

7-1-2013

# The Generative Mechanisms Of Open Government Data

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## Recommended Citation

Jetzek, Thorhildur; Avital, Michel; and Bjørn-Andersen, Niels, "The Generative Mechanisms Of Open Government Data" (2013). *ECIS 2013 Proceedings*. Paper 179.

<http://aisel.aisnet.org/ecis2013/179>

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## **THE GENERATIVE MECHANISMS OF OPEN GOVERNMENT DATA**

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### **Abstract**

*The exponentially growing production of data enables global connectivity as well as increased openness and sharing, which turn into a powerful force that is changing the global economy and society. Governments around the world have become active participants in this evolution by opening up their data for access and re-use by public and private agents alike. The recent phenomenon of Open Government Data (OGD) has spread around the world, driven by the proposition that opening government data has the ability to generate both economic and social value. However, a review of the academic research and the popular press reveals only sporadic attention given to various aspects with no overarching framework that explains how OGD generates value. We apply a critical realist approach to uncover the generative mechanisms that serve to explain this relationship. First, we present a strategic framework with four archetypical generative mechanisms. The framework outlines the different pathways to value generation and highlights the current tension between the private/public and economic/social domains. Second, we offer a conceptual model that provides a systematic way of articulating and examining further the generation of value from OGD.*

**Keywords:** *Open Government Data, Open Access, Big Data, Generative Mechanisms, Value Creation.*

## **1 Introduction**

Today, we generate and store more data than at any other time in history. Computing and networking capabilities combined with openness enhance the potential impact of the accumulated data and offer society an opportunity to drive massive social, political and economic change (Kundra, 2012). Thus far, there is an apparent tension between the social value driven networks of data, information and knowledge sharing, on the one hand, and the economic value driven products and services markets of ownership and exchange, on the other. Traditionally, these have been seen as two different ends, with businesses on one end and governments and not-for-profit organizations on the other. The presumed trade-offs between economic efficiency and social progress have almost become institutionalized (Porter and Kramer, 2011). However, in the last few years, the boundaries between the two are blurring, following the increased connectivity, openness and sharing. These increasingly complex interdependencies are forcing us to re-think the concepts of economic and social value in a world moving towards digital interoperability, information sharing, co-creation and collaborative networks (Avital et al, 2007; Hess and Ostrom, 2006).

Having *Open Government Data* (OGD) implies that the public sector relinquishes its role as information gatekeeper in lieu of a new role as information provider, leading to a realignment of the power dynamics between the public and private sectors (Davies, 2010). Proponents of OGD hope that such shifts will strengthen democracy and improve the impacts of government work through increased transparency, participation and collaboration. Moreover, advocates of OGD argue that it enables greater government efficiency through an information infrastructure that allows for better data re-use within the public sectors and inter-agency coordination. Open data advocates are also motivated by its potential for innovative entrepreneurs who can use OGD to generate new products and services. However, due to the early stage of OGD initiatives, their impact and ramifications are still debated in professional and academic circles. While economic and social value has been expected to emerge from the dissemination of OGD, evidence is still scarce. The economic and social impact of open-data policies remains largely unclear, and there are relatively little empirical data available on the effects of the various policy approaches, thus leaving policy makers without the facts they need to assess and improve these policies (Huijboom and Van den Broek, 2011; Zuiderwijk and Janssen, 2012).

This paper addresses the question: How do open government data stimulate value generation? To explore and illustrate how value can be generated from the use of OGD, we turned to the critical realist concept of a micro-to-macro mechanism as a causal structure that contingently generates observable outcomes. We use these mechanisms to portray the instrumental pathways between OGD, social factors and technological factors that have the potential to generate value. We concentrate on the overall economic and societal impacts from OGD and examine OGD initiatives as the unit of analysis. Overall, we propose that there are four archetypical generative mechanisms that explain how OGD can stimulate value generation, contingent on three enabling conditions. Furthermore, we argue that synergies between different generative mechanisms can lead to enhanced value generation and more widely dispersed value appropriation. Finally, we suggest that by contrasting different mechanisms and different perspectives, we can contribute to knowledge on how ambidextrous strategies and cross-sector collaboration within value networks can benefit OGD value generation and appropriation.

## **2 The unique features of OGD**

The amount of data accumulating in our increasingly digital world is breathtaking. In the past two years alone, the data generated from Internet-based transactions, surveillance cameras, and smart devices have boosted the amount of data available in the digital universe to its current rate of 2.8 ZB, a number that is expected to double every year. The massive increase in the amount of data, combined with openness and technologies that allow global distribution, has dramatically changed the nature of data from a closed proprietary resource to a common shared resource. Additionally, the continuously developing technical and semantic ability to merge disparate datasets, combined with sophisticated data analysis, has the potential to increase vastly the overall value of data. It is estimated that better

use of data resources in the US health care could generate USD 300 billion annually and in Europe's public sector it could generate EUR 250 billion annually (McKinsey, 2011).

*Open data* can be defined as data that are freely accessible online, available without technical restrictions to re-use, and provided under open access license that allows the data to be re-used without limitation, including across different 'fields of endeavor' (e.g., commercial and non-commercial alike) (OKF, 2012). The concept of Open Government Data (OGD) refers to government data, defined as "data and information produced or commissioned by government or government controlled entities" (OKF, 2012), that are opened up for use and re-use by public and private agents alike. In the currently used terminology, OGD does not include data that are subject to valid privacy, security or privilege limitations, as governed by other statutes. Government data sets are an interesting subset of open data because such subsets have already been collected for specific use, have been paid for by taxpayers, are relevant and offer value beyond what is captured from the originally intended use. When opened up, government data become a common, shared resource (i.e., public good) that is provided by the government. Building on Nilsen (2010) and Shapiro and Varian (1999), the typical features of OGD as a resource are as follows:

- It is non-rivalrous: One person's use of the data does not reduce availability to others.
- It is not excludable: One person cannot exclude another person from using the data.
- It has high fixed costs: Costs of collecting, processing and storing the data are generally high.
- It has (almost) zero marginal cost, i.e., it is inexpensive to reproduce the data after they have been collected.
- It offers valuable information and has high potential for re-use.

While the generative mechanisms discussed in section 5 can be applied to all types of open data as a resource, the outcomes generated from the use of open data provided by government differ from the outcomes generated by use of open data provided by the private sector. In this paper, we focus specifically on the value generated by the use of open data that are produced and provided by the government.

### **3 The multifaceted nature of value**

The most advanced economies in the world today have made two parallel shifts that, paradoxically, make possible a significant attenuation of the limitations that market-based production places on the pursuit of value that is central to liberal societies. The first is the move to an economy centered on information and the second is the move to a networked Internet-based environment. These changes have increased the role of non-market and non-proprietary production, both by individuals alone and by cooperative efforts in a wide range of loosely or tightly woven collaborations (Benkler, 2006). We can define value as objectively established or as perceived worth for somebody. In order to highlight the apparent tensions between the monetary and market based value creation and the non-proprietary and collaboration based value creation, we base our discussion on two types of value: *economic value*, defined as the worth of a good or service as determined by the market, and *social value*, which is created when resources, inputs, processes or policies are combined to generate improvements in the lives of individuals or society as a whole (Emerson et al., 2001).

The conceptual distinction between *value generation* (creation) and *value appropriation* (capture) has been growing in importance with the trend towards openness, technical connectivity and collaborative ventures. Value generation materializes when the utility of society's members increases after accounting for the resources used in that activity. Value appropriation materializes when an actor is able to capture a portion of the value created by an activity (Bowman and Ambrosini, 2000). Due to the unique features of OGD, the value that is generated from the use of data is not necessarily exclusively available for appropriation by the owner of the resource, nor even by the value creator. The relationship between the generation and appropriation of the value of multiple stakeholders in the context of alliances is increasingly being viewed to be multifaceted in nature (Sarker et al., 2012). Gil-Saura et al. (2009, p. 595) suggest that value is a subjective, multidimensional construct; accordingly, it is only through a multidimensional view that we get a true picture of the value generated within

alliance relationships. However, despite the recent focus on the creation of value in collaborative settings, little is known about the underlying mechanisms (Sarker et al., 2012). The fundamental transformation towards organizations collectively creating value has raised important new issues that cannot easily be addressed by currently used frameworks in IT value research (Grover and Kohli, 2012).

## **4 Research Strategy**

### **4.1 Research philosophy and method**

The critical realist notion of *generative mechanism* has served as a springboard for our study. The basic assumption of critical realism is the existence of a real world independent of our knowledge of it. The objects and structures of the real give rise to causal powers, called generative mechanisms, which cause the events that we may observe (Bhaskar, 1998). The aim of critical realism is not to investigate the level of events, but rather to uncover and describe the mechanisms producing these events. The mechanisms are associated with the real nature of the underlying objects, and it is thereby assumed that they are relatively stable structures created by an interplay of objects. Critical realists emphasize that causality is contingent - in the sense that the outcome of a mechanism is contextual. In that regard, the observed outcome emerges from the intersection of appropriate pre-conditions, and the mechanisms then act transfactually (Henfridsson and Bygstad, 2013). Furthermore, the critical realist approach identifies an intermediary level of analysis, between pure description and story-telling, on the one hand, and grand theorizing and universal social laws, on the other (Hedstrom and Swedberg 1998).

Due to the emergent nature of open data and their value, the research approach is phenomenon-based with the aim to capture, describe, document and conceptualize the underlying phenomenon, as well as to identify the mechanisms that explain how value is generated through the application of OGD. The investigation of a new phenomenon calls for a relatively unrestricted gathering not only of primary data, for example, interviews, but also of secondary data, for example, news reports or online sources (von Krogh et al., 2012b).

Our study was conducted in five consecutive phases: 1) identification of definitions, concepts and keywords, 2) review of the literature, 3) collection of primary data, 4) creation of a framework with the main types of generative mechanisms and 5) specification of a conceptual model. The literature review aims to: 1) reveal in what ways, and to what degree, the literature has addressed our research question, 2) organize and classify the literature according to the topics covered and 3) identify gaps in the current literature to justify the creation of a new theoretical framework.

### **4.2 Data collection**

First, we conducted a literature search based on the main concepts relevant to our topic: 'government,' 'open,' 'data' and 'value' and various combinations thereof. In order to be comprehensive, we searched for other similar terms that are used in the extant literature, e.g., 'public sector information.' We also collected diverse literature on value generation. We searched for the terms 'value generation/creation,' 'value appropriation/capture,' 'value networks' and 'value co-creation.' We searched in scientific databases, but in consideration of the nescient phenomenon, we extended the search to the blogosphere and popular press. Furthermore, we did not constrict the search to certain disciplines because we aimed to bring together previously disparate streams of work to help shed light on the phenomenon.

Second, we collected primary data from an open government data initiative in Denmark: *The Danish Basic Data Program* (Digitaliseringsstyrelsen, 2012). The obtained data were derived from project documents, nine semi-structured interviews and notes from participation in meetings and conferences related to the project. A short interview guide was used in order to keep the discussion of interviews focused on the topic of value, particularly on what kind of value could be obtained from OGD initiatives and what might be the main enablers and inhibitors for value generation. The nine

interviewees included: four project managers from different sub-projects within the main Basic Data Program; two product owners from a large supplier for public sector IT-solutions and a big user of government data in Denmark (KMD); one consultant and open data evangelist from the Netherlands; one project manager from the municipalities' common IT/project organization (KOMBIT), who was also a participant in the program; one representative from the ministry that provides property data and one representative from the organization that collects and provides geographical data. All interviews lasted between one and two hours, and were conducted consistently by one researcher.

## **5 Findings and Analysis**

### **5.1 Generative mechanisms for OGD value**

Mechanisms can be portrayed as small pieces of theory that specify how a given input will reliably create a specific output (Hedstrom and Swedberg, 1998). Mechanisms do not merely describe what happened but also how it happened, thereby allowing us to see beyond the surface-level description of a phenomenon. Mechanisms may be classified on three levels: contextual mechanisms (macro–micro level), action-formation mechanisms (micro–micro) and transformational mechanisms (micro–macro level). The latter type explains how different components interact in order to produce an outcome at the macro level (Hedstrom and Swedberg 1998). In this paper, we focus on the transformational mechanisms as socio-technical mechanisms, i.e., generative mechanisms that are triggered by the interaction of social and technological constructs. Our aim was to explain *how* use of OGD can generate value and *what* contextual elements may lead to a desired outcome.

In order to identify the main generative mechanisms, we conducted a wide search that focused on various operational definitions of open government data. We found that two distinct ideologies drive most open government data initiatives: the 'Re-use of data' perspective and the 'Open Government' perspective. We thus reviewed the respective tensions and contributions of these two unique streams. The literature on re-use of OGD is mostly focused on the *economic value* of government data, often in connection to the European PSI-directive (Janssen, 2011). The literature in the context of Open Government is mostly derived from Obama's 2009 Open Government Directive, and, in a higher grade, is directed towards government policy that is centered around how use of OGD can contribute to the generation of *social (or public) value* in collaborative settings (Linders and Wilson, 2012). The emergent open government movement is said to offer the possibility to reconcile the divergent paths of e-democracy and e-government by creating shared understanding, using new sources of expertise and building civic capacity (Harrison et al., 2011). However, the OGD discourse is increasingly citing both social and economic reasons for opening data, and the principles of supplying data for open government and re-use are converging (Janssen, 2011).

Through the lens of economic and IS-based theories on value generation, we were able to identify four distinct generative mechanisms that can explain how OGD enable generation of value. Two mechanisms were extracted from the Open Government literature: *transparency of government* and *citizen participation/collaboration* (Cordis and Warren, 2012; Harrison et al., 2011; Linders and Wilson, 2012) and another two from the Re-use literature: *efficiency* and *innovation* (Gigler et al, 2011; Halonen, 2012; Jansen, 2011). Commonly discussed barriers to value generation in both streams are: 1) closed or inaccessible datasets, 2) lack of comprehensive data policies, 3) lack of validity, completeness and exhaustiveness of datasets, 4) insufficient metadata, 5) lack of consistency in cross-border access regimes, 6) lack of motivation within public sector, 7) lack of technical and semantic interoperability between governmental systems and datasets and 8) too fragmented and disparate open data community (Davies, 2010; Dawes, 2012; Halonen, 2012; Janssen, 2011; Lee and Kwak, 2011; Mayer-Schönberger and Zappia, 2011; Zuiderwijk et al., 2012).

Finally, we looked for barriers to value appropriation and identified the following: 1) lack of technical ability to extract value from data, 4) the digital divide and 5) power differences between data users and unequal access opportunities (Bertot et al., 2010; Halonen, 2012). In order to overcome these barriers, we propose that governments should focus on three enabling factors: open access, data

governance and technical connectivity that apply to all four mechanisms, as subsequently described in section 5.3.

## 5.2 Strategic framework

We use a two-by-two matrix to represent the strategic framework of the generative mechanisms that explain how OGD can generate value (Figure 1). The framework spans the boundaries between the public and private sector, as well as the different types of strategic focus of OGD initiatives (Harrison et al., 2011; Janssen, 2012). The horizontal dimension focuses on the *sector* that generates value through OGD initiatives, spanning between public sector-based initiatives (e.g., efficiency and transparency of public services) and private sector-based initiatives (e.g., innovation and e-participation.) The vertical dimension focuses on *value*, spanning between OGD initiatives that are focused on the generation of social value (e.g., strategies focused on the softer measures of transparency, participation and collaboration and directed towards citizens) and economic value (e.g., re-use of data strategies focused on the monetary benefits that are expected to arise from increased efficiency and creation of new services and businesses). We now discuss each of the four types of generative mechanisms in greater detail.

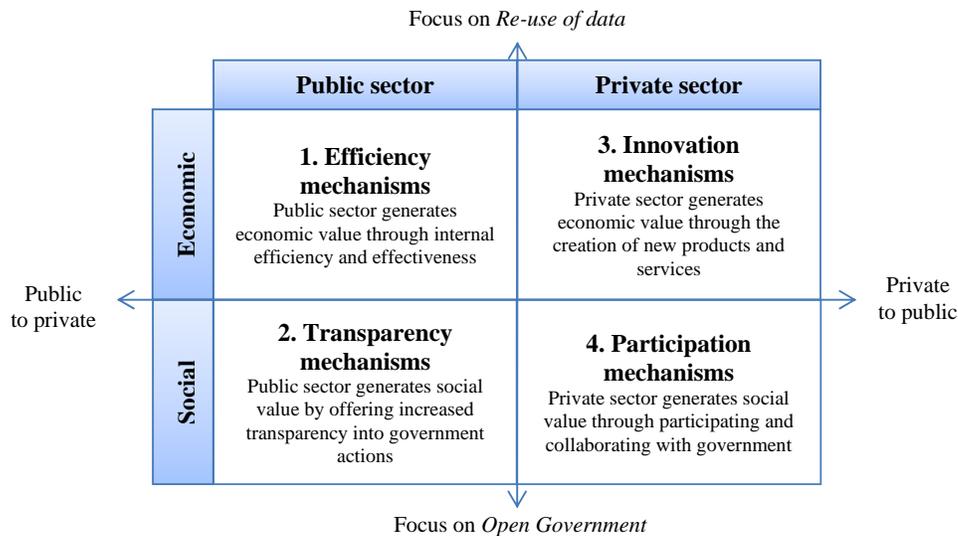


Figure 1: Strategic framework of four archetypical generative mechanisms

### 5.2.1 Efficiency mechanisms

The efficiency type of generative mechanisms enables value generation by better utilizing current resources. The general economic theory that describes how this mechanism works is *Transaction Cost Economics*, where value is generated by reducing transaction costs in operations. In the case of OGD, such transaction costs might be incurred by keying in the same data many times, saving the same data in multiple repositories or by charging for the data. The creation of more effective methods of collection, management, distribution and use of data can create direct and indirect cost-savings. In these instances, the strategy that drives value generation is motivated by the vision of a more efficient government. Moreover, these types of initiatives also have the capability of generating value for the private sector through more effective public services. As an example, the transaction costs incurred by selling and delivering geographic data to users in Australia before data were made freely available online in 2002 were estimated to be between 17 - 33% of the revenues. Assuming that transaction and access costs of users mirror those of the agencies, the net private cost savings may have been around \$1.7 million annually (deVries, 2012).

The Danish authorities have recently initiated an OGD project (the Basic Data Program), where the aim is to generate economic value through more efficient collection, dissemination and use of

government data. The number of basic data registers will be reduced from five to three and master data will be synchronized via a common data model. A common platform (where both public and private users can get access to the same, high-quality data) is being implemented. As a result of these changes, the possibility for automated business processes across authorities is greatly increased. Furthermore, as data will be freely available online, transaction costs related to user support and billing should also be diminished. The total yearly savings for the public sector are projected to be around €35 million (Digitaliseringsstyrelsen, 2012).

The focus of the Danish authorities is on initiatives that can become part of the public data infrastructure and that have the potential to induce collective savings either directly or indirectly via ripple effects through private enterprises. Moreover, the positive external effect from public initiatives that yield integrated government data of better quality also benefit various private sectors, such as real estate agencies, insurance companies, financial services and the telecom companies, which previously had to spend significant resources on creating usable information from heterogeneous data-sources. The cost-savings for the private industry are estimated to be around €65 million per annum.

### **5.2.2. Innovation mechanisms**

This type of generative mechanisms generates value through *transformational effects*, where data are supplied as a service or leveraged in applications in ways that are new and innovative. Innovation is the source of value creation in *Schumpeter's economic theory*, bringing about novel combinations of resources, new production methods, as well as new products and services, which, in turn, lead to the transformation of markets and industries, thus increasing value. An example of the positive effect of providing government data to the private sector can be found in the Netherlands, where openness and technical availability of meteorological data with an emphasis on data governance has led to the creation of a competitive and innovative private weather market. Impacts include 400% increase in turnover for private sector re-users, 250% increase in high-end users, a rise in the use activity of re-users of 300% and an increase of over €35 million on corporate tax returns (deVries, 2012).

One specific example of the innovative combination of map data with data on drug prescriptions can be found at <http://www.prescribinganalytics.com>. This website was collaboratively created by a group of NHS doctors, academics and a big-data analytics start-up company, Mastodon C. Their analytics show how prescriptions of statins, drugs used to lower cholesterol, differ between different municipalities in England. The entrepreneurs used open prescriptions data made available by the NHS in the UK, and combined them with geographic data. They used modern data analytics to produce a visualization map showing the different proportions between expensive (branded) and inexpensive (generic) statin prescriptions in different counties. Wherever the proportion of branded items were high, it represented a potential to make big savings by switching to a generic form of the same drug. According to their analysis, if two thirds of the proprietary drugs had been substituted with generic forms of the same drugs in the year to June 2012, public healthcare in the UK could have saved £200 million pounds. In this case, the innovative use of OGD, enabled by open access to reliable government data and use of technology, has generated economic value that can be appropriated by entrepreneurs as well as the UK government, subsequently improving their healthcare services.

### **5.2.3. Transparency mechanisms**

This type of generative mechanisms enables value generation by information effects. The general economic theory that explains how value is generated is based on the concept of *Information Asymmetry*. Information Asymmetry describes situations where one party has more or better information than the other while participating in transactions, negotiations or communications. Information asymmetry can cause all sorts of sub-optimal results and behaviors, such as *Moral Hazard*, where the more informed make decisions on their own benefits, with the cost falling on others. In the case of government, the consequences of misuse of public power for private benefits can be particularly dire for society in general. While empirical studies have given conflicting evidence on the relationship between transparency and corruption, the results of a recent study show that corruption conviction rates almost doubled when Freedom of Information Act (FOI) laws were strengthened in various states in the US (Cordis and Warren, 2012).

The promise of openness is to provide a source of pressure that counteracts the tendency of technology enactment to reproduce existing rules, routines, norms and power relations, despite the new and innovative capabilities introduced by these technologies. However, this promise can only be fulfilled if open government changes the nature of relationships between stakeholders and governments, thereby producing innovative forms of organizing that enable groups to link across organizational boundaries and functions (Harrison et al., 2011). One such transparency agenda for tackling poverty in the global economy was presented by the British Prime Minister, David Cameron, in the G8 meeting at the World Economic Forum in Davos in January, 2012. The plan is to tackle: illicit financial flows, the hidden company ownership that makes such flows possible, land grabs, and the secrecy by which big oil, gas and mining corporations are doing business. The claim is that citizens in developing countries are regularly robbed of the benefits of their countries' mineral wealth through poorly negotiated or corrupt backroom deals. In this case, open access to government data on company ownership, natural resources and tax information - combined with technical connectivity and governance - could enable greater cross-boundary transparency, which is the mechanism that could uncover corrupt practices, subsequently generating social value that could be appropriated by governments and citizens alike.

#### **5.2.4. Participation (and collaboration) mechanisms**

This type of generative mechanisms generates value through the *positive effects of scale*, where openness and sharing enable value generation drawing from a larger pool of resources. In the case of OGD, the generative mechanisms of *participation* lead to improved citizenship and collaborative behavior through crowdsourcing activities. A similar theoretical argument is used in the literature on *Open Innovation* (Chesbrough et al., 2006) where the principal idea is that an open approach to sharing knowledge across boundaries expands the firm's innovative potential, as the firm is able to tap into a much larger pool of ideas and find such ideas faster. But what drives individuals and organizations to share their resources without direct monetary reimbursement? The answer might lie in the notion of social value. A substantial amount of academic work has theorized about, and empirically examined, the motivations of those contributing to the development of Open Source Software, where it is argued that individual motivation should not be looked at in isolation, but in interplay with institutions, goods and the social practice: "...people's pursuit of visible carrots is at times interrupted by the larger quest for the invisible gold at the end of the rainbow" (von Krogh et al., 2012a, p. 671).

Participation in the context of OGD focuses on engaging the public to inform government solutions and decision-making. This can take two discrete forms: 1) collecting opinions (citizen engagement) and 2) collecting ideas and solutions or crowdsourcing (Linders and Wilson, 2012). An example of the former mechanism can be found in Iceland, where the public sector turned to the private sector to create and vote on a draft for a new constitution by using open data, the enabling social media technologies and open data governance. A good example of citizen collaboration is the crowdsourcing activities that have been immensely helpful in natural disaster incidents, such as hurricane Katrina and the earthquake in Haiti (Lee and Kwak, 2011). Just a few hours after the earthquake hit Haiti in January 2010 the OpenStreetMap (OSM) Community began tracing roads from imagery that was previously available from Yahoo. Within 48 hours high resolution imagery taken post-earthquake became available and in the first month over 600 people added information to the OSM. OSM communities have continued to work with NGO's and the Government of Haiti to further develop the OSM data. The collaboration between public and private stakeholders around data creation and collection is enabled by access to open data, the OSM technical platform, as well as the OSM community's access to and knowledge about geo-data. This collaboration is generating social value, appropriated by the Haitian government as well as the citizens of Haiti.

### **5.3 Conceptual model**

An interesting finding that emerged from the study is the understanding that opening government data is not in itself sufficient for value generation. A number of barriers have to be overcome in order to enable the mechanisms that allow for value generation. Accordingly, we propose that the key *enablers* for OGD value generation are as follows: open access to data, data governance procedures

and technical connectivity. Furthermore, we propose that the synergies created by the interacting mechanisms and cross sector collaboration enhance the generation of value, thus allowing both sectors to appropriate the generated value. We offer a conceptual model that depicts the relationships between the three enabling factors of ODG, the four generative mechanisms, and the resulted social and economic value (Figure 2).

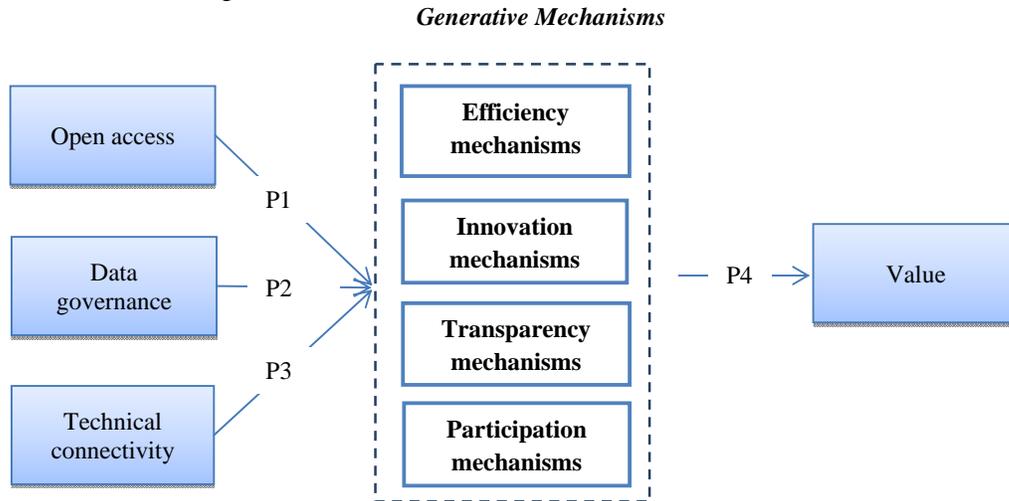


Figure 2: Conceptual model of OGD value generation

### 5.3.1 Open access

Open access to government data is a composite construct that represents the use of *open access licenses*, the *availability* of OGD and the *accessibility* of OGD. The current literature, as well as anecdotal evidence, supports the proposition that opening government data enables the generation of social and economic value. Thereby,

**Proposition 1:** *Open access to government data has a positive effect on the Generative Mechanisms.*

### 5.3.2 Data governance

Data governance is a composite construct that describes the actions and policies needed in order to provide the efficient dissemination of data of good quality and usefulness, as well as the sustainable and equitable dissemination of these data. Unknown, inconsistent or unsatisfactory *quality* of OGD leads to substantial risks for validity and relevance. *Relevance* of the data can be increased if organizations carefully consider which datasets support the strategy of the initiative (Lee and Kwak, 2011). It is important to give the correct context to the data, as government data are in many cases collected or created for specific purposes, and thus could be misleading if taken out of that context (Dawes, 2012). Accordingly, use could be stimulated if more information about the way open data are collected and processed were to be provided by including metadata (Zuiderwijk and Janssen, 2012). Citizen’s access to the Internet and their ability to utilize the provided information are important for ensuring *equitable* dissemination (Bertot et al., 2010). Finally, governance must also ensure the *sustainability* of the resource, and therefore includes the creation of sustainable business models that enable the government to guarantee the continuing collection of data (Hess and Ostrom, 2006). We propose that OGD is a common (public) resource and argue that resource governance is an enabler of all mechanisms that generate value from OGD. Thereby,

**Proposition 2:** *Data governance has a positive effect on the Generative Mechanisms.*

### 5.3.3. Technical connectivity

Technical connectivity is a composite construct that describes the availability and usability of a technical infrastructure that allows users to access and combine the data. The technological backbone

of any OGD initiative is an infrastructure that facilitates data exchange between government agencies and the public (including telecommunications infrastructure, connections between front-end web interfaces and back-end information management systems, system interoperability between agencies or government levels, and adequate availability of hardware and software within government bureaucracies) (Gigler et al., 2011). Moreover, governments have to consider not only the technical infrastructure as a tool to ensure availability and accessibility of data, but also the need of users to be able to understand and use the data as well as the technologies through which data are disseminated (Bertot et al., 2010). Schematic heterogeneity and lack of consistency can decrease usability and complicate access and integration of the data. Due to the decoupling of data from its original creation context, it is the semantic interoperability, identity resolution and ontologies that are central methodologies to ensure consistency and meaningful results and allow third parties to connect different data-sources (Alani et al., 2007). All of the identified mechanisms depend on the dissemination of data via technical platforms. Furthermore, the ability to access these platforms and to make sense of the data for different purposes is also supported by technology. Thereby,

**Proposition 3:** *Technical connectivity has a positive effect on the Generative Mechanisms.*

#### **5.3.4 Generative mechanisms**

Finally, the generative mechanisms—efficiency, transparency, innovation, and citizen participation—also form a composite. We suggest that when the different generative mechanisms interact within an open system, economic and social value is generated. This interaction can be encouraged by collaboration between sectors within value networks. Value networks are important to facilitate the sharing of not only data, but also information, know-how and other resources. In this way, value enhancement can happen, where value is extended to network participants within the value network. While value networks around open data have still not emerged to the same extent as that in the world of Free/Libre Open Source Software (Mayer-Schönberger and Zappia, 2011), communities such as the OSM and the proposed co-operation between governments proposed at the G8 meeting at the World Economic Forum in Davos give promise that we might be on the verge of a new era where governments and private sector collectively generate and appropriate value from OGD. Sarker et al. (2012) term this phenomenon, Synergistic Integration, where value is co-created through amalgamation. Thereby,

**Proposition 4:** *The Generative Mechanisms have a positive effect on value.*

## **6 Discussion and Conclusion**

The aim of this research was to identify the generative mechanisms that enable the extraction of value from OGD. To this end, we synthesized and conceptualized previous work on OGD and value generation and appropriation, and reviewed the identified relationships via the lens of current theories of IT-based value. To return to our research question: *How do open government data stimulate value generation?*, we have proposed four different archetypical generative mechanisms, each of which represents a certain type of cause-and effect relationship between OGD and value. However, we further propose that the highest level of value should be expected where there is synergistic integration between these mechanisms and where both public and private sectors are active in generating social and economic value from OGD. Unfortunately, in the many open data initiatives that we have been able to identify in the last few years, synergies do not seem to have emerged to any great extent. We suspect that the key reason for this deficiency is the prevalent tendency to implement OGD initiatives in silos, with unclear goals and a lack of both appropriate governance and proper enablement of the use of the data.

The contributions of this study to knowledge are as follows: a) the illustration of how generative mechanisms can be used to explain the relationship between OGD and value, b) the strategic framework that depicts different pathways to value generation and c) the conceptual model that illustrates the relationship between OGD, the generative mechanisms, and value. Moreover, the contribution to practice is first and foremost the identification of the factors that can enable (or hinder)

the generation of value with OGD. We believe that the insights offered in this study can be applied, at least in part, not only to OGD initiatives, but also to open data initiatives in private organizations. Open *private* data are also shared resources, and we suggest that the generative mechanisms in these instances are the same: efficiency (consolidation of databases, cross-company automated business processes), open innovation, transparency in company operations, and participation/collaboration as illustrated for example in the open design and open source software communities. The generalizability and validity of the study are inherently limited. As a theory development study, we offer a set of propositions but no empirical validation. Further confirmatory research is required to examine the mechanisms at multiple levels of analyses and various contexts.

We propose that openness is in itself an important enabler to the creation of value from data, as openness enables both the generation and appropriation of value, not only by the organization that owns the data, but also by external stakeholders. However, while openness might be seen to be the necessary condition in this context, it is insufficient on its own. Governments should increase the usability and re-usability of their data by focusing on data governance, where the aim is to ensure the quality and sustainability of the resource and to minimize risk for external users. This requires the use of technical platforms built on open standards that can increase efficiency and allow users the opportunity to link disparate data sources. Finally, governments should facilitate the emergence of value networks around open data in order to support the recursive mechanisms of synergistically co-created value. We suggest that economic markets of self-interested participants aiming to maximize their own value in value networks of sharing and co-creation enabled by openness and technical connectivity have huge potential for all participants. If the synergies between public/private and social/economic domains were to be exploited, we might have the potential for a quantum leap in increased productivity and social progress.

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