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Chokki, Abiola Paterne; Simonofski, Anthony; Clarinval, Antoine; Frénay, Benoît; Vanderose, Benoit

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# Fostering Interaction between Open Government Data Stakeholders: An Exchange Platform for Citizens, Developers and Publishers

Abiola Paterne Chokki<sup>1</sup>[0000-0003-4500-2141], Anthony Simonofski<sup>1</sup>[0000-0002-1816-5685],  
Antoine Clarinval<sup>1</sup>[0000-0003-3936-0532], Benoît Frénay<sup>1</sup>[0000-0002-7859-2750] and Benoît  
Vanderose<sup>1</sup>[0000-0001-9752-0085]

<sup>1</sup> University of Namur, Namur, Belgium

{abiola-paterne.chokki, firstname.lastname}@unamur.be

**Abstract.** Open Government Data (OGD) consists of data released by publishers to drive the creation of innovative services by developers, and ultimately deliver value to citizens. However, the lack of communication between the different OGD stakeholders impedes the realization of this objective. The goal of this paper is to fill the technical aspects of this issue by identifying requirements needed in the design of a usable tool that can facilitate communication between OGD stakeholders. The stakeholders' requirements were identified from a literature review and validated through interviews with 9 stakeholders. Then, the identified features were integrated into the ODEON (Open Data Exchange solutiON) tool and its effectiveness in facilitating interaction between stakeholders was demonstrated through an evaluation with 22 stakeholders. This paper contributes to theory by proposing a list of 16 requirements to be implemented into a tool to facilitate communication between OGD stakeholders. Second, it contributes to practice by proposing a use case diagram listing the features needed to satisfy the requirements and a usable tool implementing them.

**Keywords:** Open Government Data, Requirements, Communication, OGD Stakeholders.

## 1 Introduction

In recent years, a number of Open Government Data (OGD) movements have emerged around the world, with data reuse being one of their main goals [1]. The stakeholders involved in the OGD process are subdivided in this study into three groups: citizens, developers and publishers [2–4]. Publishers release data to drive the creation of innovative services by developers, and ultimately deliver value to the citizens. OGD reuse can lead to several benefits, such as citizen participation in policy-making, collective problem solving, citizen empowerment, democratic accountability and development of innovative products and services [5]. However, it is a fact that even though a large amount of data is available, only a few people use it [3]. This lack of use is caused by the fact that there are many impediments to OGD use. Some of these are the result of a

lack of communication between the different OGD stakeholders and therefore do not encourage them to take the first step to use or publish OGD [6, 7]. The term "communication" in this study refers to an interaction between OGD stakeholders for the purpose of creating a novel OGD-based service destined to citizens. Among these impediments, there is, for example, the unawareness of the usefulness of OGD (citizens), the unawareness of which services would be most useful to develop (developers) and the unawareness of which datasets to publish in priority (publishers) [5, 7–13]. In this study, we focus on the technical aspects of these impediments [10, 14, 15], which includes all other impediments to the use or publication of OGD that are not related to the social, emotional or motivational factors. For example, the *citizens' unawareness of the usefulness of OGD* impediment may result from social, emotional or motivational factors (e.g., citizens may not be interested in getting involved with OGD) or technical factors (e.g., few platforms demonstrate to citizens the usefulness of OGD).

Several methods and platforms have been proposed in the literature to overcome the technical aspects of the communication gap. For instance, hackathons have been put in place by public organizations (publishers) to promote the use of their published OGD to developers. However, this method does not generally involve the citizens [7]. In addition, OGD portals, where most OGD are published, do not provide a common space where, for example, all OGD stakeholders could collaborate to report certain issues on datasets and co-create new services [5, 10, 12]. In summary, even though many methods or platforms have been proposed to facilitate the communication between OGD stakeholders, none of them provides the complete functionality necessary to achieve this goal. Moreover, to the best of our knowledge, no study has been conducted in the literature to propose a list of requirements guiding the design of a usable tool that can facilitate the communication between OGD stakeholders.

This paper aims to address the mentioned gaps by first proposing a list of requirements needed in the design of a usable tool that can facilitate communication between OGD stakeholders, and then implementing them in a tool and evaluating it. Therefore, our research question is: *"How to design a tool that can facilitate communication between OGD stakeholders?"* To address this research question, we first conduct a literature review to collect the impediments of using and publishing OGD. Then, the impediments are used to derive requirements. The requirements are then presented to 9 stakeholders (1 publisher, 4 developers and 4 citizens) for validation and for gathering additional requirements, if any. Once the requirements are validated, a use case diagram listing the features needed to satisfy the requirements is proposed and the features are then integrated into a tool called ODEON (Open Data Exchange solutiON). Finally, we evaluate the ease of use and usefulness of the prototype by means of user testing with 22 stakeholders (9 citizens, 8 developers and 5 publishers). In doing so, we validate, using the implemented prototype as a proxy, the usefulness of the proposed requirements in addressing the technical aspects of the lack of communication between OGD stakeholders.

The remainder of this paper is structured as follows: we present the background related to OGD stakeholders, impediments to OGD use and publication and methods and platforms of communication between OGD stakeholders (Section 2). We then explain the design science research approach we followed (Section 3) and present the developed

tool and its evaluation (Section 4). Finally, we discuss the findings and limitations of this study as well as avenues for future work (Section 5) and conclude with a summary of the contributions (Section 6).

## 2 Background

In this section, we first clarify the stakeholder types that we consider in this study. Then, we present previous work related to the impediments resulting from the lack of communication between OGD stakeholders. Finally, we present methods and platforms proposed in the literature to facilitate the communication between OGD stakeholders.

### 2.1 OGD Stakeholders

Many stakeholders are involved in the OGD process. In this study, we focus more on stakeholders who use OGD for private needs and whose interaction with public administrations is difficult, as well as on stakeholders who publish aggregated data on portals. Thus, stakeholders such as public servants who use OGD in their daily work and organizations that provide the data for publication are not considered here. Based on previous studies [2–4], we identify three roles that these stakeholders can hold: publishers, developers and citizens. Figure 1 summarizes the OGD process, and the three roles are defined below:

**Publishers:** These stakeholders are responsible for publishing the data online. This includes public organizations and governments.

**Developers:** These stakeholders create innovative services and applications with the data published by publishers.

**Citizens:** They represent most of the population who may eventually consume data via an application developed by developers.

It is important to note that a direct link between publishers and citizens is possible but difficult to establish due to the lack of technical skills of citizens to process the data themselves.



**Fig. 1.** OGD process. Publishers publish data that will be integrated into applications or services developed by developers. These will then be used by citizens.

### 2.2 Impediments to OGD Use and Publication

Several studies [5–13, 16–18] have focused on the impediments to OGD use and publication. Below, we present the impediments resulting from the technical aspects of the lack of communication between OGD stakeholders that demotivate them to use and to publish OGD.

**From the citizens' perspective**, we identified two main impediments. First, (*IC1*) many citizens are not aware of the existence and usefulness of OGD and the services that use them [5, 7]. Second, (*IC2*) the services developed with OGD are not used by citizens due to either unawareness of the services or mismatch between the services and their needs. Indeed, most of the time, they are not involved in the service design [7, 9].

**From the developers' perspective**, we identified six main impediments. First, (*ID1*) developers are not able to come up with a service idea that may be interesting for citizens due to a lack of knowledge of citizens' needs [9]. Second, (*ID2*) developers are not able to find examples of use case or success stories of OGD use to build on to propose services that may be interesting to citizens [9]. Third, (*ID3*) once developers have an idea of the service to implement, one of the issues is the data quality and the difficulty to communicate with the publisher to solve this issue [5, 9–13]. Fourth, (*ID4*) developers are sometimes unable to find the datasets needed to create the service due to the non-publication of these datasets by OGD providers and also the lack of discussion between the two parties to request the necessary datasets [5, 9, 10, 19]. Fifth, (*ID5*) developers often do not receive feedback from publishers after requesting datasets or asking some questions [5, 12]. Sixth, (*ID6*) developers often have no information about the datasets used in a specific project in order to replicate or improve it [16–18].

**From the publishers' perspective**, we identified three main impediments. First, (*IP1*) publishers are not motivated to publish data because most published datasets are not used, making the added value and economic impact of their publication efforts uncertain [13]. Second, (*IP2*) publishers are unaware of the datasets that they need to prioritize during the publication process [6, 7]. Third, (*IP3*) publishers do not know which projects are using their published datasets, as many users do not report their reuses [13].

The impediments, repeatedly reported in the literature, highlight the need for increased communication and collaboration among OGD stakeholders.

### 2.3 Methods and Platforms of Communication between OGD Stakeholders

Many methods and platforms have been proposed in the literature to facilitate the communication between OGD stakeholders [20]. Reviewing each of them would be beyond the scope of this paper. Here, we focused on these popular (i.e. most cited or used in an OGD context) methods and platforms: hackathons, interviews, workshops, OGD portals and citizen participation platforms. Many extant platforms such as ADEQUATE [21], Github, Gitlab, Stack Overflow, gFoge, Jira, Redmine, Wiki, etc. can enable communication between users. However, in this study, we only reviewed platforms that are related to our research question i.e., that have already been used in previous studies to facilitate communication between users in the context of the OGD process and that clearly distinguish the role of each user in this process. Table 1 presents the methods and platforms reviewed, their strengths, and weaknesses.

All the gaps mentioned in the existing methods show that there is currently no method or tool that supports collaboration between OGD stakeholders adequately. This justifies the need to identify the necessary requirements such a tool should satisfy and to implement one fulfilling them. Therefore, we implemented ODEON, which differs

from the methods and platforms reviewed in that it addresses each of their shortcomings. It is important to note that ODEON does not aim to replace existing OGD portals but rather proposes complementary communication features. Similarly, ODEON complements citizen participation platforms by allowing to link each service idea to some datasets available on OGD portals that can help to implement the idea.

**Table 1.** Strengths and weaknesses of methods and platforms of communication between OGD stakeholders.

Methods/Platforms	Strengths	Weaknesses
Hackathons [7, 20]	(1) enable developers to design, implement and present services for a specific issue, beyond the “product idea” level (2) physically reunite developers and publishers for several hours to several days, creating many opportunities for discussion (3) usually very focused on technological output, developers tend to oversee other aspects than code due to competition under tight schedule	(1) no consideration of citizens’ needs (2) access limited to a certain type and number of participants (3) communication between these stakeholders is ephemeral (e.g., after the event, there is no possibility to report issues with the datasets or to request datasets) (4) no archiving option that allows, for example, other citizens or developers to know which reuses were implemented during the event (5) impossible to get feedback from participants who were not at the event on the solutions implemented
Interviews and workshops [6, 7, 19, 22, 23]	allows different OGD stakeholders to physically discuss to collect their needs or feedback	(1) access limited to a certain type and number of participants (2) communication between these stakeholders is ephemeral
OGD Portals [5, 12]	(1) help local governments to publish and manage open data on the web (2) allow developers to submit their reuses or to see existing reuses	(1) can only handle reuses and datasets from the specific portal (2) citizens’ needs are not considered (3) no common space to facilitate discussion among stakeholders (4) no archiving of the data issues and their status (5) developers are not able to collect feedback about the reuses they have submitted (6) publishers are not able to know which datasets to prioritize for publication
Citizen participation platforms (e.g., Citizenlab <sup>1</sup> , Leuven make it happen <sup>2</sup> ) [24]	(1) allow local governments to interact with the public (2) allow stakeholders to propose project ideas (3) allow stakeholders to vote on projects they are interested in (4) allow stakeholders to track the status of their projects (e.g., rejected or not)	(1) not focused on promoting the use of open data (2) unable to integrate publishers and developers into the project process (3) unable to track project progress after approval (4) unable to record existing reuses of open datasets (5) unable to link open datasets to projects (6) unable to request data to publishers (7) unable to

<sup>1</sup> <https://www.citizenlab.co/>

<sup>2</sup> <https://leuvenmaakhetmee.be/>

		report issues on open datasets (8) unable for publishers to know which datasets have priority for publication
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### 3 Research Methodology

The Design Science Research (DSR) method [25, 26] was used to address the research question of this paper. It aims to develop solutions (design cycle) that meet defined objectives, contribute to the scientific knowledge base (rigor cycle) and provide utility in the environment (relevance cycle).

In the **rigor cycle**, we conducted a literature review to access existing knowledge on the impediments resulting from the technical aspects of the lack of communication between OGD stakeholders. These impediments were extracted from 12 articles returned by a search performed on the databases “Scopus” and “Science Direct” with the keywords (“open government data” or “open data”) and (“features” or “impediments” or “barriers”) and (“(re)use” or “publication” or “communication”). The results of the literature review are presented in Section 2.2. Once this step was completed, we used the identified impediments to formulate general requirements that should be implemented in a usable tool to solve these impediments. Next, interviews were conducted by the first author with 9 stakeholders (1 publisher, 4 developers and 4 citizens) to validate the suggested requirements and gather additional ones, if any. The interviews were handled in four steps. First, we briefly introduced participants to the utility of OGD with a concrete case of the use of OGD by the city of Namur, which developed an Intelligent Transportation System<sup>3</sup>based on the OGD it published. Second, we explained the context of our project by presenting the benefits and problems related to the lack of communication between OGD stakeholders. Third, we asked participants to suggest some requirements that can address these mentioned problems. Fourth, we showed participants the requirements we extracted from our literature review and asked them, on a scale of 1 (Totally irrelevant) to 5 (Totally relevant), how relevant they were and to justify their choice. Appendix A<sup>4</sup> summarizes the questions asked during the interviews. We took note of the participants’ feedback and recorded the discussion with their agreement for transcription and later review. The interviews were later coded by the first author using short sentences to retain context and conceptual relations, and then reviewed by two other co-authors. Finally, we used the results of these interviews to provide a list of requirements that need to be incorporated into a usable tool to facilitate communication among OGD stakeholders.

In the **design cycle**, we used the validated requirements to propose a list of features that were then implemented in a tool called ODEON (Open Data Exchange solution). Once the features were implemented, we presented the tool to two stakeholders (a developer and a citizen) to get their feedback and integrate it before the evaluation phase.

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<sup>3</sup> <https://sti.namur.be/>

<sup>4</sup> <https://doi.org/10.5281/zenodo.6332097>

In the **relevance cycle**, we evaluated the prototype through a user test with 22 stakeholders (5 publishers, 8 developers and 9 citizens) to assess its ease of use and usefulness in addressing the identified impediments, and to gather additional features for future versions. The publishers were recruited through contact forms available on their OGD portals. As for the developers and citizens, they were recruited through the following communication channels: first author's university mailbox and social media. The interviews were handled in four steps. The first two steps are identical to those of the rigor cycle interviews. In the third stage we briefly presented the prototype's features to the participants in 10 minutes, and then gave them 20 minutes to perform scenarios related to their profile with ODEON. Citizens were invited to (1) explore existing projects, (2) suggest a new project with the content of their choosing, and (3) provide feedback on two projects of their choosing. Developers were asked to (1) explore existing projects, (2) suggest a new project with the content of their choosing, (3) request a dataset of their choosing they would be needed to develop the project they suggested in the second scenario, (4) report an issue with an existing dataset of their choosing, and (5) provide feedback on two other projects and two other datasets of their choosing. Finally, publishers were asked to (1) explore existing projects and (2) provide feedback on two projects and two dataset issues of their choosing. We encouraged them to perform think-aloud as they explored to gather qualitative data on their overall feeling and expectations. They were also given the opportunity to ask the interviewer questions if necessary. However, in accordance with user testing guidelines [27], the sequence of actions to perform the scenarios was not given to participants. Next, we collected participants' feedback through a questionnaire consisting of three types of questions: questions with a 7-point Likert scale (from "Strongly Disagree" to "Strongly Agree") based on the Technology Acceptance Model (TAM) [28] to assess the ease of use of prototype functionalities, the ease of use and usefulness of the prototype in solving the identified impediments, open-ended questions to gather general opinions and suggestions for additional features for future versions and to explain quantitative ratings, and questions on the respondent's profile. The questionnaire was pretested with two people to ensure that all kinds of errors that are associated with survey research are reduced [29]. Appendix B<sup>4</sup> presents the questions contained in the questionnaire according to the stakeholder roles. After collecting participants' feedback, the median, mean and standard deviation were calculated for the Likert questions to evaluate the following aspects: (A1) ease of use of each prototype feature, (A2) overall ease of use of the prototype, (A3) usefulness of each prototype feature and (A4) overall usefulness of the prototype for facilitating communication between OGD stakeholders. The A1 (respectively A3) questions were used as a reference to understand the answers to the A2 (respectively A4) questions. These statistical measures were chosen because they are the most appropriate for analyzing Likert data and for having a central tendency measure [30]. Verbal thoughts and responses collected from the free text questions were coded using short sentences to retain context and conceptual relations.

## 4 Results

In this section, we first present the requirements that need to be incorporated into a usable tool to facilitate communication among OGD stakeholders. Next, we describe how the ODEON prototype was implemented to meet these requirements. Finally, we present the results of the evaluation of ODEON.

### 4.1 Requirements Identification for Communication between OGD Stakeholders

Based on the identified impediments, we derived several requirements that were confronted with the participants during the rigor cycle interviews. Table 2 presents the requirements along with insights from the literature and interviewees.

**Table 2.** List of requirements to design a tool that can facilitate the communication between the OGD stakeholders along with insights from the literature and interviewees. “All” means that all participants were agreed that the requirement is relevant.

Requirements (C = citizens, D = developers, P = publishers)	Insights from	
	Literature	# Participants
RC1. Inform citizens of existing projects based on OGD	IC1	All
RC2. Allow citizens to be involved in the service development process	IC2	All
RC3. Allow citizens to propose project ideas	IC2, ID1	All
RC4. Allow citizens to register existing projects	/	1
RC5. Allow citizens to define which requested projects should be prioritized	/	4
RD1. Allow developers to register existing projects	ID2	All
RD2. Inform developers about existing projects based on OGD	ID2	All
RD3. Allow developers to report issues related to the use of published datasets	ID3	All
RD4. Allow developers to request datasets that do not exist on the portals	ID4	All
RD5. Allow developers to provide feedback on projects and datasets	ID5	All
RD6. Inform developers about the datasets used in projects	ID6	All
RD7. Allow developers to propose project ideas	/	1
RD8. Allow developers to define which requested projects and data should be prioritized	/	4
RP1. Inform publishers about existing projects based on OGD	IP1	All
RP2. Inform publishers of priority data to be published	IP2	All
RP3. Inform publishers of projects using their datasets	IP3	All

## 4.2 ODEON System Description

We designed features that could meet the collected requirements and then implemented them in the prototype ODEON (source code available<sup>5</sup>). The following paragraphs explain how the implemented features meet the different requirements.

**Provide a form to register a project (RC4 and RD1).** It allows developers and citizens to register an existing project in two steps. First, they fill in the following information: country, city, domain, title, access link, description, image and contact information. Then, they can add the datasets used in the project in three ways: by searching and selecting datasets directly from the OGD portals, by uploading files, or by using external links. To avoid duplicate entries, an auto-completion feature for the title field was added, as suggested by an interviewee. Regarding the addition of datasets related to a project from the OGD portals, ODEON provides a search option that allows users to search and select the desired dataset directly from any CKAN or OpenDataSoft portal using the APIs provided by these two systems.

**Provide a form to suggest a project (RC3 and RD7).** The form to be filled in is similar to the project registration form, except that the access link is not requested, and developers and citizens can also skip the step of adding or requesting datasets for the project.

**Display the list of projects (RC1, RD2 and RP1).** It displays all registered (existing and requested) projects.

**Search projects (RC1, RD2 and RP1).** It allows stakeholders to search for specific projects among the registered projects based on the following criteria: keywords, domain, project type (requested or existing), country and city.

**Display details of a specific project (RD6).** It allows stakeholders to see all information about a specific project: general information (title, description, country, comments, etc.) and data used or requested in the project.

**Display details of a specific dataset (RP3).** It allows stakeholders to see all information about a specific dataset: general information (title, description, country, comments, etc.) and projects that use the dataset.

**Provide a form to request data (RD4).** It allows developers and citizens to request data by filling in the following information: country, city, title, description and contact information.

**Provide a form to comment a specific project (RC2 and RD5).** It provides two options. The first option allows any user to provide general feedback on the project or respond to an existing comment. The second option allows developers to inform citizens of the progress of the project development.

**Provide a form to comment a specific data (RD3).** It provides two options. The first option allows any user to provide general feedback on the data or respond to an existing comment. The second option allows stakeholders to report data issues. The form has the following fields: comment type (general comment or report data issue), name, comment and attachment.

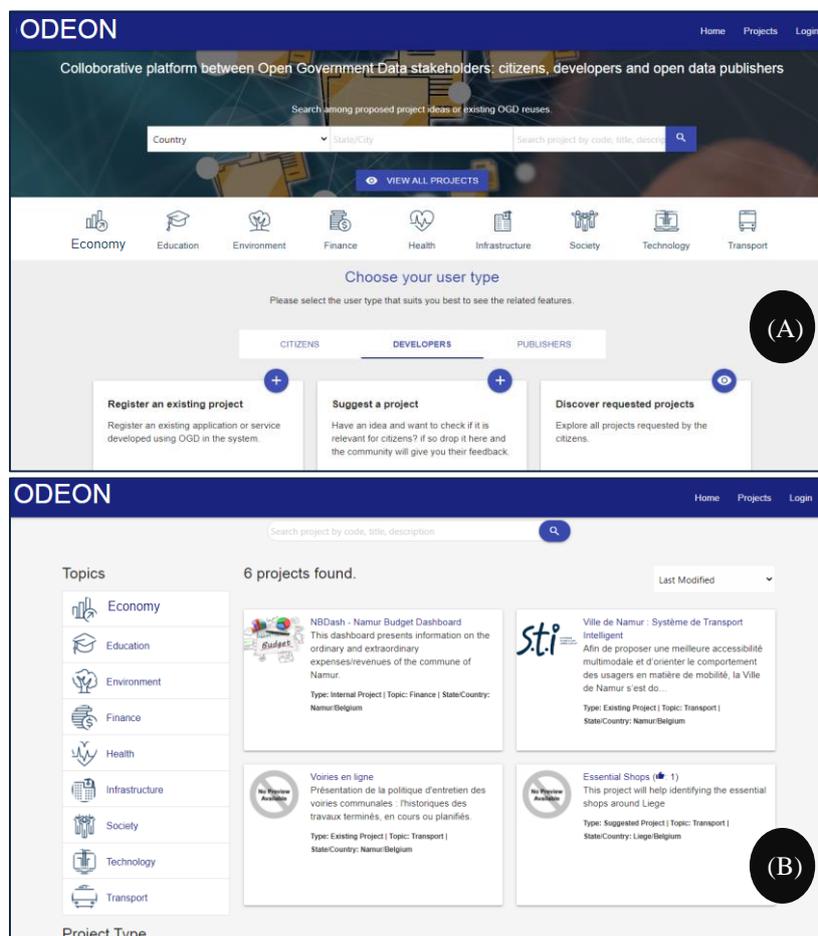
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<sup>5</sup> <https://github.com/chokkipaterne/odeon>

**Display and search requested data (RP2).** It lists all the requested data. There is also a search option that allows filtering the display using the following options: country, state and keywords.

**Display and search data issues (RD3).** It lists all data issues reported by stakeholders. There is also a search option that allows filtering the display using the following options: country, state and keywords.

**Add a voting option for requested projects and data (RC5 and RD8).** It consists of adding a “Like” button for each requested project or data so that any user can click on the button to indicate that the requested project or data is relevant.



**Fig. 2.** Two pages of ODEON. (A) represents a portion of the homepage and (B) represents a portion of the project list page with available search options.

ODEON is a web application built using the Django framework. Figure 3 shows two pages of the prototype. (A) represents a portion of the homepage where the stakeholders can make a quick search of project or can access other features of the prototype based

on their profile (citizen, developer or publisher) and (B) represents a portion of the project list page with available search options (keywords, topic, project type and location).

### 4.3 Evaluation

In total, 22 participants (9 citizens, 8 developers and 5 publishers) participated in the evaluation of ODEON and completed the questionnaire. Table 3 presents the median, mean and standard deviation (SD) for the Likert questions regarding the ease of use and the usefulness of the prototype. The following conclusions can be drawn from the results of Table 3, for the different stakeholders:

**Citizens.** Most of the citizens agreed that the proposed prototype was easy to use (median and mean  $\geq 5$  for A2 with a low standard deviation around 1) and useful for facilitating the communication between OGD stakeholders (median and mean  $\geq 5$  for A4 with a low standard deviation around 1). More specifically, many citizens found that the prototype met their expectations and was user-friendly for the features such as discovering existing projects, registering and suggesting projects, but had a more mixed opinion about the monitoring project development and reporting data issue features. Indeed, the means of participants' scores on the ease of use (A1) and usefulness (A3) questions ranged between 3 and 5 for these features.

**Developers.** Most of the developers also found that the proposed prototype was easy to use (median and mean  $\geq 5$  for A2 with a low standard deviation around 1) and useful for facilitating the communication between OGD stakeholders (median and mean  $\geq 5$  for A4 with a low standard deviation around 1). However, like the citizens, they found it more difficult to use for some features such as updating the status of the project and reporting data issue. The means of participants' scores for these features were less than 5.

**Publishers.** The publishers were quite satisfied with the proposed prototype and found it easy to use (median and mean  $\geq 5$  for A2 with a low standard deviation around 1) and useful for facilitating the communication between OGD stakeholders (median and mean  $\geq 5$  for A4 with a low standard deviation around 1). Compared to the other two OGD stakeholders, the publishers are concerned by only three features of ODEON and all these features were easy to use and useful for them (median and mean  $\geq 5$  for A1 & A3 questions). However, they were concerned that the comments would pile up and that they would get lost in them.

**Table 3.** Median, mean and standard deviation (SD) of ease of use and usefulness questions.

	Citizens (N = 9)		Developers (N = 8)		Publishers (N = 5)	
	Median	Mean (SD)	Median	Mean (SD)	Median	Mean (SD)
<b>A2. Ease of use of the prototype</b>	5	5.19 (1.13)	5.5	5.25 (1.18)	6	5.7 (0.82)
<b>A4. Usefulness of the prototype</b>	5	5.36 (1.27)	5	5.67 (1.14)	6	6 (1.41)

In addition to these findings, some new features and suggestions for improving the UI design were gathered from the verbal thoughts and answers to the open-ended questions provided by the participants. The new features are as follows. First, citizens and developers suggested having a feature that helps them to subscribe to a dataset or project to get weekly updates on the data or projects they have subscribed to. Second, publishers suggested having a monthly summary of requested datasets or data issues directly in their inbox. Third, for the discovery functionality of existing and requested projects, participants suggested moving the project type and location filters close to the search field to make them more visible. Fourth, participants suggested adding a status attribute for projects to help to identify the current status of each project: requirements analysis, under development, development complete and abandoned project.

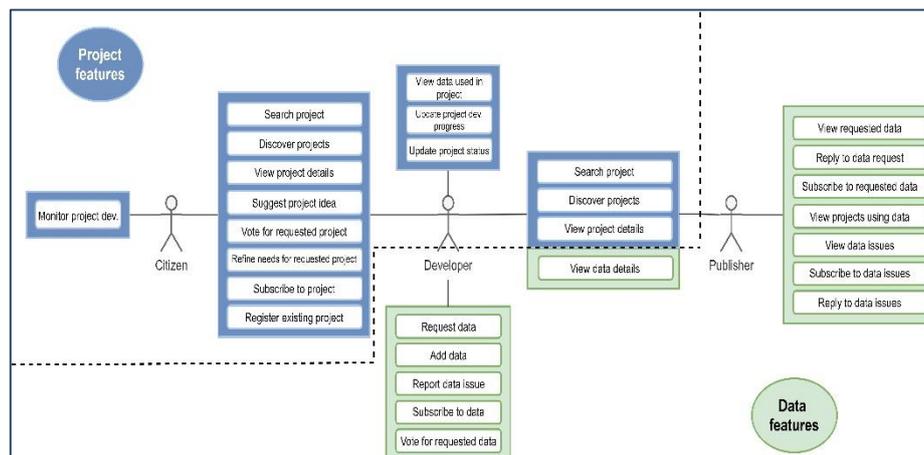
## 5 Discussion

This research contributes to theory in the following aspects. First, it extends previous studies related to impediments [5, 7–13], building on the previously identified impediments to propose a list of 16 requirements that should be implemented in a usable tool to facilitate the communication between OGD stakeholders. These identified requirements can also be used as reference by open data publishers or developers of citizen participation platforms to help them to know what features need to be added to their existing platforms to fully facilitate communication between OGD stakeholders. They can also be used by researchers to evaluate applications whose objective is to facilitate communication between OGD stakeholders. Second, unlike previous studies [5, 7–13] that focused only on a specific user profile or only on impediments, this research validates the identified impediments as well as the requirements through interviews with three different stakeholder roles. Third, the results obtained from the evaluation show that ODEON and the implemented features were easy to use and useful to address the technical aspects of the lack of communication between OGD stakeholders.

This research also contributes to practice in the following aspects. First, unlike previous studies [5, 7–13] that identified impediments without providing a list of features of a usable tool to address them, we derived a list of features from the requirements for each OGD stakeholder, and we present it as the use case diagram shown in Figure 3. In this diagram, features are subdivided into data features and project features. The data features address the following impediments: data quality and lack of awareness of which data should be released first. The project features resolve other identified impediments, such as unawareness of the existing projects based on OGD, difficulty finding a project idea, lack of citizen involvement in project development, etc. Second, we provide access to the source code of ODEON<sup>5</sup>. This can be used as a starting point by developers to create their own online tool for facilitating the collaboration between OGD stakeholders or to improve the prototype. The use case diagram can be used as starting point as well.

However, this research has some limitations that will need to be addressed in future work. The first limitation concerns the representativeness of the participants in the evaluation. The number of participants may be small, but referring to previous studies [31,

32] 5 participants is a good baseline for usability tests and we also observed that our findings were reaching saturation at that point. However, to increase representativeness, we suggest using other communication channels or collecting data on-site in administrations, universities, workshops, hackathons or public places to recruit participants for the evaluation of the future prototype version. In this study, this was not feasible due to the COVID-19 situation. The third limitation is that we did not consider the discovery step of ODEON. Indeed, a multi-stakeholder collaboration platforms relies heavily on a community that needs to be attracted on the platform. One approach to address this issue will be to communicate about this prototype using social networks and by presenting it at open data workshops and hackathons. The fourth limitation is the non-generalization of the proposed requirements to other areas. Other researchers can start by investigating whether the existent platforms (e.g., Github, Wiki) can be adapted to the context of open data or whether the proposed requirements can be used or extend to other areas such as open data ecosystems, open government ecosystems, and open source software ecosystems. Future work will also include an implementation of the suggested new features and a field evaluation of ODEON, for example, by offering hackathon organizers to use it as meeting point between the stakeholders involved in the event.



**Fig. 3.** Use case diagram of ODEON. The features are subdivided into two groups: the features related to the project (project features) and the features related to the data (data features).

## 6 Conclusion

The aim of this paper was to address the technical aspects of the lack of communication between OGD stakeholders (citizens, developers and publishers). To achieve that goal, we first identified the impediments resulting from the technical aspects of the lack of communication between OGD stakeholders that demotivate them to use and to publish OGD through a literature review. Then, through interviews with 9 stakeholders, we deduced and validated, the requirements that should be satisfied by a usable tool that

addresses these impediments. Next, we implemented the ODEON prototype based on the collected requirements and used it as proxy to measure the extent to which the requirements were easy to use and useful to facilitate the communication between OGD stakeholders through an evaluation conducted with 22 stakeholders from the three different profiles.

The results of the literature review and successive evaluations have led to the proposal and validation of a list of 16 requirements along with a use case diagram of features that should be implemented in a usable tool to facilitate the communication between OGD stakeholders. These features are classified into two categories: data features and project features. Among the data features, the main ones are reporting data issues, requesting data and replying to data requests and issues. From the project features, the main ones are suggesting a project, discovering requested and existing projects, updating project development progress, and monitoring project development. Second, the evaluation results show that publishers are more satisfied with the proposed prototype compared to the citizens and the developers. Both latter stakeholders, however, were fully in agreement with the implemented features, but they just complained about the ease of use of some features and then gave us improvement suggestions that we plan to integrate in future versions.

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