Open Government Data Platforms – A Complex Adaptive Sociomaterial Systems Perspective*

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*"When we try to pick out anything by itself,
we find it hitched to everything else in the universe"*
- *John Muir - naturalist, environmental philosopher
and the "Father of the National Parks"*

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Abstract

In this paper we focus on the emerging phenomenon of Open Government Data Platforms (OGDPs), in particular those that provide open performance data to general public. Governments world-wide continue to implement these platforms, aiming to increase transparency and accountability. However, in spite of their positive intentions, ODGPs that provide performance data (e.g. about schools or hospitals) are reported to create serious harmful social effects. While the related literature has reported numerous cases of these unintended effects, the questions regarding why and how they emerge remain open. This is not surprising, given the complexity and dynamics of processes instigated through the use of ODGPs by a very large number of known and unknowable actors. Through a diffractive reading of complexity theories, in particular Complex Adaptive Systems (CAS) and sociomateriality, in this paper we propose a Complex Adaptive Sociomaterial Systems (CASS) theorization of OGDPs. Drawing from a case of OGDP in Australia called My School, which provides open performance data for more than 10.000 schools, we demonstrate how the proposed theoretical lens of CASS enables us to reveal and explain why and how these platforms perform unintended, yet serious social harm. Given that OGDPs are rapidly emerging around the world, our research opens a pathway for a research-informed public discourse about their harmful effects and responsibilities of different stakeholders.

Keywords: Open Data Platforms; Open Government Data Platforms, Open performance data; Harmful social effects; Complex adaptive systems; Sociomateriality; Complex adaptive sociomaterial systems;

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1. Introduction

Driven by a resolute commitment to modernization, transparency and accountability, governments around the world are making their data available to public (Manyika et al., 2013; G8, 2013; UN, 2013). Consequently, very diverse phenomena, such as energy consumption, salary rates, public spending, schools and hospitals performance, are now being 'datafied' (Mayer-Schonberger & Cukier, 2013) and made available on Open Government Data Platforms (OGDPs) (Janssen et al., 2012; Ruier et al., 2017; Danneels et al., 2017).

ODGPs are often considered to be simple Information Systems (IS), such as web-based directories of open data files, or more often, web portals providing data along with simple search and data analysis tools. A typical ODGP, thus enables anyone with public access to find, download and interrogate government data using for example, graphs, charts and visual maps (Laurenco et al., 2013, 2017). A well-known example of ODGPs is the UK Open Government Portal (n.d), which is considered a global leader of the open government movement (Wang & Shepherd, 2020). Similar examples could be found in other countries around the world. Judging by governments' enthusiasm for, and large investments into open data world-wide (G8, 2013; UN, 2016), OGDPs are here to stay.

OGDPs came to exemplify a widely promoted government promise of "a better world for all" (G8, 2013, p.1). This promise is based on a genuine belief that provision of open data will create significant long-term benefits (G8, 2013; UN, 2013). Indeed, prior studies report on various positive effects of these systems and open data they provide. For example, OGDPs are reported to result in significant savings by providing open data on public spending (Lourenco, 2013), real-time traffic data (Croydon et al., 2017) and prescription medicine (G8, 2013).

In this paper, we focus on a particular type of OGDPs that provides open *performance data,* such as performance of schools, hospitals, healthcare and other public service organisations. Prior research outside the IS discipline found that such data platforms create serious harmful social effects for individuals (students, teachers, patients), organizations (schools, hospitals) and the whole social domains (education system, healthcare system, cultural sector) - see for example Smith (1995), Jacob & Levitt (2003), Henrikson, et al. (2011), Berenson & Rice (2013) and Chen et al. (2017). While prior research provides evidence of harmful effects, the questions as to why and how they occur remain unanswered.

The problem of harmful effects is not only serious but also likely to be further exacerbated by international governments' declared long-term commitment to open all government data by

default, except some highly sensitive data, such as crime data (G8, 2013). As stated in the G8 open data declaration, which is signed by all G8 world leaders, these default data sets include "health performance data" and "performance of schools" (G8, 2013, p.9).

So far, IS researchers have shown little interest in OGDPs, let alone in examining and explaining their harmful effects. Moreover, the unintended harmful social effects of these IS are creating a novel challenge for the IS discipline. This is because the IS discipline is yet to offer a suitable conceptualization of large scale societal IS, such as OGDPs, that involve a constantly growing and ultimately *unknowable* number of stakeholders, beyond direct users of open data portals. Moreover, driven by their individual interests and goals, each of these stakeholders is interpreting, reusing, and acting upon 'perpetually constructed' data originally sourced from OGDP, in their own contexts and based on their own interpretation. In such a way they impact on other stakeholders of OGDP, by shaping their reuse of data and their goal-oriented acting based on their interpretation of data, with implication for a social domain, such as education or healthcare. As a consequence, the stakeholders of OGDPs not only affect each other, but also the social domain itself in unpredictable ways.

We argue that these characteristics of OGDPs challenge the traditional conceptual foundations of IS. In particular, (i) the substantialist ontology of IS, which sees an IS as a self-contained entity, which consists of a set of predefined and self-contained components/parts (entities) described by their properties; (ii) the notion of predetermined "IS users" limited to those accessing and using IT applications (a web portal providing open data); (iii) the "organizational container" view of IS, with the boundaries of the system and the respective responsibilities being determined by the organizational boundaries; and (iv) the realist view of data as objective representations of the real world (see e.g. Demetis & Lee, 2016; Wand & Weber, 1990; Weber, 2012).

It is important to note that these conceptual foundations of IS have been challenged, both individually and in different combinations, by a growing number of IS researchers, who question their fundamental assumptions (see Cecez-Kecmanovic et al., 2014; Jones, 2014; Mazmanian et al., 2014; Orlikowski, 2007; Østerlie et al., 2012; Riemer & Johnston 2014, 2017; Scott & Orlikowski, 2014; Robey & Mikhaeil, 2016, Schultze, 2017). While their work provides important insights into a sociomaterial nature of IS that are relevant for OGDPs, no coherent conception of IS has been proposed to help understand how this class of society-wide IS, which are developed with the best intentions to benefit citizens and society, turns out to perform demonstrably harmful social effects. Given that OGDPs are widely adopted and growing, a new theorisation of OGDPs thus becomes an urgent challenge for IS.

In this conceptual paper we aim to develop a better understanding of OGDPs and in particular propose a new theorization of society-wide IS such as OGDPs, which can explain why and how these systems perform harmful effects. To achieve this aim, we draw from complexity theories and sociomateriality, or more precisely by reading them diffractively, one through the other (inspired by Haraway 2004/1992 and Barad 2007), we propose a novel theorisation of OGDPs as Complex Adaptive Sociomaterial Systems (CASS). We focus on a particular stream of contemporary complexity theory developed by Merali (2006), Merali & McKelvey (2006), Benbya & McKeley (2006); Benbya et al. (2020), and its key concept of Complex Adaptive Systems (CAS), which in this complexity stream is ontologically compatible with sociomateriality. On the other hand, our consideration of sociomateriality, which is characterized by relational ontology and process thinking, has been informed by the growing IS research stream that includes Cecez-Kecmanovic et al. (2014), Cecez-Kecmanovic (2016), Jones (2014), Mazmanian et al. (2014), Orlikowski (2007 2010), Østerlie et al. (2012), Riemer & Johnston (2014, 2017), Scott & Orlikowski (2014), among others. By drawing from an example of OGDP we illustrate how the proposed theorization can be used to reveal and explain the instances of unintended systemic harm and the associated responsibilities.

This paper makes two key theoretical contributions:

1. It identifies and draws attention to a new class of IS, Open Government Data Platforms, that provide performance data to public, with unpredictable and unintended harmful social effects.
2. It proposes Complex Adaptive Sociomaterial Systems (CASS) – as a theoretical foundation for understanding OGDPs and explaining why and how they create harmful social effects.

The main practical contribution of this research comes from providing a conceptual grounding for recognition of, and a more productive public discourse about harmful effects of OGDPs that provide open performance data. A better understanding of the nature of OGDPs, the ways harmful social effects are performed and the roles of its stakeholders, would also contribute to better understanding of their respective responsibilities for such effects. This is an important contribution, given the growing use of OGDPs to make performance of hospitals, schools, universities and other public institutions open.

The paper is organised as follows. In the next section we review the multidisciplinary literature on unintentional harmful effects of various OGDP and a wider class of Open Data Platforms (ODP) not hosted by governments, all providing performance data to public. We also briefly describe the traditional conceptual foundation of IS that are being challenged by OGDPs. In

Section 3, we then articulate a new concept of CASS as a novel theorizing OGDPs. In Section 4 we provide a brief description of an illustrative case of OGDP in Australia, called My School, which provide open performance data on almost 10,000 schools to the public, now for more than 10 years. Drawing from the case, in Section 5 we demonstrate how a CASS theorisation of My School enables us to explain why and how it produces harm to individuals (students, teachers), organisations (individual schools), educational system and the whole society. We conclude with Section 6, in which we reiterate our key contributions, reflect on complexity and complex systems in IS and beyond, and offer a call for further research on ODGPs as important society-wide IS and their effects.

2. Critical Review of Prior Studies

2.1. OGDPs and the reported harmful effects

OGDPs is a subclass of a much larger class of IS called Open Data Platforms (ODP) (Ruier et al., 2017, Danneels, Viane & Van der Bergh, 2017). When ODPs provide government-related open data, they are called Open Government Data (OGD) platforms (Danneels, Viane and Van der Bergh, 2017) or OGDPs. Whether hosted by governments or other organizations, OGPs have shared objectives to achieve transparency, accountability and innovation of services. OGDPs are a particularly critical subclass of ODPs, as the legitimacy of the provider (i.e. government or a governmental agency) leads to their data being perceived as authoritative and objective.

Our review of the related literature from IS and a wide range of disciplines such as eGovernment, public policy, public administration, social sciences, cultural studies, management, healthcare and education, reveals a number of prior studies of various OGDPs and a larger class of ODP that provide performance data. While we recognize their intended benefits, in this paper we focus on their harmful effects. Prior studies conducted outside of the IS discipline, thus offer numerous examples of serious harmful effects of making performance data open to public on various OGDPs and non-governmental ODP, for example in healthcare and education. The reported examples, reviewed in this section, come from the healthcare sector (Marshall et al., 2000; Bevan & Hood, 2006; Chatterjee & Joynt, 2014; Berenson & Rice, 2016; Chen et al., 2017), pharmaceutical industry (Dambrin & Robson, 2011), arts and cultural sector (Selwood, 2009) and education (Smith, 1995; Jacob & Levitt, 2003; Earl & Katz, 2006; Espeland & Sauder, 2007; Henrikson et al., 2011; Dahler-Larsen, 2014; West, 2017; Hartong & Forschler, 2019).

The key issue with these ODPs is that very complex, multi-faceted phenomena such as performance of human experts (e.g. doctors and teachers) and institutions (e.g. hospitals and

schools) are turned into overly simplified 'proxy' data, or what West (2017, p.1) calls 'second-hand representations', typically in the form of numbers. For instance, standardized test results of students are used as an 'objective' measure of teaching performance (Smith, 1995; Jacob & Levitt, 2003; Earl & Katz, 2006; Espeland et al. 2007; Henrikson et al., 2011; Dahler-Larsen, 2014). In the healthcare sector, hospital mortality rates, public ratings of physicians and hospitals by patients (Halladay et al., 2009; Chen et al, 2017), or even patients' biological data such as measures of haemoglobin levels (Brenson & Rice, 2015) are taken as objective indicators of surgeons', physicians', and ultimately, hospitals' performance. These proxy data are then used by administrators 'to speak on behalf' of various stakeholders about the overall quality of the system (Hartong & Forschler, 2019).

Moreover, when performance data are interpreted, taken out of original context and reused for different purposes as well as reinterpreted and recombined with other data in unknowable contexts by an ever-growing group of stakeholders, their meaning become further and further distorted. These practices result in widespread, unintended and ultimately unpredictable effects, including serious harm. For instance, the selection of hospitals based on published hospital performance data, resulted in surgeons' reluctance to operate high-risk terminally-ill patients (Marshall et al., 2000; Bevan & Hood, 2006). Physicians, measured on their 30-day mortality rate, ended up postponing potentially life-saving treatment (Maxwell et al., 2014) and causing "a surprising spike in postoperative cardiac surgery deaths at day 31" (Berenson & Rice, 2016, p.2165). In another sector, public education, publishing school performance data in the UK (Smith, 1995), Denmark (Henrikson et al., 2011) and USA (Jacob & Levitt, 2003) resulted in the disruption of education systems and serious harmful effects for teachers, students and their parents. These examples confirm Hartong & Forschler's (2019) observation, that "the social and technical are not only deeply interwoven, …[these] data practices always have political implications, particularly when applied to systems of (high or low stakes) accountability" (p.10). While these researchers are reporting various harmful effects of OGDPs, research in public administration and egovernment is still predominantly focused on positive effects, as recently reported by Matheus & Janssen (2020). Consequently, there is a need for more research on the negative (i.e. harmful) effects of these platforms (ibid), which we address by our research.

We note that OGDPs and ODPs and their societal effects have been largely overlooked by IS research. As Matheus & Janssen (2020) demonstrate through their comprehensive multidisciplinary literature review, when it comes to open government, the IS field remains focused on technical issues such as "user interface, user experience and data quality" (p.503).

We recognize OGDPs are an important class of IS whose harmful effects are puzzling. As such they require us to revisit the conceptual foundations of IS, as discussed next.

2.2.   OGDPs and the conceptual foundations of IS

Based on the reviewed literature, we argue that OGDPs challenges the traditional conceptual foundations of IS in several important ways. First, OGDPs challenge the widely-used conceptualisation of IS grounded in a substantialist ontology, which remains the dominant ontology in IS (Orlikowski & Baroudi, 1991; Orlikowski & Scott 2008; Cecez-Kecmanovic, 2016; Reimer & Jonhston, 2017). As Schultze (2017) explains: "A substantialist ontology advances a view of the world as a collection of substances, i.e. essential static things, that are more or less able to act under their own power. … Even though the substances are seen as interdependent and relationships among them are examined, such inter-entity engagements are assumed to leave the interacting objects largely fixed and unchanged" (Schultze, 2017, p.61). Based on this ontology, an IS is assumed to consist of fixed, pre-defined stable components (i.e. IS parts), which interact to achieve the set goal. These components are self-contained entities, which can be described by their respective properties (Demetis & Lee 2016, Wand & Weber 1990, Weber 2012). While some properties change, the components (i.e. parts) remain the same entities (e.g. a particular technology or particular social actors).

It is important to note that the substantialist view was adequate for IS supporting well-defined organizational processes and recurring, routine activities with predictable tasks (Cortada, 2004, 2006, 2008). However, its limitations have been recognised by a growing number of IS researchers, who have abandoned the substantialist view, either explicitly or implicitly. Especially in more recent times, as new types of complex and unpredictable IS are emerging, including those enabled by social media, Artificial Intelligence (AI), algorithms, open data platforms, mobile technologies and Internet-of-Things (IoT). The substantialist ontological foundations of emerging types of IS have been problematized by a number of IS researchers, such as Reimer and Jonhston (2013), Robey and Mikaeil, (2016), Schultze (2017) and others.

Second, OGDPs' ongoing society-wide datafication processes also challenge the notion of 'IS users', which is limited to those accessing technology (i.e. web site) in a direct way. These are the users whose requirements a particular OGDP is expected to meet. However, OGDP's open data are propagated and reused through ongoing society-wide datafication processes. Consequently, OGDPs involve a much wider group of social actors, which is not entirely predictable and knowable. The recent IS literature points to harmful effects of society-wide datafication (Markus, 2017; Galliers et al. 2017). While not specifically focused on open performance data or OGDP, this growing body of research on datafication in IS and elsewhere,

contributes to our understanding of harmful effects of OGDPs. However, the underlying mechanisms how harm is performed through datafication remain unexplored.

Third, OGDPs challenge a realist view of data, assumed in the traditional conception of IS. Namely, it is taken for granted that data 'represent' things (with given properties and boundaries) that pre-exists in the real world. It is further assumed that things are represented 'objectively' as they really are in reality (Mingers & Standing, 2018). Thus, the representation of things by data is assumed to be neutral, self-evident and objective (Gitelman, 2013; Ribes & Jackson, 2013). Moreover, the intended meaning is assumed to be embedded in data, and as such is independent of users' interpretation. Hence, by accessing data, the users of OGDPs get the objective and intended meaning about the organizations of interest (schools or hospitals). This relist view of data is at odds with users' ongoing reinterpretation of data provided by OGDPs and the resulting datafication processes (Gitelman, 2013; Ribes & Jackson, 2013; Authors, 2017).

Concluding from these insights into limitations of the traditional conceptual foundations of IS, we can see why they are not helpful in understanding and explaining how the class of society-wide, complex IS, such as OGDPs, continue to perform demonstrably harmful social effects. To address this impasse, we follow the lead of two streams of literature: complexity theories, in particular their key concept of Complex Adaptive Systems (Merali 2006; Benbya & McKelvey 2006; Benbya et al. 2020) and sociomateriality (Cecez-Kecmanovic et al. 2014a; Orlikowski 2007, 2010; Scott & Orlikowski 2014). While both streams address the limitations of the traditional foundations of IS, they do it by offering different conceptual apparatuses, each with distinct strength. Although each can be useful to understand the class of systems such as OGDPs and their social effects, we engage them together, by reading them diffractively, through one another. Through such engagement we propose Complex Adaptive Sociomaterial Systems (CASS) —as a more appropriate and more potent conceptual foundation for OGDPs. In the following section we first discuss them individually and then explain CASS as a conceptual foundation of OGDPs.

3. OGDPs as Complex Adaptive Sociomaterial Systems

3.1. Complex Adaptive Systems

The notion of complexity and the key concept of Complex Adaptive Systems (CAS), which could be traced to biological sciences (Benbya et al. 2020) have been interpreted and used in a variety of ways across different disciplines, such as natural science, social sciences, management, computer sciences and IS. In the absence of a widely-agreed dominant definition of CAS, we base our interpretation of CAS, including its main characteristics, on a

particular stream of complexity thinking as theorized by Cilliers (2004, 2013), Stacey et al. (2000), Stacy (2003, 2006), Merali (2006), Benbya & McKelvey (2006) and Benbya et al. (2020).[1]

Merali (2006) defines complex systems as ''non-linear systems, composed of many (often heterogeneous) partly connected components that interact with each other through a diversity of feedback loops'' (p.219). Complex Adaptive Systems (CAS) are a type of open complex systems, which *adapt* and *evolve* over time in unpredictable and unknowable ways. This conception of CAS, Merali (2006) warns, is different from the engineering and IT systems with predefined components, designed and implemented to operate in a particular way in order to meet the predefined goal, as determined by the design requirements.

Furthermore, following Merali (2006), Benbya and McKelvey (2006) and Benbya et al. (2020), CAS are understood as a type of socio-technical systems that emerge towards unknown and unknowable future states. The non-linear interactions and mutual adaptations among its components (that include both technical and social agents), lead to unpredictable system's behaviour. CAS are open systems as they are constantly interacting with their environment in a mutually shaping manner. Consequently, their boundaries are malleable and as such influenced both by the system's observer and its perceived purpose (Cilliers, 2004). This also means that different observers may perceive the same CAS to have different purposes.

CAS' components are autonomous and loosely connected agents (Stacey et al., 2000). Agents are able to act in response to actions of other agents and are thus assumed to have 'agency' (Choi, et al. 2001). Importantly, in this particular interpretation, CAS' components are never stable nor pre-defined. Instead, they are constantly changing with new ones emerging.

Another important property of CAS is *self-organization*, which is an emergent behaviour, manifested through mutual adaptations of components as well as through ongoing interactions between a system and its environment (Merali, 2006). As Stacey (2003) points out ''[i]t is the very essence of self-organization that none of the agents, as individuals, nor any small group of their own, can directly design, or even directly shape, the evolution of the system as a whole. The impact of any agent, no matter how powerful, on the system is indirect through their local interactions only'' (p.

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[1] It is important to note that this particular interpretation of CAS is ontologically consistent with a sociomateriality perspective, which we adopt to theorize CASS as explained later in the paper.

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267). Consequently, and contrary to engineering systems, CAS' behaviour cannot be inferred from localized behaviours of its agents (Benbya & McKelvey, 2006).

Finally, sociotechnical CAS are now recognized to have a different nature of complexity than physical and social systems. As Benbya et al. (2020) explain:

"While complexity in physical or social system is predominantly driven by either material operations or human agency, complexity in sociotechnical systems arises from the continuing and evolving entanglement of the social (human agency), the symbolic (symbol-based computation in digital technologies), and the material (physical artifacts that house or interact with computing machines)…[D]igital technologies can both mitigate or intensify complexity…This dual effect of digital technologies on complexity can produce dynamic interaction patterns and outcomes that are qualitatively different from those in other complex systems" (p.3).

It is Benbya et al.'s (2020) notion of complexity as 'continuing and evolving entanglement' of the social, symbolic and material that inspired our idea to observe such a complexity through the lens of sociomateriality, introduced next.

3.2.   *Sociomateriality*

The sociomaterial perspective provides yet another distinct alternative to the traditional substantialist view of IS, as demonstrated by a growing stream of IS research (Cecez-Kecmanovic et al. 2014; Jones 2014; Mazmanian et al. 2014; Orlikowski 2007; 2010; Østerlie et al. 2012; Riemer & Johnston 2014, 2017; Scott & Orlikowski 2014; Introna 2019). While taking different philosophical grounding, these researchers all question the substantialist (entitative) view of IS and adopt some form of relational (non-substantialist) process ontology. For the purpose of this paper we draw from a well-established sociomaterial perspective proposed by Orlikowski (2007) and Orlikowski & Scott (2008), based on Barad's (2003, 2007) agential realist philosophy. While a comprehensive account of the sociomaterial perspective is beyond the scope of this paper, we briefly describe its key concepts that are relevant for our theorizing of OGDPs.

The central distinguishing feature of the sociomaterial approach grounded on agential realism (Barad, 2003, 2007) is the assumption that everything exists, and is created through relational processes. This implies that people, things, technologies, do not pre-exist as separate, self-contained entities that then mutually interact and affect each other, as assumed by substantialist ontology. Instead, relational ontology considers 'relations' as primary and 'relata' (entities) as secondary (Barad, 2003). Such relations or relational processes are productive of everything that exists, that we commonly perceive as given in reality. In other

words, everything that exists is not inherently separable but is continually brought into being through relations. Everything that exists is thus in a continuous process of becoming. Relational ontology assumes an open-ended becoming of the world.

To clearly demarcate the becoming of entities through relations Barad (2007) introduces the notion of *intra-action*:

> "The notion of intra-action (in contrast to the usual "interaction," which presumes the prior existence of independent entities/relata) represents a profound conceptual shift. It is through specific agential intra-actions that the boundaries and properties of the "components" of phenomena become determinate and that particular embodied concepts become meaningful" (Barad 2003, p.815, emphasis in original).

In other words, it is through agential intra-activity that entities, humans and nonhumans, their properties and boundaries are continually re-constituted and re-configured. In this sense intra-actions are "causally constraining nondeterministic enactments" (Barad, 2003, p. 823) through which humans and non-humans become differentially constituted, separated and stabilized, although only temporarily. Such differential constitution involves particular inclusions and exclusions, interpretations and materialization, performed by material-discursive practices of intra-acting. Understanding the nondeterministic causal nature of agential intra-actions – involving re-configurations, entanglements, reconstitutions – is important for comprehending human action, agency and responsibility.

The agential realist view of agency departs from the traditional "humanist" view. Agency is not an attribute of either humans or non-humans (technologies). In Barad's words: "Agency is not aligned with human intentionality or subjectivity. … Agency is a matter of intra-acting; it *is an enactment, not something that someone or something has*. Agency cannot be designated as an attribute of "subjects" or "objects" (as they do not pre-exist as such). Agency is not an attribute whatsoever—it is "doing"/"being" in its intra-activity" (Barad 2003, p. 826-7; emphasis added). Importantly, through intra-acting, possibilities for actions are changing, with different opportunities emerging at every moment. This is where we locate accountability and responsibility to act and intervene in (re)configuration of material-discursive practices of becoming. While this is nondeterministic, the dynamism of agency and the changing possibilities for action entail responsibility to act and accountability for the becoming.

Through intra-actions all things happen, become performed through discursive-material practices. When events, entities are 'represented' in such practices (in e.g. data platforms) and then acted upon, the representations are made real, actual. This is happening because it is taken for granted that representations are simple, neutral mappings of given entities (its

properties) into a data set. Using the data set to act thus performs entities as they are depicted by the data set. These are representationalist assumptions that underpin the traditional view of IS. The key issue here is that the material discursive practices of 'representing' are disregarded (Rouse 1996). Actions of representing are material-discursive practices that are performative, As Introna (2019) emphasises," in the ontology of becoming all acts are performative; all performative acts produce what such acts already assume (as pre-existing)" (p. 319).

4. Theorizing OGDP as CASS

Building from the core complexity concept of Complex Adaptive System (CAS) and the sociomaterial theoretical perspective, briefly described above, we propose a novel theorisation of ODGP. More precisely, by reading them 'diffractively' we develop a new concept of Complex Adaptive Sociomaterial Systems (CASS) as a theoretical foundation for OGDPs. Thus, through diffractive reading, inspired by both Haraway (2004/1992) and Barad (2007), we are able to cross disciplinary boundaries and engage with both theoretical traditions. Reading them "through one another" entails respectful engagement with each and together, which as a result lead to CASS as a novel theoretical concept.

The first feature of OGDP as CASS is its *transformative teleology*, which assumes the "*unknowable*" rather than a goal-oriented future. While OGDP are initially designed with particular purpose and goals (e.g. web portals and websites are developed to make certain data publicly available to benefit some citizens or communities), they cannot maintain these predefined purpose and goals. This is because different stakeholders interpret and perpetually reconstruct data which originate from OGDP, in their own contexts, driven by their own goals and purposes. Consequently, OGDPs continuously *emerge* within wider sociomaterial processes, towards an unpredictable and ultimately unknowable future.

Second, OGDPs' transformative teleology can be conceptually linked to *relational ontology*. OGDPs are part of and constitutive of reality that is dynamic and processual in nature. Rather than being a collection of given, self-contained and *static* components that mutually interact (as in substantialist ontology), OGDPs as CASS are enacted through *relations* (Orlikowski, 2010) together with their components, that is, actors. To emphasise that components are not static but enacted, we use the term CASS' (i.e. OGDP's) 'actors'.

Moreover, what is considered to be an OGDP is also constantly emerging as an accomplishment of multiple, ongoing intra-actions, through which both the heterogeneous components and the system are continuously reconfigured and performed. Through intra-

acting, OGDP's components' properties and boundaries are re-configured together with their respective often mutually-inconsistent goals, as they differentially engage and mutually re-construct each other. Through intra-acting they at the same time perform an OGDP, while performing themselves. Intra-acting involves, in the language of complexity, unfolding processes of ongoing actors' mutual adaptation and emergence of new behaviours, which is manifested as OGDP's ongoing *emergence* through *self-organisation.*

This in turn implies that OGDP have malleable, continuously emerging and unpredictable boundaries. Consequently, design of an OGDP as a stable 'whole' is not possible as relations emerge and actors are performed; design of (interventions in) specific components may affect relations and in turn system's emergence in non-linear and unpredictable ways. Consequently, the overall behaviour of an OGDP cannot be controlled by any of its actors (Merali, 2006; Merali & McKelvey, 2006).

Third, we identify heterogeneous actors of an OGDP as a variety of stakeholders including: a government as the owner and regulator of the IT systems (infrastructure, software, databases, rules); public sector organizations from which data are collected and about which performance data are computed and made publicly available via IT systems; and a wide range of organizations, and citizens who (re)interpret and (re)use the data in order to take their own goal-driven actions. An actor becomes a stakeholder when it uses and interprets the data or is affected, disrupted or provoked to act by the data and/or other actors' actions based on their data interpretation. In such a way, the actors become performed in relations – through various entanglements with both data and other actors – that constitute them as OGDP stakeholders. The stakeholders are therefore continuously emerging and cannot be all known in advance.

Importantly these stakeholders, often seen as 'users', are not mere users of data but, as we explained, are the key actors of OGDP. Abandoning the term 'user" and adopting instead a stakeholder, as Markus (2017) suggests, is not a stylistic matter. As actors, stakeholders are active constituents of complex systems, not passive users or consumers of data provided by IT. Markus (2017) warns:

> "To refer to the 'users' of today's complex systems is to invite intellectual errors either by focusing on one category of actors and neglecting the others or by assuming incorrectly that all actors involved with the same technology have similar purposes and practices or experience the same consequences. ... IS datification researchers need to chart the entire constellation of participating stakeholders, regardless of their status as systems users" (p.237).

The intra-acting of OGDP's stakeholders is also localised, because in CAS actors only respond to limited data within their local environment. This localised intra-acting in the language of complexity theory is described as mutual adaptation (Cilliers, 2004). Consequently, actors are ignorant of the behaviour of an OGDP as a whole (Cilliers, 2013). Instead, they perceive the OGDP, only from their own (limited) perspectives, through the prism of their interests and goals. This also means that different stakeholders often perceive an OGDP's overall purpose and goals differently, sometimes even in a conflicting way. To understand overall OGDP behaviour at any point in time it is important to recognize that stakeholders' actions are guided by their individual interests and goals, typically disregarding those of other stakeholders (that they may not even be aware of). The overall behaviour of the system results from numerous ongoing adaptational and emergent intra-actions and thus cannot be determined by studying the behaviours of its individual components as it is done in systems science with various reductionist (engineering) methods of systems analysis and design (Merali, 2006).

Fourth, the concept of OGDPs as CASS also assumes a performative view of data. Unlike realist view of data assumed by the traditional IS view, data are not seen as simple representations or (largely neutral) mappings of things in the world. As things are not seen as static entities with inherent boundaries and properties, any representation of things involves 'fixing' their boundaries and selecting some properties while ignoring others. Data thus 'represent' things in particular ways, from a particular perspective, using particular instruments, tools or techniques, that is, resulting from various *practices of representing* and measuring. For instance, performance measurements of schools or hospitals are based on certain views on schools and hospitals (each having a particular boundary and properties) and assumptions about their 'performance' (including some performance measures and excluding others). In Barad's words representations or "measurements do not represent measurement-independent states of being" (2003, p. 813), rather, that which is represented depends on the practices of representing. Data collected, processed and made open by OGDPs, in CASS view, are therefore not simple, objective, neutral measurements or maps of the real-world phenomena (such as performance of schools or hospitals) but rather result from specific discursive-material practices of representing through which particular exclusionary boundaries and properties are enacted and made real. When an OGDP stakeholder act based on the data that purportedly represent schools' and hospitals' performance (e.g. chooses a hospital for an operation), schools and hospitals become performed as such (e.g. as low or high performing).

Furthermore, particular stakeholders' use and interpretation of the data are performed through intra-actions. As a consequence, specific interpretations or meanings derived from data inform stakeholders' actions and, in this sense, *perform* reality. At the same time, what constitute 'data' is no longer static and predefined, but perpetually re-constructed through intra-actions of OGDP's stakeholders.

Fifth, of particular interest for understanding OGDP behaviour and effects are datafication processes triggered by the provision and proliferation of open performance data (for detailed discussion of datafication mechanisms see Authors, 2017). When a stakeholder interprets and (re)uses the data outside of the original contexts of data collections, the data are de-contextualized, the intended meanings of data are lost and new meanings created. The meanings are further distorted when such decontextualized data are re-combined with data from other sources and then used as 'accurate' and 'legitimate' basis for actions. These datafication processes often lead to selective and strategic use of de-contextualized and recombined data for specific agents' interests leading to further actions, often showing gaming behaviour (Espeland et al. 2007; Chen et al, 2017). These actions, in turn, trigger further actions, contributing to wider and wider cascading effects that are very difficult to trace, let alone moderate and regulate. For example, hospital public ratings impacting on patients' decisions, but also on a physician's unwillingness to operate on high-risk patients, which in turn result in higher mortality rates (Maxwell et al. 2014; Berenson & Rise, 2015).

The above exploration identifies distinct features of OGDPs as CASS and explains how the CASS view enables, and indeed compels, the analysis of emerging sociomaterial processes that constitute OGDP as well as those within wider environment, both producing various social impacts. The CASS view helps us understand how harmful effects are created through unfolding and ultimately unpredictable intra-acting of OGDP's actors in their sociomaterial contexts through goal-driven, localised mutual adaptations, triggered by, and triggering society-wide datafication. Datafication, is also explained as a sociomaterial entanglement involved in CASS. We can see that datafication is performed through ongoing intra-acting, in which one actor's interpretation of data (and potentially re-processing with other data sources), becomes another actor's input. These mutually triggering intra-actions involve unpredictable actors and are uncontrollable. The reality they ultimately perform are uncertain and unpredictable.

Table 1 provides a summary of our proposed theorisation of OGDPs as CASS. In the next section, we introduce an example of OGDP, which we later theorise through CASS.

<Insert Table 1 about here>

An Illustrative Case of OGDP

To illustrate how the proposed theorisation of OGDPs as a CASS contributes to their understanding and makes it possible to explain their societal harm, we draw from a real-life case of OGDP in Australia called *My School* (ACARA, 2020), briefly described in this section[2]. My School was designed and open to public January 2010 with an objective *to support* "national transparency and accountability of Australia's schools, by publishing nationally-consistent school-level data about every school in Australia" (My School, n/d). Behind it, there has been an expectation that transparency and accountability achieved through open data will lead significant improvements in students' educational outcomes (ACARA, 2010, 2020b).

The school-level performance data posted on My School include individual schools' results of the national numeracy and literacy test (known as NAPLAN), administered each year to 3, 5, 7 and 9 year students and collected from the participating schools. At the time it was open in Jan 2010, My School provided two sets of data (2008 & 2009) that were collected prior and through manual processes. Since then it grew to currently provide 13 years of data (2008-2020) on 'almost all' primary and secondary schools (more than 10.000) in Australia (ACARA, 2020, n/p). As such, it is considered to be the most comprehensive and most authoritative source of school performance in Australia (ACARA, 2020). The My School portal also provides various easy-to-use tools for any (unregistered) user to search and compare various aspects of schools' performance over time.

In the public discourse My School has always been referred to as a simple web site, as illustrated by the following statement: *"My School is a website that provides information about nearly every school in Australia, including school finances, enrolment profile, attendance rates and teacher numbers"* (Australian Government, 2020). Moreover, data provided continue to be promoted as "objective, measurable and reputable" (Mocker, 2013).

In spite of good intentions and the expected benefits for everyone in the school system, My School continue to create serious harm not only to the expected beneficiaries but for the society at large. For example, soon after its launch, it created an unprecedented disturbance in the education sector and wider society. The newspapers started to publish 'school league tables' (The Australian Editorial, 2010, Sydney Morning Herald Editorial, 2010). Because they

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[2] A more detailed empirical case study of My School and the associated datafication patterns are provided in (Authors, 2017).

were calculated using the official Government system, My School, the league tables were also perceived as 'official' and 'legitimate' assessments of schools' performance, claimed to be the first of its kind in Australia. Disregarding the fact that school league tables were created from literacy and numeracy test results, schools were labelled 'good' or 'bad' (that is, above average or below average in the table). In response, many parents attempted to move their children from 'bad' schools to 'good' schools causing a chaotic situation in the education system. In the process, some children were stigmatised because they were "coming from bad schools" and their parents seen as not able to offer "better education" to their children (Wyn et al. 2014).

Worryingly, the harmful effects experienced by students, parents, teachers, schools and the whole education system continue to this day and are becoming more and more entrenched. For example, the reported harmful effects for children include increased stress, discrimination and labelling of students based on their test score; Some schools even avoid enrolling disadvantaged students, such as those from indigenous and migrant backgrounds, and students with disabilities; Some are asking parents of struggling students to keep them at home on the test day; Teachers have their reputation at stake and are pressured to 'teach to test'; Some are even given initiatives to teach high-achieving students i.e. 'strong performers' in order to lift the performance of their schools; When applying for jobs, teachers are assessed and labelled based on their 'performance', even in job advertisements; Many are experiencing ethical and moral degradation of their profession; School principals are pressured to improve 'performance ranking' and manage staff by numbers; These effects have now been experienced for more than a decade, as evidenced by numerous reports and publications (The Australian Senate, 2010, 2014; Wyn et al., 2014; Thompson, et al. 2016; Suskin, 2017; Rak, 2018, Cook, 2018; Louden, 2019, AEU, 2019; QTU, 2020).

The labelling of schools and comparisons also continue to this day in various forms and even for commercial purposes. For example, financial and property advisors publish reports on "good value for money schools" (PropertyValue, 2016), while commercial web sites publish their own annual good school guides ebooks (The Good Schools Guide, 2020). Their business models are all based on NAPLAN data published on My School, which they add value to, by their own reinterpretation.

In numerous attempts to address the reported issues, including society-wide harmful effects, My School has been subjected to two Senate Inquiries (conducted for matters of national importance) (The Australian Senate 2010, 2014, Australian Government, 2011) and several subsequent major reviews commissioned by the Australian Federal or State Governments (see Cook, 2014; Zinno & Matheson, 2015; Australian Government, 2015; Louden, 2019,

McGaw et. al., 2020). Yet, harmful effects continue with no one taking any responsibility for them. As noted in the Second Senate Inquiry by an Indigenous educator: "It is curious there is so little engagement by responsible [Government] departments with misinterpretations [of My School data]" (The Australian Senate Inquiry, 2014, Submission 82). This statement remains valid today.

Each inquiry into, assessment of, or review of My School effects, was followed by another round of the reported improvements of the My School website, including for example, a recent major overhaul of the way how school results are presented to its users (Zaglas, 2020). Consequently, significant resources are invested in ongoing improvements of the IT system. The objective of each improvement is to better meet "user requirements", in terms of efficiency of data collection and processing through, for example provision of online tests, more user-friendly tools on My School, better user-interface – as evident from many announcements on the ACARA website from 2010 to present date.

Even when transparency and credibility of data are questioned, due to for example outage of online tests (AEU, 2019), ACARA's responsibility continue to be limited to provision of data with the caveat that *'results should be interpreted with care'*." (AEU, 2019, p.1). Regardless, data are still perceived as objective and authoritative, and as such continue to be used "to make judgements about school and school system performance." (Louden, 2019, p.8).

At the same time, the main objective of improving educational outcomes through transparency and accountability has not been achieved. As reported, "little has changed in 10 years" (Sales, 2017, p.1; Robinson, 2018) and some results "have gone backwards over the past decade" (Martin, 2019.p.1). Publishing school results on My School, Fowler (2017) observes, is "at best useless and at worst harmful" (p.1). It also comes at cost to the wider Australian society. For example, calling the annual reporting on NAPLAN results on My School "the annual bureaucratic extravagance in the name of quality education and transparency", Coulson (2015, p.1) reported its estimated cost to Australian taxpayers in 2015 to be 100 million dollars.

The example of OGDP My School illustrates that technologically-simple provision of open performance data on a government web portal (OGDP) is far from being simple. While ample empirical studies and ongoing government reviews of My School all reported harmful effects, there hasn't been any comprehensive explanation or a shared understanding as to why they continue to occur.

All along, these harmful effects remain unintentional side effects of positive intentions and a genuine belief that My School will bring widespread benefits to schools, teachers, parents, students and the educational system (ACARA, 2010). As stated in a school principal's submission to the Second Senate Inquiry: "How is [My School] created? Not by evil trolls beavering away in subterranean caves, lit by the flickering fires of hell. No. It is created by well-meaning souls who believe they are doing something good for education" (The Australian Senate Inquiry, 2014, Submission 84).

As Thompson, et al. (2016) observe in spite of all interventions (by ACARA) and recommendations (by the Senate inquiries), My School has evolved and continue to evolve in a way no one could predict. Consequently, My School is now seen to have acquired the "life of its own", which "extends well beyond classrooms and schools to the reworking of political and educational systems and the integration of testing data with other data sets created outside of education and beyond the nation" (Lingard et al., 2016, p.15).

Based on evidence presented, we observe that the widely used conceptualisation of My School as a web site, or a simple data platform that provides open data to public, has never been questioned, let alone examined. Understanding such an OGDP from the traditional view of prevents us from recognising, and explaining how and why they create harmful societal effects. In the next section, we illustrate how this could be achieved by theorizing My School as an example of OGDPs, though the lens of CASS.

5. A Complex Adaptive Sociomaterial System (CASS) theorization of My School

Conceptualization of OGDP as CASS, enables us to recognise that harmful social consequences occur through mutually shaping intra-actions of an even growing group of actors all interpreting data and acting upon them in their own sociomaterial contexts. These intra-actions in the forms of adaptations and emergence, also explain why My School has acquired 'the life of its own' (Lingard et al. 2016, p.15). Moreover, entangled with society-wide datafication, widening and ultimately unknowable intra-actions result in an ever-widening boundaries of CASS that now include whole society.

Contrary to the substantivist view, My School as CASS involves actors who are constantly changing not only in terms of their properties, but what they are ontologically. As these actors are not entirely known or even knowable in advance suggests that My School boundary is malleable rather than fixed. Most importantly, these actors are stakeholders, not just 'users' of the My School website who use, interpret and repurpose open data to achieve their own

independent and often mutually-conflicting goals. While ACARA explicitly identifies My School's intended key users and beneficiaries – schools, teachers, parents, and students – and aim to include their representatives in the ongoing consultations about My School functional improvements, it does not recognise a wider group of *stakeholders.* When observed as CASS, My School's stakeholders also include those who are impacted (both intentionally and unintentionally) by other actors' use of data. For example, people purchasing real estate and taxpayers are also impacted by My School data, even though they may not have any connection to the education system or interest in school performance. Based on CASS, we argue that these stakeholders cannot be consulted in advance about their preferred functioning of My School, as it is done with 'user groups' of My School. These stakeholders are not even knowable in advance.

The sociomaterial nature of My School also draws attention to the entanglement of the social and the technological (Orlikowski, 2010; Orlikowski and Scott, 2008) that questions any decision regarding My School design and its 'improvements' based on the isolated consideration of its technology. Moreover, even technical improvements also trigger further adaptation of other actors, with their actions in turn impacting other actors and their actions. For example, following major issues with data collection in 2019, due to the online test outage, ACARA still proceeded to published the 2019 results on My School. In reaction to ACARA's advice to the My School users to, as always, interpret data with care, the Australian Education Union (2019) accused ACARA of using this advice to masking the truth about performance data. They then used this particular case to intensify pressure on federal and state governments to abandon My School and NAPLAN altogether. New technical improvements followed, while other reactions continue. More recently (Oct 2020), and having "exhausted all reasonable efforts to minimise the negative effects of NAPLAN on students, teachers and education generally", (QTU, 2020a, p.1) another stakeholder (Queensland Teachers' Union) voted to ban NAPLAN and cease all related activities "for the reminder of 2020 and the 2021 school year" (QTU, 2020b). This in turn will result in data for all Queensland-based schools not being published by My School, for at least two years. Other state unions are likely to follow, resulting in even more cascading and ultimately unknowable future effects.

My School observed as CASS also reveals its embeddedness within the broad educational field in which My School is continuously preformed as a particular system (actor) with specific effects. The performing of My School simultaneously involves mutually-shaping performing of its stakeholders, some of whom become socially undesirable actors ('bad students', 'bad schools', and 'bad teachers'). The becoming of socially undesirable actors in turn involves a variety of consequences and actions. For instance, some, especially low-ranked, schools seek

to increase their ranking (in school league tables) by putting pressure on 'bad teachers' to improve their students' NAPLAN results. Some teachers respond by allocating more time to teaching-to-test. Some find ways to discourage low-performing students to attend school on test days. As a consequence, students feel discriminated and become stressed and frustrated. These examples illustrate material implications of emerging datafication processes – interpretation, repurposing and reinterpretation of My School open data in educational practices. They also show that the view of open data and their value for intended beneficiaries in isolation from their ongoing propagation, interpretation and reuse by different stakeholders in their own contexts and for their own purposes, is flowed and misleading. The CASS view of My School, on their other hand, enables us to see that open data are not ontologically separable (Orlikowski, 2010) from the becoming of its 'intended beneficiaries', including schools, teachers and students, and other stakeholders.

In spite of being promoted as such, the conceptualization of My School as CASS assumes that the meaning of data is not given and fixed. Instead, the meaning of data is *perpetually* constructed through use and related engagement among agents, depending on their interpretive schemes, interests, goals and purposes. In other words, the meaning of open data cannot be understood if their usages by an emerging group of actors are excluded from view, that is, by reducing My School to the IT system. Referring to My School data, Thompson et al. (2016) tell us "data are expressions of human subjectivity, an expression of the values, sensibilities, processes that lead to their creation, and then the paths that the data lay down for individuals in terms of their choices, actions and acts of enunciation" (224). Consequently, My School data become "performative" as they help make reality they purport to represent. For example, as quality of education and school performance are viewed through the published open data, the highest priority of schools is to improve data, rather than actual practices (Carter, 2017, p.1). At the same time, the reality, viewed though data, is also manipulated (i.e. created) by data. Thus, using My School data, governments (federal and state) and education departments specify exact improvement targets and provide financial incentives for continuous improvement of the measure (i.e. data), rather than the actual practices.

The CASS view of My School makes us question any singular purpose/objective of My School and the claim that it has been achieved. This is clearly articulated in a submission to the Second Senate inquiry: "At present stakeholders have different ideas about objectives and use of NAPLAN. … If a range of stakeholders believe such different things about NAPLAN's purposes, how can a judgement be made that NAPLAN has achieved its stated objectives?" (The Australian Senate Inquiry, 2014, Submission 82).

Our conceptualisation of My School as CASS also offers an important insight that this society-wide OGDP cannot be controlled or directed by a single stakeholder (including Government). As Thompson, et al. (2016) observes in spite of all interventions (by ACARA) and recommendations (by the Senate inquiries), My School has evolved, continue to evolve in a way no one could predict. This means also that a single stakeholder cannot stop these harmful effects. Even if My School portal was closed, My School as CASS will continue to 'live', fed by 'data out there', including various digital repositories (My School 'replicas') established by various stakeholders for their legitimate purposes. This, in turn opens new research questions about the responsibilities for harm caused by My School as CASS, which need to consider the roles and legitimate goals of different stakeholders. We see them as important opportunities for future work.

In summary, conceptualization of OGDP as CASS, thus, enables us to understand and explain how and why these social consequences occur through mutually shaping intra-actions of a growing group of actors all interpreting data and acting upon them in their own sociomaterial contexts. The CASS view of OGDPs also demonstrates the relevance of the IS discipline in addressing emerging phenomena of the digital world, especially in providing theoretical foundations necessary for our shared understanding of the detrimental social consequences of OGDPs for citizens and society. The proposed conceptualization of OGDPs as CASS therefore has a potential to inform the wider public and cross-disciplinary debate and stimulate further empirical studies of these systems.

6. Concluding remarks

In conclusion, we reiterate that OGDPs are yet to live up to their promise of creating widespread social benefits by providing open data (G8, 2013; UN, 2016). While benefits do exist (Lourenco, 2013; Manyika et al., 2013; Luna-Reyes et al., 2014; G8, 2013; Croydon et al., 2017), we are witnessing an alarming lack of understanding of the societal harms created by rapidly emerging OGDPs and other ODPs providing open performance data. Unchallenged, these platforms continue to create harm - all while hiding in our plain site as simple portals "just providing" open data. The challenge we propose in this paper, draws attention to the complexity and performativity of OGDPs and their uncertain and unknowable goals.

Our research makes two key theoretical contributions. First, we draw our collective attention to a rapidly-growing class of IS, Open Government Data Platforms, that provide performance data to public, with unpredictable and unintended harmful social effects. Second, we propose a novel concept Complex Adaptive Sociomaterial Systems (CASS) – as a theoretical

foundation for understanding OGDPs and explaining why and how they create harmful social effects.

Based on recent discussions on complexity theories in IS (Benbya et al. 2020), we argue that the proposed theorization of CASS is an important theoretical contribution to both IS and complexity theories in general. In doing so, we echo Benbya et al.'s (2020) observation that the IS field has an opportunity not only to apply complexity theories, but also to make important contributions to them.

The main practical contribution of our work is in providing a much-needed theoretical grounding for a better understanding of OGPDs and their unintended harmful effects. For example, informed by CASS, a Senate inquiry into My School would have a theoretical grounding for a deeper and socially inclusive understanding of the presented evidence of harmful effects, possibly leading to better insights into stakeholders' responsibilities for these harmful effects.

The vision of OGDP as complex adaptive sociomaterial systems offers a new way of thinking about society-wide IS. It also demonstrates that a conceptualization of IS is not just an intriguing scholarly topic but an increasingly critical practical question, highly consequential for citizens and society. The proposed theorisation of OGPDs as CASS enables us to recognise and explain how IS are engaged in performing new worlds (education system; healthcare system). Based on our research, we claim that while these worlds are ultimately unknowable, the underlying mechanisms are not. The CASS view opens future IS opportunities to study these mechanisms, not only in the context of OGDPs but also in other types of open data platforms providing performance data.

While our research is specifically focused on OGDPs as a subclass of ODP, we envisage future research on CASS in other types of society-wide IS. Especially those causing society-wide datafication. We therefore call for further development and refinement of CASS, a as possible theoretical grounding for society-wide IS and their social consequences.

Finally, in the world of open performance ranking, now found in healthcare, secondary and higher education, aged care, and other public sectors of critical importance for our societal wellbeing, understanding how these well-intended practices result in a long-term societal harm is not only important, but urgent. The research we present here is a reminder of our shared responsibility for making a better world for all.

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Table 1: Conceptualisation of OGDP as Complex Adaptive Sociomaterial System

	Conceptualization of OGDP as CASS
Teleology	*OGDPs are characterised by transformative teleology*: OGDP cannot maintain a predefined purpose or have knowable goals: they emerge through unfolding processes of intra-acting, including self-organization and adaptation, within wider sociomaterial processes;
Ontology	*Relational ontology: OGDPs emerge through relation* OGDPs are dynamic sociomaterial systems with emerging properties and malleable boundaries; they are constitutive of reality that is dynamic, performed and processual in nature; OGDPs are continuously enacted through relations together with their heterogeneous components/agents; intra-acting components/agents enact OGDP while at the same time re-enacting themselves; Design of a 'whole' system is not possible as components/agents emerge through relations; design of (interventions in) specific components may affect some relations and thus other components as well as system's emergence in non-linear and unpredictable ways;
System's users or stakeholders	*OGDP stakeholders* OGDP involve a changing group of stakeholders (not all known in advance) – heterogeneous agents that emerge from relations that at the same time perform OGDP; The stakeholders have different and sometimes conflicting perspectives as to what the purpose and goals of the OGDP are; Stakeholders' actions are guided by their individual interests and goals typically disregarding that of other stakeholders; as stakeholders' actions are mutually influencing their effects on specific stakeholders and the overall OGDP's are not predictable and not always identifiable;
Data	*Performative assumptions:* Data are not simple representations or mappings of things in the real world as any representation of things involves fixing their boundaries and selecting some properties while ignoring others; data thus "represent" things in *particular ways*, from a *particular perspective*, through various "practices of representing"; Stakeholders interpret data based on their background knowledge, interests and goals; different stakeholders thus do not necessarily derive the same meanings from the data;
System's behaviour and effects	*OGDPs' behaviour is unpredictable and unknowable* OGDP's behaviour emerges through intra-acting, involving self-organization and adaptation processes among stakeholders not all predictable in advance, nor knowable in their totality; OGDP's behaviour and effects can be revealed by investigating propagation and reuse of open data (datafication) throughout a society by different stakeholders for their own purposes.