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## ► To cite this version:

Anneke Zuiderwijk, Marijn Janssen. A Coordination Theory Perspective to Improve the Use of Open Data in Policy-Making. 12th International Conference on Electronic Government (EGOV), Sep 2013, Koblenz, Germany. pp.38-49, 10.1007/978-3-642-40358-3\_4 . hal-01490921

**HAL Id: hal-01490921**

**<https://inria.hal.science/hal-01490921>**

Submitted on 16 Mar 2017

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# A Coordination Theory Perspective to Improve the Use of Open Data in Policy-making

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**Abstract.** At this moment there is little coordination of the publication and use of open data. In this research coordination needs and challenges for open data and coordination mechanisms that can help in improving coordination are identified. A literature review shows that the opening and use of data are isolated and unrelated processes. Open data publishers do not profit from the wisdom of the crowd by having knowledge of how their data are reused. In addition, results of data reuse are not discussed and little feedback is gained by data providers, in this way barely supporting policy and decision-making. Coordination mechanisms, such as standardization and interconnected processes, can enable open data providers to profit from publishing data and to use this for improving their policy-making and decision-making. Yet, it is difficult to coordinate the open data process with these coordination mechanisms due to the complexity, lack of structure, uncertainty, dynamism, and the involvement of varying stakeholders in the open data process. Further research is necessary to investigate which coordination mechanisms are appropriate in the context of open data publication and use.

**Keywords:** open data, coordination, coordination theory, coordination mechanisms, challenges, improvement, open data process.

## 1 Introduction

The open data process consists of many activities that are performed by different stakeholders [1, 2]. Following [3] and [4], we define the open data process as all activities between the moment that data are starting to be created and the moment that data are being discussed, including the activities to publish, find and use open data. At least open data publishers and users are involved, but often many more stakeholders are involved, such as open data facilitators, brokers (e.g. organizations that bring together open data users and producers by providing open data websites) and open data legislators (e.g. the European Commission and national political parties).

The intention of open data publication is to make data available to have them reused by external users, in this way profiting from the wisdom of the crowd, and subsequently to support and improve policy-making and decision-making by discussing data and providing feedback to open data providers. However, as stated by

Braunschweig et al., activities of the open data community are largely uncoordinated [2]. This statement is based on a survey of open data platforms, focusing on the technical aspects using open data, but not focusing on other parts of the open data process. Open data publishers are often unaware of what is done with the data, which value they can create and how they can be used for improving their own policies and decisions. Open data publishers and users are often not aware of each other's needs and activities. For instance, many open data providers are primarily focused on making data available and do not know which format is preferred by users and how the way that they publish data can stimulate the use of open data. Stimulating the use of open data is an important factor in creating the intended effects [5]. Coordination is important, because it may lead to increased understanding of the open data process and could result in concerted action [6], improved performance [7, 8] and improved policies. In addition, it can help to accomplish advantages, such as increased transparency [9, 10], economic growth and innovation [10, 11], empowerment of open data user [9, 12] and improvement of policy and decision making [9, 10].

This research aims to 1) determine which coordination needs and challenges exist in the open data process and 2) to investigate how coordination in the open data process can be improved. A literature review is performed to examine coordination theory and to define coordination. On the basis of concepts derived from the literature and an analysis of interdependencies between activities in the open data process, coordination needs and challenges are identified. Finally, coordination mechanisms are described to deal with the coordination challenges and to improve coordination in the open data process.

## **2 Coordination theory**

In this section background information is given about how coordination can be defined (Section 2.1) and which coordination mechanisms are identified in the literature to improve coordination (Section 2.2).

### **2.1 Coordination**

Coordination theory provides an approach to the study of processes [13] and has been studied in numerous disciplines, such as computer science, sociology, political science and management science [14]. Although we all have an intuitive sense of what the word 'coordination' means, debate has been going on for years about what it really is. According to Van de Ven, Delbecq and Koenig [15, p. 322], "coordination means integrating or linking together different parts of an organization to accomplish a collective set of tasks." Heath and Staudenmayer [16, p. 156] state that coordination in organizations refers to "organizing individuals so that their actions are aligned". In line with these definitions, Thompson [17, p. 37], postulates that coordination means that "the elements in the system are somehow brought into an alignment, considered and made to act together".

From this perspective, the division of labour in organizations leads to the need for coordination, as interdependencies between tasks and the individuals performing them need to be coordinated [16]. For this reason, Malone and Crowston [14, p. 361, 18]

define coordination as “the act of managing interdependencies between activities performed to achieve a goal”. In line with this, Gosain, Lee and Kim [19, p. 372] define coordination as “a process of linking together different activities of organizations to accomplish a common goal”. Coordination is thus needed to map goals to activities, relate activities performed by different actors and to manage the interdependencies between these activities [14, 18].

In this research, interdependence is viewed as the extent to which activities in the open data process require the elements, such as the actors, systems and divisions, to work together [20, 21]. The management of interdependencies between activities could result in the alignment of actions of stakeholders in the open data process and in this way result in coordination.

## 2.2 Coordination mechanisms

Coordination, i.e. the management of interdependencies between activities, can be achieved by coordination mechanisms. On the basis of the work of March and Simon [22], Thompson [6] expounds three types of coordination mechanisms. First, coordination by standardization refers to the development of routines or rules, which constrain action of each organizational part or position. This type of coordination requires an internally consistent set of rules and a stable and repetitive situation to be coordinated [6]. Second, coordination by plan requires a lower degree of stability and routines than coordination by standardization and refers to the creation of schedules for interdependent organizational parts. These schedules may govern their actions and they are appropriate for dynamic situations, such as changing tasks [6, 22]. Third, *coordination by mutual adjustment* is suitable for reciprocal interdependence. This type of coordination needs most communication and decisions, as it “involves the transmission of new information during the process of action” [p. 56]. Coordination by mutual adjustment is possible for variable and unpredictable situations [6]. March and Simon [22] refer to this as *coordination by feedback*.

Also based on March and Simon’s [22] work, Gosain, Malhotra and El Sawy [23] argue that in an inter-enterprise setting, coordination outcomes can be achieved by combining advanced structuring and a dynamic adjustment approach. Advanced structuring refers to structuring information flows and interconnected processes that exist between organizations before they take place (i.e. in advance). The advantage of this approach is that the effort related to adjusting to changing environments is reduced. Advanced structuring makes use of ‘loose coupling’, which means that certain elements of systems are linked (i.e. “coupled”) to attain some degree of structuring, while spontaneous change may occur, leading to a certain degree of independence (i.e. “looseness”). Gosain et al. (2004) identified three aspects that advance the ‘coupling’ and looseness’ in the advanced structuring approach. First, standardization of process and content interfaces concerns “explicit or implicit agreement on common specifications for information exchange formats, data repositories, and processing tasks at the interfaces between interacting supply chain partners” [23, p. 14]. Second, modular interconnected processes, which means “the breaking up of complex processes into sub processes (activities) that are performed by different organizations independently (such that sub processes occur through overlapping phases, or better still, fully simultaneously) with clearly specified interlinked outputs” [p. 16]. Third,

structured data connectivity refers to “the ability to exchange structured transaction data and content with another enterprise in electronic form” [p. 17].

The dynamic adjustment approach refers to effectively and quickly reconfiguring interorganizational processes, so that these processes become appropriate for a changed organizational environment. The reconfiguration is supported through (IT) learning and adaptation [23]. Aspects that advance the dynamic adjustment approach are 1) the breadth of information shared with supply chain partners, 2) the quality of information shared with supply chain partners and 3) deep coordination-related knowledge. Breadth of shared information is required to react to unexpected change, while information of high quality is needed to make effective and efficient inferences. Deep coordination-related knowledge consists of knowledge of partner competencies, process and content, organization memory of past change episodes and understanding of causal linkages [23].

### **3 Coordination needs and challenges in the open data process**

In the previous section it was stated that coordination refers to the management of interdependencies between activities [14, 18]. Crowston [24] argues that “to analyze an organizational process, it is important to identify the dependencies that arise and the coordination mechanisms that are used to manage those dependencies” (p. 86). In this section, we elaborate on the need to coordinate the open data process (Section 3.1) and analyze interdependencies to determine which coordination challenges currently exist (Section 3.2).

#### **3.1 Coordination needs**

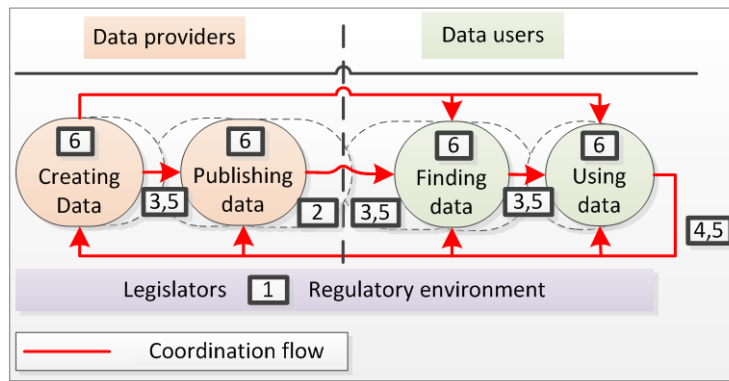
Project and organization complexities, interdependencies in work activities and uncertainty in the environment of the organization lead to a need for coordination [19]. Realizing coordination in the open data process is important, as coordinating by tightly coupling relationships provides the advantage to jointly exploit the capabilities of process partners [25, 26]. For instance, open data providers can use the wisdom of open data users to discuss their data. Moreover, coordination may lead to an increased understanding of the open data process and could result in concerted action [6] and improved performance [7, 8].

In the open data process, concerted action of the actors could deal with the complexities, interdependencies and uncertainties and stimulate the realization of benefits of the open data process [27]. For instance, to achieve economic growth, providers of open data should take into account the needs of open data users, such as needs for certain data formats or metadata, and they should actively discuss those needs, so ensure that open data will actually be used. Furthermore, to improve public policies and policy and decision making, open data users can communicate with open data providers about the way that they used open data and to recommend policy improvements. Thus, there is a need for coordination in the open data process.

### 3.2 Coordination challenges

As there is a need for coordination in the open data process, it is important to identify the coordination challenges that currently exist. We define a coordination challenge as a situation in which a goal is defined, but coordination (i.e. the act of managing interdependencies between activities performed to achieve this goal) is inappropriate. We refer to Figure 1 to show in which part of the open data process the challenges exist. Each number in the figure refers to a challenge that is described thereafter.

As Figure 1 shows, the current open data process is characterized by four main activities. First, data are created by governmental and non-governmental organizations. Second, these organizations can decide to publish the created data on the internet. Third, the published data can be found by (potential) users, such as researchers and citizens. And, fourth, the found data can be used.



**Fig. 1.** Coordination challenges in the open data process.

#### 1. *Inappropriate regulatory environment (challenge 1 in Figure 1)*

**Actors:** Open data legislators, providers and users.

**Activity goal:** To publish data in such a way that they can be reused by external users, in this way profiting from the wisdom of the crowd, and subsequently to support and improve policy-making and decision-making by discussing data and providing feedback to open data providers.

**Interdependence:** The way that the open data provider makes data available highly influences the way that external users can make use of the data. As a consequence, this influences the type of feedback that open data providers can obtain from the crowd and the way that they can apply this feedback to their own processes, such as policy-making and decision-making.

**Coordination mechanisms:** There are only limited coordination mechanisms in the form of legal frameworks, policies and guidelines. Although coordination by plan is applied to the open data process in the form of legislation, open data policies and organizational guidelines, these mechanisms provide little improvement of coordination in the open data process. There are many differences among open data legislation and policies, for instance with regard to policy objectives and policy instruments, and

there are many opportunities for improving open data policies [5]. Additionally, the legal frameworks, policies and guidelines do not refer to standards or plans that reflect what users need or how the data provider can obtain feedback from its own data.

## **2. Fragmentation of open data (challenge 2 in Figure 1)**

Actor: Open data providers.

Activity goal: Open data providers aim to publish data in such a way that the data can be found and reused easily, so that the advantages of open data can be realized.

Interdependence: The ease of finding open data influences the way that open data can be reused effectively. When the data cannot be found easily, they are less likely to be reused and the benefits of open data are not fully realized.

Coordination mechanisms: Open data are fragmented, which makes it difficult to find them. One reason for this is that data are published via various open data platforms. Even though some catalogues exist, describing which data can be found on different open data platforms, these catalogues are incomplete and usually not linked to other catalogues. In addition, there is no overview of who creates which data. As a consequence, open data users often do not know where they can find the data that they want to use.

## **3. Unclear boundaries of responsibilities (challenge 3 in Figure 1)**

Actor: Open data providers and users.

Activity goal: Clearly define the boundaries of responsibilities of open data providers and users, so that they know what they can expect from each other and use this information to effectively execute their processes.

Interdependence: Open data providers and users adapt themselves to the information and knowledge that they have about the boundaries of their own responsibilities and the responsibilities of the other stakeholders in the open data process to effectively perform their work.

Coordination mechanisms: The boundaries of the responsibilities of stakeholders in the open data process are often unclear. There is no widely accepted agreement about which stakeholders perform which activities. Furthermore, there is no coordinator who is responsible for the whole open data process. A cause of this boundary uncertainty could be that stakeholders in the open data process lack information concerning each other's status and activities and that different organizational units observe different parts of the process [28].

## **4. Lack of feedback on and discussion of data use (challenge 4 in Figure 1)**

Actor: Open data providers and open data users.

Activity goal: To discuss with other stakeholders in the open data process and to provide them with feedback on their activities.

Interdependence: Applying discussion and feedback mechanisms in the open data process is important, as they can be beneficial for data providers as well as data users. Open data providers and users can use discussion and feedback mechanisms to improve the quality of the data, the data publishing processes and open data and other policies. Additionally, they can help users to better understand how they can use and interpret data and what the value of the data is [29].

Applied coordination mechanisms: The current open data process is lacking discussion and feedback mechanisms. For instance, after open data have been used, there are usually no coordination mechanisms that facilitate the provision of feedback to data providers and that facilitate a discussion about the reused data.

#### **5. Lack of interconnected processes (challenge 5 in Figure 1)**

Actor: Open data providers and users.

Activity goal: Connect sub processes of the open data process, so that open data providers and users can gear the activities that they perform to one another.

Interdependence: The open data process is divided into main processes, which can be divided into sub processes. An example of such a sub process is the preparation of the dataset or checking whether the dataset can be published. The way that stakeholders perform their activities influences the extent to which other stakeholders are able to perform their activities in other sub processes. A lack of interconnected processes can lead to the situation in which one stakeholder executes activities in such a way that other stakeholders are hindered in performing their own activities. For instance, when a data provider does not have the insight that open data users need considerable metadata to be able to use the data, he or she may not provide these metadata and hinders the open data user to use the data and realize their benefits.

Coordination mechanisms: The sub processes in the open data process usually do not have clearly specified interlinked outputs. The coordination mechanism of deep coordination-related knowledge, including knowledge of partner competencies, process and content, organization memory of past change episodes and understanding of causal linkages, is lacking in the open data process. For example, many organizations merely release data on the internet without considering the way that their data can be used or how they can get feedback on the data [30].

#### **6. Lack of standardized and planned processes (challenge 6 in Figure 1)**

Actor: Open data providers and open data users.

Activity goal: To perform the open data process in a standardized way.

Interdependence: The extent of standardization used in the open data process influences easiness, time-consumption and efficiency to participate in it.

Coordination mechanisms: The mechanisms of coordination by standardization and coordination by plan are barely applied in the open data process. This may be caused by the fact that the sub processes of the open data process are not stable and sometimes not repetitive, which makes it difficult to apply coordination by standardization and plan. For instance, open data can be published and reused in various ways and feedback can be provided and received in many ways. This finding is in line with research of Braunschweig et al. [2], who write that considerable differences exist between the ways that data can be reused in open data repositories.

### **4 Mechanisms to improve coordination in the open data process**

In the previous section, various coordination challenges for the open data process were identified. In this section we focus on the second aim of this paper, namely to investigate how coordination in the open data process can be improved. Table 1

shows an overview of the coordination challenges that were identified in the previous sections and the related coordination mechanisms that may help in solving these challenges.

**Table 1.** An overview of coordination challenges related to coordination mechanisms that may help in solving these challenges.

<b>Coordination challenges</b>	<b>Coordination mechanisms to solve these challenges</b>
1. Inappropriate regulatory environment	Coordination by standardization, plan, deep coordination-related knowledge
2. Fragmentation of open data	Coordination by standardization, plan, structured data connectivity, deep coordination-related knowledge
3. Unclear boundaries of responsibilities	Coordination by plan, modular interconnected processes, deep coordination-related knowledge
4. Lack of feedback on and discussion of data use	Coordination by mutual adjustment, modular interconnected processes, structured data connectivity, deep coordination-related knowledge
5. Lack of interconnected processes	Coordination by standardization, plans, mutual adjustment, modular interconnected processes, structured data connectivity, breadth and quality of shared information, deep coordination-related knowledge
6. Lack of standardized and planned processes	Coordination by standardization, plan, deep coordination-related knowledge

Although the coordination mechanisms that were described by Thompson [6] and Gosain et al. [23] are only applied on a small scale in the open data process at this moment, all the coordination mechanisms that were described by them seem to be appropriate to use to improve coordination in the open data process, as all of them could be related to at least one of the identified coordination challenges. Therefore, we recommend to use the identified coordination mechanisms.

Table 1 shows that different coordination challenges might be solved by using different coordination mechanisms. For example, the lack of interconnected processes could be solved by applying all mechanisms, but solving the lack of communication would benefit mainly from coordination by mutual adjustment and deep coordination-related knowledge, rather than other mechanisms, such as the breadth and quality of shared information. Coordination by deep coordination-related knowledge could be used for all of the coordination challenges and was mentioned most often.

The second column of Table 1 shows that we propose to use a combination of coordination mechanisms from all three approaches that we analyzed, namely from Thompson's [6] approach and from Gosain et al.'s [23] approach of advanced structuring and dynamic adjustment. For instance, to solve the challenge of unclear boundaries of responsibilities, we propose to combine mechanisms from all three approaches, namely coordination by plan defined by Thompson [6], modular interconnected processes defined by Gosain et al.'s [23] approach of advanced structuring and deep

coordination-related knowledge defined by Gosain et al.'s [23] approach of dynamic adjustment.

But although several useful coordination mechanisms are described in the literature, these coordination mechanisms cannot be directly applied to solve all the challenges in an appropriate way. For instance, while it is clear that fragmentation of open data could be solved by coordination by standardization, existing research does not explain how this standardization could be applied to the open data process. It is difficult to coordinate the open data process due to its complexity, lack of structure, uncertainty, dynamism, and the involvement of many stakeholders. Because of these characteristics of the open data process, it is unclear how activities in the open data process could be interconnected and how deep coordination-related knowledge could be obtained by stakeholders involved in the open data process. It is hard to define suitable coordination mechanisms in advance. In different circumstances different coordination mechanisms might be appropriate. Further research is needed to investigate whether and how coordination theory could be extended to provide more appropriate coordination mechanisms in the context of open data.

As a first step towards examining how coordination mechanisms can be applied, we suggest the development of an open data e-infrastructure where open data providers and users can find and contact each other and collaborate. Such an open data e-infrastructure has the advantage that it brings together different stakeholders who are involved in the open data process and, as a consequence, it provides an overview of these stakeholders and it gives more insight into how the open data process could be coordinated. Open data e-infrastructures may provide, among others, the functionalities of data provision, data retrieval and use, data linking, user rating and user cooperation [30]. E-infrastructure may be helpful in supporting coordination by:

- Using an Application Programming Interface (API) that allows publishers to integrate the publishing workflow in their own dataset management systems and upload or update datasets automatically on open data infrastructures.
- Interconnecting processes performed by data providers and data users, for example, by keeping track of their status from the phase of publication until the phase of data reuse and discussion;
- Describing and clarifying the responsibilities of stakeholders involved in the open data process;
- Providing deep coordination-related knowledge;
- Linking data and showing them in linked catalogues to improve their findability;
- Giving information about open data regulations (e.g. policies and guidelines);
- Enabling the discussion of reused data by making it possible for users to discuss datasets individually or in groups of users, in this way stimulating iterative open data processes;
- Enabling the provision of feedback on data and on policies;
- Enabling monitoring data reuse, data discussions and feedback on datasets and policies by providing tools to monitor these;

- Standardizing processes of uploading, downloading, reusing and discussing data, for instance by describing formats in which data could be published to facilitate their reuse [30].

## 5 Conclusions

The aim of this research was 1) to determine which coordination needs and challenges exist in the open data process, and 2) to investigate how coordination in the open data process can be improved. A literature review was performed, which pointed at coordination mechanisms that can be applied to improve the open data process. Subsequently, the open data process was analyzed. Interdependencies between activities were examined and it was found that some of the coordination mechanisms derived from the literature are used in the open data process, but only on a very small scale. Six different coordination challenges were identified in the open data process, namely 1) an inappropriate regulatory environment, 2) fragmentation of open data, 3) unclear boundaries of responsibilities, 4) a lack of feedback on and discussion of data use, 5) a lack of interconnected processes, and 6) a lack of standardized and planned processes.

Coordination mechanisms can be used to overcome these challenges. The use of coordination mechanisms in the open data process could stimulate the realization of the advantages of open data, such as enabling open data users to reuse data and enabling open data providers to profit from publishing data and to use this for improving their policy-making and decision-making. Yet, we found that it is difficult to coordinate the open data process due to its complexity, lack of structure, uncertainty, dynamism, and the involvement of varying stakeholders. Further research is necessary to investigate which coordination mechanisms are appropriate in the context of open data publication and use.

**Acknowledgements.** This paper is related to the ENGAGE FP7 Infrastructure Project (An Infrastructure for Open, Linked Governmental Data Provision Towards Research Communities and Citizens; [www.engage-project.eu](http://www.engage-project.eu); [www.engagedata.eu](http://www.engagedata.eu)), that started in June 2011. The authors would like to thank their colleagues of the ENGAGE project for their input for this paper although the views expressed are the views of the authors and not necessarily of the project.

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