Journal of Universal Computer Science, vol. 20, no. 11 (2014), 1564-1582
submitted: 11/11/13, accepted: 30/6/14, appeared: 28/10/14 © J.UCS

A Model to Guide the Open Government Data Implementation in Public Agencies

Mauricio Solar
(Universidad Técnica Federico Santa María-UTFSM, Santiago, Chile
mauricio.solar@usm.cl)

Fernando Daniels
(Inter-American Organization for Higher Education, OUI-IOHE, Montreal, Canada
danielsf@oui-iohe.org)

Roberto López
(The Network of e-Government Leaders of Latin America and the Caribbean, RED GEALC
Uruguay
roberto.lopez@redgealc.net)

Luis Meijueiro
(Fundación CTIC, Gijón, Spain
luis.meijueiro@fundacionctic.org)

Abstract: This paper presents a model to diagnose maturity and capabilities of Public Agencies (PAs) in pursuing the open data principles and practices. The open data maturity model, called OD-MM, was piloted in ten PAs from three Latin American countries, validating in this way the web tool that operationalizes the model. This web tool is a valuable diagnostic tool for PA's, since it shows all weaknesses and provides the instrument (a roadmap) to progress in the implementation of open data. We also propose a guide to implement open data in PAs. This guide is the result of the OD-MM application in Latin American PAs. The guide is simple and orients decision makers so that PAs following the actions of the guide can see their improved capacities when facing a diagnosis of their institutional maturity in the implementation of open data.

Key Words: Maturity Model, Open Data, Open Government Data, Roadmap
Category: D.2.8, D.2.9, J.7, K.4.1, K.4.3, K.5.2

1 Introduction

Since the publication of the eight principles of open government data [OGD, 07], and the "five stars" test proposed by [Berners, 09], several authors have presented different criteria to assess and diagnose the Open Government Data (OGD), such as [Gartner, 10] and [Yates, 11], the Open Data Readiness Assessment tool created by [World Bank, 13], the conceptual framework of the United Nations E-Government Survey [UN, 14] and others [ODG, 13].

One of these proposals is [Reggy, 11], who defines a four level model for each of the eight principles based principally on the guides on the World Wide Web Consortium [W3C, 11], and the Central Office of Information in the UK. Each of the

eight principles has a score assigned according to its level: Level 0-0%; Level 1-33%; Level 2-66%; and Level 3-100%. A compound indicator assesses global quality of every program by calculating an average score associated with the eight principles.

"Methodology for releasing Open Data" [MELODA, 11] provides a tool for releasing information to society, specifically from the public sector, and from the private sphere as well. The focus of this approach is to maximize the use of information released, including commercial uses, or mixed with private resources. The analysis covers three dimensions: "Legal Framework", "Technical Standards", and "Accessibility to Information". There are five maturity levels for each dimension.

[Morgan, 10] recommends in his blog developing a three dimension maturity model and four maturity levels. Levels proposed are, emerging (level 1), practicing (level 2), enabling (level 3); and leading (level 4). The three dimensions proposed by [Morgan, 10] are, "Strategy and Policy"; "Availability," and "Description & Documentation Practices."

The implementation model published by [Lee, 11] recommends agencies to advance their open government initiatives incrementally in stages, moving from one stage to another as they mature their adoption of open government. Starting from increasing data transparency (stage 1), the process moves on to improving open participation (stage 2), enhancing open collaboration (stage 3), and realizing ubiquitous engagement (stage 4). Lee and Kwak [Lee, 11] argue that by following this sequence, agencies can minimize risk, and effectively harness the power of social media in order to engage the public.

In [Kalampokis, 11] has proposed a stage model for OGD with two main dimensions, namely, organizational & technological complexity, and added value for data consumers. Kalampokis et al. [Kalampokis, 11] admit that, despite the potential that the various models, recently emergent in literature, as those previously presented, there is currently a lack of roadmaps, guidelines, and benchmarking frameworks to drive and measure OGD progress. So, robust methodology and measurement frameworks are needed [Stragier, 10].

[Solar, 12] presents the maturity model design to establish Open Data capacities in a Public Agency (**PA**), named OD-MM (Open Data Maturity Model). The operationalization of the OD-MM was through a web tool developed by researchers of UTFSM with the participation of CTIC Foundation and the support of the Organization of American States (OAS), Red GEALC, and IDRC. The advantage of the OD-MM is that, from the diagnosis of a PA it automatically generates the roadmap with recommendations to evolve to higher levels of organizational maturity.

Government representatives of Chile, Colombia, and El Salvador, civil society and open data application developers validated the OD-MM in conceptual terms, followed by the implementation of the web tool for data survey that the model needs for its validation through a pilot [Solar, 13a]. The experience of applying a pilot to ten PAs in three Latin American countries, gave the base to assume the weaknesses detected in the diagnosis of these PAs, and propose the actions as a guide to reach level 3 of maturity, or very close to it [Solar, 13b].

In the following section, a brief summary introduces the OD-MM maturity model. The application of the model was at a pilot level, in ten PAs of three Latin American countries (Chile, Colombia, and El Salvador); section 3 shows its results, as well as the region-wide diagnosis. In relation to data opening, and given the diagnosis

and the reality of each PA in the region, the model automatically generates a roadmap with the recommendation that institutions must follow to evolve to higher maturity levels in the organization. Section 4 presents an example of a roadmap generated in the pilot. Section 5 shows the guide to implement open data in PAs, and the last section shows the conclusions.

2 Maturity Model and Open Data Capacities

The important elements that have been identified in literature and should be considered when diagnosing the implementation of Open Data at PA level are those that stand out in successful cases described in literature. Among these perspectives the followings appear in almost all proposals, being important to be considered:

- The **establishment** of a PA, given that the importance of leadership and strategy in OGD initiatives is highlighted in the literature.
- The **legal aspect** allows for having a legal frame when implementing *Open Data*.
- The **technological perspective** on the accomplishment of *Open Data* principles, such as access to data, data quality and its availability.
- The **citizen perspective** from participation and collaboration point of view.
- And **developers** and entrepreneurs in the reuse of data.

All these elements are considered in the maturity model proposal to assess the capabilities and maturity of public institutions in the Open Data implementation. We merge the first two perspectives (establishment and legal aspects) into a single domain, as well as the last two already mentioned (citizen and developer's perspective), so that the proposed model has three perspectives or domains.

OD-MM is on three levels hierarchically structured: Domain, Sub-domain (SD) and Variables (V_i). The designed OD-MM incorporates three domains; each one made of three SD's. [Solar, 12] describes the conceptualization of 33 variables defined and is distributed in nine SDs. Four capacity levels, from 1 to 4 (Inexistent, Incipient, Existent and Advanced), were established to assess the capacity in each of these variables.

2.1 Connection of Variable Capacities and SD's

Weights (w_i) of variables (V_i) for OD-MM model, determined through a methodology explained in [Solar, 12], allowed to establish the weight for each SD. Table 1 shows the weight of every variable in each Subdomain and Domain. In this way, 100% of an SD weight is distributed among the variables it is composed of, i.e., *External Regulation*s (0.2), *Internal Regulations* (0.4), and *Licensing* (0.4), add up to 1, equivalent to 100%.

Thus, the capacity level (CL) of a SD turns out to be an weighted sum (w_i) of their constituent CL variables (V_i), according to Equation 1.

$$CL_{SD} = \sum_{i=1}^{n} (CL(V_i) \times w_i) \quad \text{(Eq. 1)}$$

Domain	Subdomain	Variable	w_i
	Strategy, Leadership & Institutional Framework	Strategy	0.3
		Leadership	0.4
		Institutional Framework	0.3
Institutional & Legal	Laws & Regulations	External Regulations	0.2
		Internal Regulations	0.4
		Licensing	0.4
	Management	Training	0.3
		Project Management	0.3
		Performance Assessment	0.4
	Safety & Availability	Safety System	0.2
		Data Availability	0.3
		Data Updating	0.3
		Use Level Measurement Tools	0.2
Technological	Access	Data Automatized Reading	0.3
		Metadata	0.3
		Easiness in Classification & Finding	0.2
		Use of Semantic Technologies	0.2
	Data Quality [Caballero, 08]	Data Format	0.3
		Free Data	0.25
		Primary Data	0.25
		Data Integrity	0.2
	Data Reuse [Dolog, 11]	OD Developed Initiatives	0.3
		Quantity of Available OD	0.3
		Single Access Point	0.2
		Data Access Measurement	0.2
Citizen's & Entrepreneurial	Developers	Data Gratuitousness	0.2
		Fostering of Reuse	0.4
		Claim and Complaints Resolution	0.2
		PSI Projects Financing	0.2
	Participation & Collaboration	Participation & Collaboration Means	0.3
		Participative Transparency	0.2
		Active Listening	0.3
		Measurement of Data Use (apps)	0.2

Table 1: Variables weight by SD

Table 2 shows the mechanism used to obtain the organization maturity as from subdomains CL. The advantage of this mechanism is its flexibility, since it only establishes a minimum group of SDs, important in a given maturity level (ML). Countrywide, it allows regulating progresses according to an Open Data national strategy, while the SD's that do not appear in a ML in Table 2 are left to the discretion of the organization itself.

In this way, a PA will be in ML 2 if only if all the five SD's (according to Table 2) in CL 2 (*Management*; *Access*; *Data Reuse*; *Developers*; and *Participation & Collaboration*). It doesn't matter in which CL are the other SD's, this PA will be in ML 2, but if any of these five SD's is in CL 1, then the ML of this PA goes immediately to 1.

Perspective (Domain)	Subdomain	ML 1	ML 2	ML 3	ML 4
Institutional &	Strategy, Leadership & Institutional Framework			2	3
Legal	Laws & Regulations			3	4
	Management		2	3	4
Technological	Safety & Availability			2	3
	Access		2	3	4
	Data Quality			2	3
Citizen's &	Data Reuse		2	3	4
Entrepreneurial	Developers		2	3	4
	Participation & Collaboration		2	3	4

Table 2: Organizational maturity estimation based on a set of priority SD's

The model was conceptually validated by the Ministry of Information Technologies and Communications of Colombia; Ministry of the Department of Presidency of Chile; Intelligent Citizen Foundation in Chile; and the Department of Technology and Information Technologies Innovation of the Government of El Salvador. The next step was implementing a web tool for the data survey required by the model, establishing an approach to apply a pilot in ten PAs of three Latin American countries.

2.2 Implementation and use of the web tool

In the implementation of the OD-MM model it was used PHP version 5.3.3, MySQL superior to 5.5, and Apache 2.2.26 with *mode_rewrite* activated. For the implementation of other maturity models in other areas, it was used a framework developed by our team. For e-mails sending within the same application, we used Postfix. The system can run on Linux, Windows, or MacOS, since it is displayed in a browser and the mentioned tools are supported in these operating systems. The interface is in Spanish, because it was developed for Latin American countries.

2.2.1 Use of the web tool

It is possible to accede to "Use of the Model" when entering to the tool in the URL http://odmm.inf.santiago.usm.cl/, which explains step by step in Spanish how to proceed.

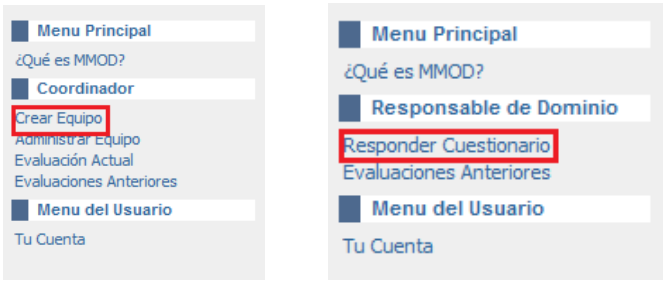
The login of the tool accepts two types of users to conduct the diagnosis:

- **Coordinator**: He is who takes the lead in a diagnosis, responsible for defining the work team and of the diagnosis itself. He should request to those "Responsible of the domain" to respond to the questionnaires associated with that domain; he should validate the responses of each domain; he should close and send the diagnosis; and should finally accept or reject the roadmap automatically generated with the diagnosis.
- **Responsible of the domain**: A user created by the "Coordinator", who belongs to the work team of a diagnosis, with the following assignments:
    - Respond to the questionnaires linked to his domain.

- Be responsible for the domain he is in charge of.
- To view the responses of other domains he is not responsible for.
- To view the roadmap generated in previous diagnostics of the institution.

The first step is the "Coordinator's" log-in. It should be only one Coordinator by institution; if the institution is already registered, it will not allow the registration of another coordinator. Then, click on the button "Sign up" in the access form to start the registration (located on the left hand side of the main screen). It continues displaying a form containing all the fields to be completed for the Coordinator's registration. Once all the registration data are entered, the system indicates "Successfully Sign-Up," and sends a message to the email registered, to activate the entered account. When accepting the link sent by e-mail, a message is displayed indicating that the account has been successfully activated and is now in the position of accessing to the Login with the User and the registration Password.

To create a "Responsible" it is necessary to select "Create Team" ("Crear Equipo" in Fig. 1a), filling out the form with the requested data and select the domains to be responded. A Responsible can be created for each domain, or one for all the domains, or any combination. Once the data of the people "Responsible" are registered, they will receive an e-mail with a link to activate the account of the "responsible", with the access data and the information of the domains whereto they were assigned.



(a) *(b)*

Figure 1: Main Menu o: (a) Coordinator, (b) Responsible.

If the Coordinator has conducted a diagnosis using this tool, and wants to redefine the team for a new diagnosis with the same people Responsible already registered, he must select the option "Manage Team" ("Administrar Equipo" in Fig. 1a) to reassign the domains.

Those who are responsible, when entering to the login with the data assigned by the Coordinator (User and Password), have the menu options showed in Fig. 1b. By selecting the option "Respond Questionnaire" ("Responder Cuestionario") it is displayed the model Domains, emphasizing in bold (blue in Fig. 2) the domains for which he has the responsibility to respond, and in gray color those assigned to the other people Responsible. To answer the questionnaires, he must choose the Domain and Subdomain, and then are displayed the different descriptions indicating the levels in which this institution might be. The Responsible must select the description that

best reflects the situation of his organization. For example, in Fig. 2 it was selected level 2 for the Project Management variable.

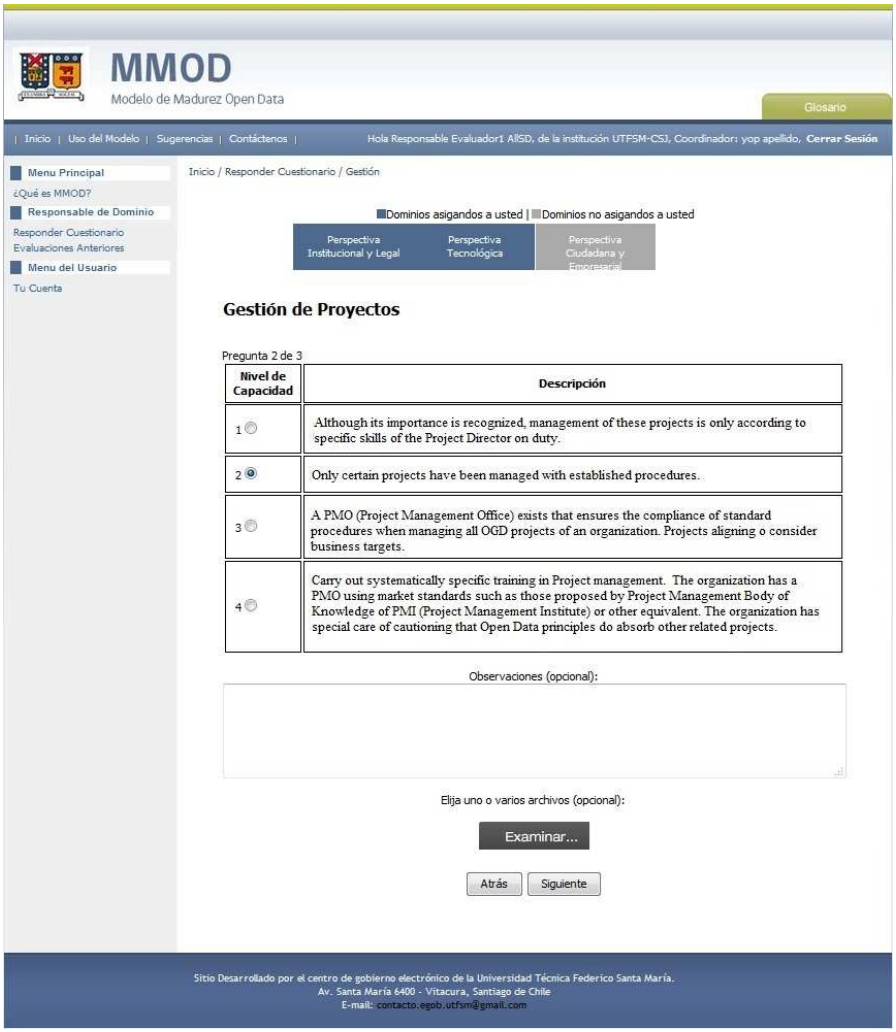


Figure 2: Selecting Capacity level 2 in variable "Project Management".

Once the people Responsible have answered all the three Domains, the Coordinator can view the screen of Fig. 3 with the capacity levels by subdomain. In this stage, the Coordinator has to validate the questionnaires so that the system automatically generates the roadmap (option "See RoadMap"); here are displayed the initiatives and recommendations to move from the current level to the referential objective level. If the Coordinator agrees with the description of the Roadmap, then he "accepts" it, thus displaying a warning message confirming that the diagnosis process is completed, and no changes to it will be possible.

In the case he does not agree, he can "reject" the roadmap generated, returning to the step in which those Responsible can make changes according to the observations delivered by the Coordinator.

3 Pilot Results of OD-MM

3.1 Pilot Methodology

The main aspects of the methodology used in the application of the pilot in the PAs, have the following characteristics:

- Supported with directive sensitization.
- Performed as a guided survey.
- Preceded by training workshops through distance.

A strategy was defined in the information survey, which considered the three roles definition required for each organization to respond to the domains (Table 3).

The opinion and commitment of the service directors involved was sought to obtain their sponsoring, by appointing and assigning the time to the coordinators of the teams and participants responsible.

The Web tool previously described was used to simplify the data collection, which allows to operate in a self-diagnosis mode in each organization. We must make clear here that the purpose of this self-diagnosis tool is not to establish a ranking between the participating organizations. The core objective of every organization is to know its own situation through a self-diagnostic, honest, and adjusted to its own reality. A diagnosis adjusted to the real development of the organization allows the web tool to generate reasonable recommendations for a continual and gradual improvement of the maturity level. Self-diagnosis is prone to error and may be potentially dangerous if inappropriate decisions are made on the basis of a misdiagnosis.

Introduction of elements that will provide more accuracy for the self-diagnosis was supported by:

- E-mail communications, conferences through Skype, and teleconferencing to describe the model and the use of the tool; here participates at least one coordinator for each country involved. For Colombia and El Salvador correspond to the OAS Liaison Officers, and in the case of Chile, at least one coordinator of each organization involved.
- Segmentation of the areas of diagnosis, so the information required is available for participants. The three areas considered are: operational and strategic management, technological management, and human capital management (Table 3).
- Designation of a coordinator who is responsible for the closure of the self-diagnosis process; he ensures the representativeness of the information provided.
- Support through a Call center and written material describing the structure of the model, and each of its components (domains, subdomains and variables).
- Diagnosis and generation of the roadmap is done automatically by the Web tool. The roadmap is based on the model guidelines, the knowledge and

experience of the experts who have validated the model conceptually, and the development of the organizational maturity.

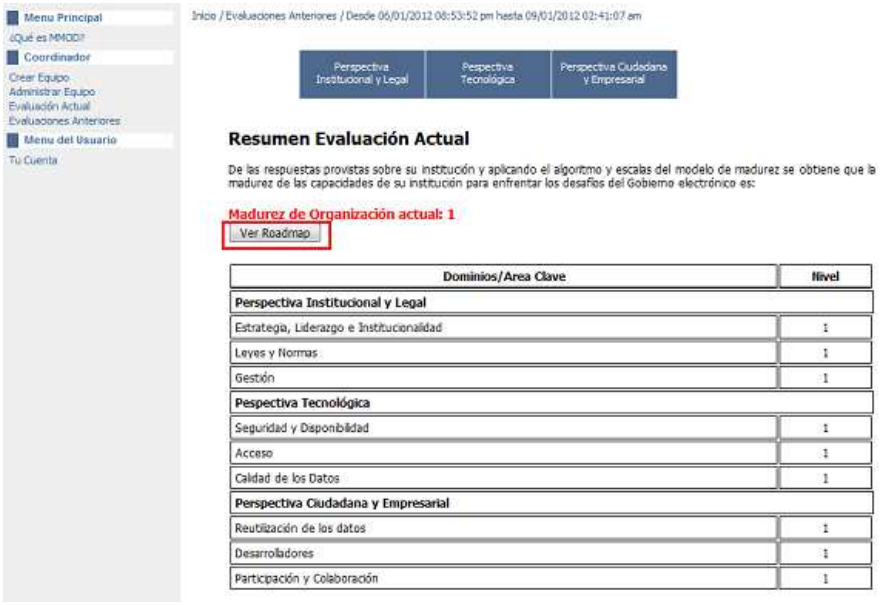


Figure 3: A summary of the current evaluation in the OD-MM tool.

Areas	Profile
Operational Management	Director, Operational Subdirectors or 2nd management line
IT Management	Subdirector or IT Head of Unit
Customer Service	OIRS Leader

Table 3: Areas and profile of the survey participants

As the final step of the pilot, is the compilation of the feedback regarding the model and its potential improvements to ensure the usability of the tool in the next massive applications.

3.2 Pilot Sample

Ten PA's participated in a sampling of the pilot validation of the proposed model, in three countries that attended and validated the OD-MM model design. From these ten PA's that were invited in Chile, Colombia, and El Salvador, seven responded to the pilot (Table 4).

3.3 Pilot Results

Table 5 shows the results of a survey carried out between January and March 2012, in which attendees answered a web questionnaire, according to their roles in each of the three domains (see Table 3). Table 5 displays also the capacity levels by SD, in each

of the institutions taking part in it. Applying Equation 1 in each PA made possible to obtain the CL value by SD. Six of the participant PA's responded three areas (PA6 was the exception, responding only one domain, the *Technological* one). The last column shows the CL average in the PA by SD.

PA		Abbreviation
Chilean PAs		
PA1.	Ministry of Education	MINEDUC
PA2.	National Congress Library	BCN
PA3.	Foreign Trade Integrated System (Ministry of IRS)	SICEX
Colombian PAs		
PA4.	National Administration of Planning	DNP
PA5.	Ministry of Internal Revenue Service and Public Credit	MHCP
PA6.	Colombian Institute for Superior Education Building	ICFES
Salvadorian PA		
PA7.	Government Dept. of IT Science Innovation of El Salvador	ITIGES

Table 4: PA's participating in the pilot

Capacity values emphasized in grey colour are higher than the average SD's; this is a way to highlight these extreme cases. On one side, SD *Developers* average 1.7, and four PA's have a higher CL than that average. Case PA2 highlights, since its assessment in this SD is the lowest, as an institution. Not a single PA is at level 3 or 4 of capacity, which coincides with present circumstances.

At the other end are those SD's (*Management* and *Access*) with only one PA above the average (PA2). All the others are below the average. In the case of *Management*, all PA's are at Level 1, except PA2 which is at level 2; although its evaluation is the lowest, it is the highest one in the group.

Perspective	Subdomain	PA 1	PA 2	PA 3	PA 4	PA 5	PA 7	CL_{SD}
Institutional	Strategy, Leader & Inst. Framework	3	3	1	3	1	2	*2.2*
&	Laws & Regulations	2	3	1	2	1	1	*1.7*
Legal	Management	1	2	1	1	1	1	*1.2*
	Average	*2.0*	*2.7*	*1.0*	*2.0*	*1.0*	*1.3*	
Technological	Safety & Availability	2	3	2	2	3	2	*2.3*
	Access	2	4	1	2	2	2	*2.2*
	Data Quality	2	3	2	3	2	1	*2.2*
	Average	*2.0*	*3.3*	*1.7*	*2.3*	*2.3*	*1.7*	
Citizen's	Data Reuse	2	3	1	2	1	1	*1.7*
&	Developers	1	2	2	2	1	2	*1.7*
Entrepreneurial	Participation & Collaboration	1	4	1	4	2	1	*2.2*
	Average	*1.3*	*3.0*	*1.3*	*2.7*	*1.3*	*1.3*	
	Average by PA	**1.8**	**3.0**	**1.3**	**2.3**	**1.6**	**1.4**	**1.9**

Table 5: CL of SD's for PA's participating in the pilot

SD's *Participation & Collaboration*, and *Access* are the only SD's with greater dispersion, with levels of assessment between 1 and 4. For *Participation & Collaboration*, three PA's obtained level 1; one obtained level 2, and two obtained level 4. In *Access*, one solely PA obtained level 1, four of them obtained level 2, and only one got level 4. We believe that these SD variables (*Participation & Collaboration Means*; *Participative Transparency*; *Active Listening*; and *Measurement of Data Use-applications*) were misunderstood, since dispersion is inconsistent with the observed reality. After clarifying the consultations with the review teams, it was incorporated in the Glossary the technical terms that appear in the questionnaires, which created confusion in their interpretations; i.e., the term RISP (Reuse of Public Information), not included in the glossary. Furthermore, it was improved the semantics of some descriptions that caused confusion in the use of technical terms.

Table 5 shows each Domain simple average by the PA. In all cases, this average is always above or equal to the respective CL domain in that PA. PA2 was the only PA that obtained a level 2 of institutional maturity. Observations point out that its domains averages 2.7 (*Institutional & Legal* perspective), 3.3 (*Technological* perspective), and 3.0 (*Citizen's & Entrepreneurial* perspective). These results provide a global average of 3.0; that is to say, with a 100% compliance for level 3 of maturity, but when applying the pattern of the Table 2, the institution remains in ML 2.

Carrying out this same analysis for PA4, it is observed that all SD's have a simple average above or equal to 2, namely 2.0 (*Institutional & Legal* perspective), 2.3 (*Technological* perspective), and 2.7 (*Citizen's & Entrepreneurial* perspective), but when applying compliance patterns of Table 2, PA4 reaches a level 1 of maturity. However, to reach ML 2 (Table 2), it should only evolve one level in subdomain *Management*.

3.1.1 SD's Analysis

Table 6 indicates the capacity average value in each SD for the PA representative portion that participated in the pilot of the model and the web tool. Most developed SD's are: "*Safety & Availability*"; "*Strategy, Leadership & Institutional Framework*"; "*Access*" and "*Data Quality*". This result matches with the emphasis made generally by governments, in having IT infrastructure available, since all SD's of the *Technological* perspective are better developed than other SD's.

Sub-domain	Average Capacity
Safety & Availability	2.3
Strategy, Leadership & Institutional Framework	2.2
Access	2.2
Data Quality	2.2
Participation & Collaboration	2.2
Laws & Regulations	1.7
Data Reuse	1.7
Developers	1.7
Management	1.2

Table 6: SD's average capacity

Less-developed SD's are: *Data Reuse; Developers*; and *Management*. These results allow suggesting the hypothesis that the effort aimed to introduce OGD concept in PA's is not aligned with the *Citizen's & Entrepreneurial* domain. Also, important to mention is that being SD *Management* the lowest assessment of all SD's of the model, efforts to introduce OGD in PA does not coincide with the formalization of internal processes, development of human capital required and performance assessments. This usually results in inefficient uses of financial resources and additional effort of human capital. Another element to consider is that the average value of all SD's does not reach level 3 (Existent).

3.1.2 Variables Analysis

Table 7 shows the capacity average value (x_m) in each variable in PA sample that participated in the pilot of the model and web tool.

Variables best-developed averaging above 3 are: "*Data Gratuitousness*"; "*Data Availability*"; "*Free Data*"; and "*Active Listening*". This result coincides with the compliance of Access to Information and Transparency laws, in force in Chile, Colombia, and El Salvador, being not possible to project it to other Latin American countries, since not all of them have access to information and transparency laws.

All *Management* variables stand out from variables averaging below 2, being these: *Training* (1.8), *Project Management* (1.5), and *Performance Assessment* (1.2), this last one the lowest.

The variables *Quantity of Available OD* (1.8), *Data Access Measurement* (1.7), *Fostering of Reuse* (1.8), and *PSI Projects Financing* (1.3), are noteworthy, all of them part of *Citizen's & Entrepreneurial* perspective, the worst evaluated. Variable *Use of Semantic Technologies* (1.7) is the worst evaluated of the *Technological* perspective, which is the most developed of the three domains.

All the variables averaging under 2 (V1 to V13 in grey in Table 7) are elements identified as weak and should be used as a base to propose an open data implementation guide as we will show in section 5.

4 Roadmap Generation

OD-MM application allows knowing the diagnosis of a PA, but it also proposes improvements instances on these matters (roadmap). This means that it offers an orientation to objectively canalize financial and human capital of an organization that needs to improve its capacities to fulfill Open Data initiatives.

Table 8 describes the variable "*Project Management*" to all capacity levels. The selection carried out by PA2 for this variable was level 2 (see Table 8). Fig. 2 shows the interface in Spanish (description translated to English to better understanding) of the web tool for the same variable of Table 8.

Variables	PA 1	PA 2	PA 3	PA 4	PA 5	PA 7	x_m
Data Gratuitousness	4	4	4	4	4	3	**3.8**
Data Availability	3	4	2	3	3	4	**3.2**
Free Data	3	4	2	4	3	2	**3.0**
Active Listening	2	4	3	4	3	2	**3.0**
Safety System	3	4	2	3	4	1	**2.8**
Leadership	3	4	2	4	1	2	**2.7**
Data Updating	2	3	3	3	3	2	**2.7**
Easiness in Classification & Finding	2	4	2	2	2	4	**2.7**
Data Automatized Reading	1	4	2	3	3	2	**2.5**
Metadata	4	4	1	2	2	2	**2.5**
Data Format	2	4	2	3	3	1	**2.5**
Participation & Collaboration Means	1	4	2	4	2	2	**2.5**
Strategy	4	3	1	3	1	2	**2.3**
Institutional Framework	2	3	2	3	1	3	**2.3**
Data Integrity	3	3	2	3	2	1	**2.3**
Use Level Measurement Tools	1	3	2	2	4	1	**2.2**
Primary Data	2	3	2	2	2	2	**2.2**
OD Developed Initiatives	3	4	1	3	1	1	**2.2**
Single Access Point	2	4	1	4	1	1	**2.2**
Participative Transparency	1	4	1	4	2	1	**2.2**
(V1) External Regulations	1	3	2	2	3	1	**2.0**
(V2) Licensing	3	4	1	2	1	1	**2.0**
(V3) Claim & Complaints Resolution	2	2	2	3	1	2	**2.0**
(V4) Measurement of Data Use (apps)	1	4	1	4	1	1	**2.0**
(V5) Internal Regulations	2	2	1	2	1	3	**1.8**
(V6) Training	2	3	1	2	1	2	**1.8**
(V7) Quantity of Available OD	2	4	1	2	1	1	**1.8**
(V8) Fostering of Reuse	1	3	1	3	1	2	**1.8**
(V9) Use of Semantic Technologies	1	4	1	1	1	2	**1.7**
(V10) Data Access Measurement	2	3	1	2	1	1	**1.7**
(V11) Project Management	1	2	2	2	1	1	**1.5**
(V12) PSI Projects Financing	1	2	2	1	1	1	**1.3**
(V13) Performance Assessment	1	2	1	1	1	1	**1.2**
Average	**2.1**	**3.4**	**1.7**	**2.7**	**1.9**	**1.8**	**2.3**

Table 7: Average variables capacity

Table 9 displays a description of capacity levels of the variable "*Performance Assessment*".

As seen in Table 10, when applying Equation 1, calculation of weighted average of the variables for subdomain "*Management*" infers that "*Training* (3*0.3) + *Project Management* (2*0.3) + *Performance Assessment* (2*0.4) = 0.9 + 0.6 + 0.8 = 2.3. If this result is truncated, it remains at capacity level 2.

CL	Variable: *Project Management (30%)*
1	Although its importance is recognized, management of these projects is only according to specific skills of the Project Director on duty.
2	**Only certain projects have been managed with established procedures.**
3	A PMO (Project Management Office) exists that ensures the compliance of standard procedures when managing all OGD projects of an organization. Projects aligning to consider business targets.
4	Fulfill systematically specific training in Project management. The organization has a PMO that uses market standards such as those proposed by Project Management Body of Knowledge of PMI (Project Management Institute) or other equivalent. The organization has a special care of cautioning that Open Data principles do absorb other related projects.

Table 8: CL description of Project Management variable

CL	Variable: *Performance Assessment (40%)*
1	No formal mechanism exists, either metrics of assessment for OGD programs or initiatives.
2	**There are a few metrics to assess OGD initiatives. Results of programs or initiatives can be sporadically measured, but still without a procedure able to standardize this practice, neither compliance goals.**
3	There is a periodic and systematic assessment plan where it is possible to identify a set of metrics suitable to assess the performance of OGD initiatives, such as external regulations compliance, among others. There are also established procedures regulating the periodic and systematic application of performance assessment for OGD programs and initiatives, as well as established compliance targets.
4	Taking corrective actions of performance of the improved initiatives. These results and progresses are released to the whole organization. There are specific initiatives to assure a proper coordination and good performance of activities jointly carried out by other agencies.

Table 9: CL description of variable Performance Assessment

Subdomain	CL	Variables	Weight	CL
Strategy, Leadership & Inst. Framework	3	Strategy	0.3	3
		Leadership	0.4	4
		Institutional Framework	0.3	3
Laws & Regulations	3	External Regulations	0.2	3
		Internal Regulations	0.4	2
		Licensing	0.4	4
Management	2	Training	0.3	3
		Project Management	0.3	2
		Performance Assessment	0.4	2

Table 10: CL of Legal & Institutional domain chosen by PA2

If the institution has ML 2, then the roadmap generated points out to achieve capacities of ML 3, and from ML 3 it is generated a roadmap to ML 4 that belongs to Advanced Capacities. From Table 2, PA2 postulates to institutional ML 2, since when "*Management*" subdomain is in CL 2, it does not reach institutional ML 3. Table 11 shows that subdomain "*Strategy, Leadership, & Institutional Framework*" has a CL 3, which exceeds the requirement in the reference level for ML 3.

Subdomain	Current CL	Level of Reference
Strategy, Leadership & Institutional Framework	3	2
Laws & Regulations	3	3
Management	2	3

Table 11: Reference Capacity level for Level 3 of maturity

Table 12 shows the generated roadmap, which is equivalent to the elements recommended to incorporate in the institution, to develop capacities to reach ML 3. [Solar, 14] shows the details of the algorithm to generate the recommendations of the roadmap starting from the CL of diagnosis. Table 8 and Table 9 provide these recommendations, and descriptions of CL 3 of the variables *Project Management* and *Performance Assessment*.

Variable	***Roadmap* Element to increase capacity**
Project Management	Manage projects with established procedures. Create a PMO (Project Management Office), to ensure compliance of standard procedures in all OGD project management. Align projects with business target.
Performance Assessment	Establish metrics to assess OGD initiatives. Create standards and compliance targets to measure results of programs and initiatives. Create a periodic and systematic assessment plan identifying a set of metrics to evaluate performance of OGD initiatives, as external regulations compliance, among others. Create established procedures that regulate the application of periodic and systematic performance assessment for OGD programs and initiatives.

Table 12: Roadmap generated to reach level 3 of maturity

5 Open Data Implementation Guide (ODIG)

The open data implementation guide (ODIG) is a consequence of the OD-MM application since it incorporates elements detected as weak in pilot PA's; as well as elements of both, bibliographical exploration and field research carried out throughout first-hand sources [Solar, 13b].

Table 13 shows the fifteen recommendations and each origin of the source. This means that when following actions proposed in the guide, institutions will reach level 3 of maturity for sure, or very close to it (of a maximum of 4).

The most common recommendations that were automatically generated by the algorithm [Solar, 14] to improve the less-developed variables (V1 to V13 averaging below 2, in grey in Table 7) and addressed to all PAs are the following:

Rec1. Create training initiatives on issues related to OGD, as the use of IT tools, digital communications systems, office automation, e-services, etc. Create an OGD specific training plan identifying the needs of training and other relevant matters, where staff responsible for OGD training requires an appropriate training.

Rec2. Manage OGD projects with established procedures. Create a PMO ensuring the compliance of standard procedures in the management of all OGD projects of the organization. Align projects with business targets.

Rec3. Establish metrics to assess OGD initiatives. Prepare a standard and compliance goals to measure results of programs and initiatives. Create a regular and systematic assessment plan to identify a set of appropriate metrics to evaluate OGD initiative performance, as the compliance of external regulations, among others.

The field research carried out through expert opinions as first-hand sources show that the most important lacks when implementing OGD are (see study in [Solar, 13b]):

Exp1. Lack of political will.

Exp2. Lack of laws and regulations (including improving internal processes).

Exp3. Lack of leadership.

Concerning the bibliographical research shown in [Solar, 13b], we can summarize the most important aspects as follows:

Exp4. "Align OGD initiatives with the PA's goals", "institutionalize OGD initiatives" [Lee, 11], and "create and institutionalize a culture of OGD" [McDermott, 10].

Exp5. "Consider conducting pilot projects" [Lee, 11], or "flagship initiatives" in the Obamas' memorandum [McDermott, 10].

Exp6. "Create and maintain a dialogue " [Kaufman, 12], and "use a democratic, bottom-up approach" [Lee, 11].

Recommendation	Source
1. The existence of an institutional framework with a recognized organization for OGD	Pub1
2. Existence of a recognized leader in charge of implementing an OGD initiative	Exp3
3. Formulation of an OGD strategic development plan	V7 & V12
4. Construction and delivery of necessary laws to the congress for a better operation of the OGD	Exp1
5. Promulgation of policies and internal regulations	Exp2 & V5
6. Training plan in OGD	Rec1 & V6
7. Project Management Office development	Rec2 & V11
8. Have a performance assessment system of the projects	Rec3 & V13
9. Development of a study of required ICT infrastructure capacity	V4
10. Gradually incorporate semantic technologies	V9
11. Development of a first OGI	Pub2
12. The existence and management of datasets indicators for access and/or downloading, together with data monitoring	V10
13. Promotion actions for re-use	V8
14. Existence of a channel for complaints and conflict resolution	V3
15. Existence of a formal channel of participation and collaboration of civil society	Pub3

Table 13: A recommendation with a reference to the source that creates it.

6 Conclusions

The OD-MM approach, model, and web tool grant several contributions to the adoption and improvement of open data implementation in public agencies:

- It is the first specially developed model used as a basis by developing countries.
- It allows PA's to fulfill a self-assessment through a web-based tool for simplicity and wider availability. None of the other models have this feature present.
- Simple and fast to use, since self-assessment tool does not require special technology training, and is freely available.
- Each application of the model automatically generates a roadmap with recommendations to evolve to a higher maturity level.

In summary, real contributions of OD-MM are its simplicity (self-assessment), and the roadmap, automatically generated with recommendations to improve.

From the results obtained, the implementation of Open Data presents important challenges in several fronts, being the following the most relevant:

- Experience in different countries demonstrates the need of training people that will be in charge of OGD in each PA, which requires time.
- The fact is that laws and decrees are not enough, it is fundamental to accompany them with an accordingly assignment of resources for their implementation.

- Finally, and perhaps the most important, it is necessary to emphasize the requirement of a strong political support, and consider OGD as a fundamental policy to improve transparency of a government. Without an appraisal of the political world, any effort will only remain as a declaration of good intentions. Even more, this support should be reflected in the assignment of resources. As any other public policy, implementing OGD requires time, and money; this may allow people in charge to fulfill it.

The new elements in the actions proposed by the ODIG are the formulation of OGD training plans, the formulation by the PA of a strategic OGD development plan, and having a performance evaluation system of OGD projects, including the development of a PMO.

The experience of applying a pilot to ten PA's in three Latin American countries, demonstrates that the presented ODIG, assumes its weaknesses detected in the diagnosis of these PA's. Therefore, when following the actions proposed by ODIG, these PA's will reach level 3 of maturity, or very close to it (from a maximum of 4), for sure.

Acknowledgements

The authors would like to thank Gonzalo Valdes, Gastón Concha, Cristián Torres, and José Gleiser for their work in the project. This work was partially supported by the grants DGIP 241142, International Development Research Center (IDRC/CDRI) with the collaboration of Inter-American Organization for Higher Education (OUI).

References

[Berners, 09] Berners-Lee, T.: Linked Open Data. What is the idea? 2009. http://www.thenationaldialogue.org/ideas/linked-open-data.

[Caballero, 08] Caballero, I., Caro, A., Calero, C. and Piattini, M.: IQM3: Information Quality Management Maturity Model. *Journal of Universal Computer Science*, vol. 14, no. 22, pp. 3658-3685. 2008.

[Dolog, 11] Dolog, P., Durao, F., Jahn, K., Lin, Y. and Peitersen, D.K.: Recommending Open Linked Data in Creativity Sessions using Web Portals with Collaborative Real Time Environment. *Journal of Universal Computer Science*, Vol. 17, No. 12, pp. 1690-1709, 2011.

[Gartner, 10] Gartner: Gartner Open Government Maturity Model. 2010. http://www.gartner.com/DisplayDocument?ref=clientFriendlyUrl&id=1390447

[Kalampokis, 11] Kalampokis, E., Tambouris, E. and Tarabanis, K.: Open Government Data: A Stage Model. *Lecture Notes in Computer Science* 6846, pp 235-246. 2011.

[Kaufman, 12] Kaufman, S.M. and Wagner, R.F.: Getting Started with Open Data: A Guide for Transportation Agencies. NYU Rudin Center for Transportation Policy and Management. 2012.

[Lee, 11] Lee, G. and Kwak, Y.H.: An Open Government Implementation Model: Moving to Increased Public Engagement. IBM Center for the Business of Government. 2011.

[McDermott, 10] McDermott, P.: Building open government. *Government Information Quarterly* 27, pp. 401-413. 2010.

[MELODA, 11] Methodology for Releasing Open Data (MELODA). 2011. http://gobernamos.com

[Morgan, 10] Morgan, D.: Toward an Open Data Maturity Model. 2010. http://www.govloop.com/profiles/blogs/toward-an-open-data-maturity

[ODG, 13] Open Data Group, 2013. http://opendatagroup.com/page/2/

[OGD, 07] 8 Principles of Open Government Data. 2007. http://www.opengovdata.org/home/8principles

[Reggy, 11] Reggy, L.: Benchmarking Open Data Availability across Europe: The Case of EU Structural Funds. *European Journal of ePractice* · www.epracticejournal.eu Nº 12, March/April. 2011.

[Solar, 12] Solar, M., Concha, G. and Meijueiro, L.: A Model to Asses Open Government Data in Public Agencies, in. H.J. Scholl et al. (Eds.): EGOV 2012, LNCS 7443, pp. 210–221. 2012.

[Solar, 13a] Solar, M., Daniels, F., Lopez, R. and Meijueiro, L.: Identifying Weaknesses for Latin American Open Data Implementation in Public Agencies. in Álvarez, L. and Anido, L. (Eds.): MeTTeG 13. 7th Int. Conf. on Methodologies, Technologies and Tools enabling e-Government. University of Vigo, Spain. pp. 219 – 228. Oct 17-18, 2013.

[Solar, 13b] Solar, M., Meijueiro, L. and Daniels, F.: A Guide to Implement Open Data in Public Agencies, in M.A. Wimmer, M. Janssen and H.J. Scholl (Eds.): EGOV 2013, LNCS 8074, pp. 75–86. 2013.

[Solar, 14] Solar, M., Daniels, F. and Lopez, R.: Automatic Generation of Roadmap for Open Data, in M. Janssen, H.J. Scholl, M.A. Wimmer & F. Bannister (Eds.): EGOV 2014, IOS press, 2014.

[Stragier, 10] Stragier, J., Verdegem, P. and Verleye, G.: How is e-Government Progressing? A Data Driven Approach to E-government Monitoring. *Journal of Universal Computer Science*, vol. 16, no. 8, pp. 1075-1088. 2010.

[UN, 14] United Nations E-Government Survey 2014: E-Government for the Future we Want. New York, 2014.

[World Bank, 13] Open Government Data Toolkit. 2013. http://data.worldbank.org/ogd

[W3C, 11] Government Linked Data (GLD) Working Group. 2013. http://www.w3.org/2011/gld/wiki/Main_Page

[Yates, 11] Yates, M.: Business Strategy: Smart Government Maturity Model - Open Data and Collaboration in Central and Eastern Europe. IDC. 2011.