarding social media integration, these platforms only allow a link to social media accounts. Personalisation in the context of this evaluation is only limited to end-user ability to change the behaviour of the platform based on preferences. Table 2 provides a summary of features for the eleven platforms.

#### 4.2 Platform pathologies

This section presents a summary of the data obtained from interviews and workshop sessions on barriers and limitations of current open data platforms as well as desired features to address some of the identified shortcomings. Categories of stakeholders engaged include open data consumers, enablers, suppliers, and mediators.

Our analysis showed that the most common barrier to the use of open data platforms is *perceived the poor quality of open data available on the platforms*. Poor data quality according to stakeholders is associated with poor metadata, failure to use the right format for different audience and difficulty in locating data of interest. Other barriers identified are related to non-relevancy of available datasets, the usability of platforms and data available on the platform and lack of example of the prior use of available datasets. We highlight in Table 3 some of the barriers identified by stakeholders. For each barrier we: 1) specify a generic class (i.e. coded each barrier instance) for the problem such as “Non-relevancy” or “Poor awareness” and then 2) associate it with a high-level transparency quality, e.g. Accessibility and a more specific quality such as “Availability”. This coding is based on the models described in Section 3. Poor usability (transparency related barrier) stood out as the most prominent shortcoming.

**Table 3: Shortcomings of State-of-the-art Open Data Platforms**

Issue	Stakeholder	Problem	Transparency Quality	Specific Transparency Quality
Available datasets are not 'relevant' to people's interest	Consumer	Non-Relevancy	Accessibility	Availability
Metadata problems	Supplier/Mediator	Poor Data Quality	Informativeness	Clarity
There is a lack of useful data	Consumer	Non-Relevancy	Accessibility	Availability
Difficulty in finding data - potential data dump, no good standards for cataloguing, describing, linking data	Consumer	Poor Data Quality	Understandability	Conciseness
Reliability of data feeds and keeping them updated; old data is gone off	Consumer	Poor Data Quality	Informativeness	Currency
Poor service design and management	Supplier/Mediator	Poor Platform Usability	Usability	User-Friendliness
Information spread out across multiple organisations, no single one-stop portal for open data access	Supplier	No one-stop Consolidation	Understandability	Integration

Data on screen may be displayed in a technical way or use unfamiliar technical language	Supplier/Mediator	Poor usability	Understandability	Comprehension
Minimal publicity about available data leading to lack of awareness of its existence	Supplier/Enabler	Poor Information	Accessibility	Publicity
Data is in a dense form and requires design input to make it accessible	Consumer	Technicality of Data Presentation	Understandability	Comprehension
No information on the circumstances of data production	Consumer	Poor Data Quality	Informativeness	Metadata quality and Provenance
No user-friendly file-formats and interface	Consumer	Usability of data	Usability	Operability - data formats
Lack of engaging activities/information for those users who arrive at a page without an explicit goal	Consumer	Weak user engagement	Usability	User-Friendliness
Lack of examples available for smart use of open data	Consumer	No smart use example	Usability	User-Friendliness
Lack of sufficient broadband / bandwidth to successfully interact with Open Data	Enabler	Poor access to open data platforms	Accessibility	Resource constraints
Level of openness and licences for commercial use	Enabler	Openness of data	Usability	Openness
The quality of data, right formats to the right audience e.g. spreadsheets for 'tourists' and API for data 'miners'.	Supplier	Poor Data Quality	Usability	User-Friendliness
Usability; need preview, mapping, visualisation, multiple data layering	Consumer	Usability of data	Usability	User-Friendliness

### 4.3 Desired Affordances

The desired features contributed by stakeholders for next generation open data platforms were captured under three categories: 1) Information needs, 2) Social and Collaboration, and 3) Understandability, Usability and Decision making needs. Regarding information need, stakeholders wanted the platforms to provide *access to datasets* about their immediate communities like crime statistics, public health data and data about their environment. *Dataset rating and feedback on datasets, Wall style feedback, collaborative curation of datasets, prioritization and voting on dataset requests, reward system and gamification* are some of the features expressed under the social and collaborative needs. To enable better understandability, usability and better decision-making on next generation platforms, users requested for *customizable dashboards, data mining tools and custom visualization tools, support for linked data and map-based search* as well as a *question and answering features*. Details of the desired affordances are provided in Table 4.

**Table 4: Desired Features in Future Open Data Platforms**

Information needs
<ul style="list-style-type: none"> <li>• Inventory of local business people —support local enterprise</li> <li>• Key indicators for my neighbourhood (social, crime, environment, health, etc.) for informed decision making</li> <li>• Local info of all kinds—planning, sports, cultural, commercial, social, councilors –</li> </ul>

Social and Collaborative Needs
<ul style="list-style-type: none"> <li>• <b>Support for anonymity</b></li> <li>• <b>Closed loop, share results of interactions &amp; collaborations</b></li> <li>• <b>Contact tools for finding Public Administration, forums, public participation, network, social media interaction, twitter, facebook</b></li> <li>• <b>Dataset rating &amp; ranking, Calendar, wall style fast feedback, live chat, comments on dataset, blogs, collaborative editing, curating, adding metadata for dataset</b></li> <li>• <b>Diversity of engagement—creativity, inclusion, new knowledge &amp; value Embed data for viral travel of data + its conversations Expert facilitation Live webcast with feedback, newsfeed for decision, Mission/vision statement for discussion Original data location — show paths to where it is shared Prioritisation of data request based on needs/voting Project management tool Reward system, gamification, acknowledgement</b></li> <li>• <b>Verification/traceability of account</b></li> </ul>
Understandability, Usability and decision-making needs
<ul style="list-style-type: none"> <li>• <b>Modelling and simulations, Animations e.g. to illustrate changes, Interactive Visualisation and Predictive Analytics</b></li> <li>• <b>Customizable Dashboards, Personalisation</b></li> <li>• <b>Data availability over several portable devices; Customised display —pull in from other platforms + layer data</b></li> <li>• <b>Support for integration of related datasets</b></li> <li>• <b>Data mining tools &amp; analysis tools for information extraction to support decision-making or interface to external tools</b></li> <li>• <b>In-file data descriptors</b></li> <li>• <b>Interactions, 'rate my dataset', submit suggestions on map get feedback</b></li> <li>• <b>Interactive graphical representations as transparency enhancing tools, promote easy reading, understandability, making sense of data</b></li> <li>• <b>Linked data for comparison</b></li> <li>• <b>Map based search &amp; queries</b></li> <li>• <b>Tools for Metadata management</b></li> <li>• <b>Modelling tools, layered maps</b></li> <li>• <b>Personalisation —search with filter, especially with memory, notifications &amp; updates</b></li> <li>• <b>Polls and surveys on datasets</b></li> <li>• <b>Public or anonymous profile options Q &amp; A mechanism Question &amp; answer, feedback mechanism monitored up-to-date Scheduling services— identify what is logged, actioned or closed Statistics under-pinning policies</b></li> </ul>

## 5 Discussion

The development of the first generation of open data platforms has mirrored the development of e-government websites. The current generation open government provide very basic data catalog features with minimal two-interactivity. While this type of design may suffice for technical users and developers; findings from our study show that regular end-users like members of the public *require significantly friendlier or more usable platform to further transparency goals*. Drawing from sound practices in the e-government domain where citizen-centric and one-stop service design are imperative for uptake and use of e-services; *we argue that open data portals must offer the public a one-stop access to “data services”*. Regardless of the transparency context considered, i.e. whether monitorial, deliberative or participatory (Meijer 2009) (Keane 2009) (Meijer 2015), social interaction among members of the community is important. *Consequently, any platform support for the use of open data for better transparency should include support for social interaction. Interviewed experts and workshop participants requested features for sharing and discussing datasets*. The



integration of open data and social media platform was the subject of research reported in (Alexopoulos et al. 2014). An interesting finding is the *demand for anonymity in the use of open data by end-users*. This raises an interesting point that citizens still treat open data portals like a government website. Findings from our studies are also consistent with those from the Open Data Barometer report (Davies 2013)(Davies, Sharif, and Alonso 2015) which provides broad understanding of open data landscape around the world and identifies challenges to the lack of access and availability of open data and its potentials exploitations. Findings from these reports indicate that lack of data quality, trustworthiness and relevant data and the need for more timely data need for sustained ways to maintain open data and to keep it up to date are preventing open data initiatives from achieving their ends. In transitioning into next generation open data platforms; it is reasonable to expect that future platforms will be built upon existing ones. Our review of the existing platforms shows some of the current platforms have an open architecture and can be extended to accommodate new features. We observed that CKAN, DKAN and Semantic MediaWiki are the most extensible providing free and open source codes, rich set of extension mechanisms and open architecture, a guide to support developers in building such extensions and support for additional fields in the metadata schema. However, Callimachus and DataTank being open source could also be modified as desired albeit at a much higher cost compared to the above that provide explicit extension mechanisms. Thus, we believe that existing platforms provide some foundation for next-generation platforms with the desirable set of affordances.

## 6 Conclusions

We have sought in our work to provide a better understanding of the shortcomings of the current generation of open data platforms and desirable affordances for next generation ones. This paper complements existing research as it focuses on the evaluation of the platform from perspectives of open data transparency. Other current reports have focused primarily on the technical aspects of the platforms. Also, the complementary analyses of the stakeholders input on platform pathologies and desired affordances provide a practical context for the technical evaluation. From our findings, a few art open data platforms such as CKAN, Socrata, DKAN, Semantic MediaWiki provides well-developed features to support good data transparency and quality when publishing datasets. With three of these platforms are open-source and explicitly provide extension mechanisms, they arguably stand out as choice base platforms for building next generation open data platforms. Despite these features provided by some of these platforms, there are still significant challenges that must be tackled for these platforms to be adopted and used as desired by public administrations and other stakeholders. One of the barriers that stand out in this area is the perceived poor quality of datasets published on these platforms. However, our findings also show that open and extensible base technology platforms are available as a foundation for the development of next generation open data platform with features described above. In particular, CKAN, DKAN and Semantic MediaWiki are candidate base platform for such innovation activities.

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