On Complex Adaptive Systems and Electronic Government: A Proposed Theoretical Approach for Electronic Government Studies

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Abstract: Electronic government (EG) is a multidisciplinary research field that has been developing rapidly since its initial conceptualization in the 1990s. It is currently experiencing high levels of growth in terms of scholars in the field, publications, research funding opportunities, and dedicated conferences. Though the field is growing in terms of research output, it does appear that the field is stagnated when it comes to theoretical development. This paper aims to address this stagnation by proposing a new approach for scholars within the field of EG to understand and study the complex issues that exist within the field. In this paper, it is argued that the field of electronic government is, in actuality, studying the co-evolutionary relationship between ICT and government within a changing environment. Thus, by adopting an approach based around complex adaptive systems (CAS) and complexity theory, new insight and potential research directions should become possible.

Keywords: Complex adaptive systems, e-government, complexity

Highlights:
- Provides a meta-analysis of the current state of the electronic government field
- Presents an overview of complexity theory and complex adaptive systems.
- Discusses the current state of the electronic government field and argues that a complex adaptive systems approach to the study of complex electronic government phenomena would be beneficial for the field.
- Provides some initial propositions about what the inclusion of complexity into the field of electronic government means.

1.   Introduction

The academic discipline of electronic government (EG) has been growing and developing as its own research discipline since its initial conceptualization in the 1990s (Grönlund, 2004). This growth has largely been in terms of the number of publications, research in the field, conferences, and academics who self-declare themselves as belonging to the field of EG. Though there has been growth in the number of publications, published research within the field of EG often lacks quality, rigor, does not aim to advance or generate new concepts for the discipline, and lacks any sense of research philosophy, goals, or direction (Heeks and Bailur, 2007). This criticism has been repeated on numerous occasions since this 2007 paper by other scholars as well e.g. (Castelnovo and Sorrentino, 2018; Joseph, 2013; Meijer and Bekkers, 2015; Norris, 2010; Yildiz, 2007).

Though this criticism exists, there are those who argue an alternative. In Scholl (2006), it is argued that as EG is an applied multi-disciplinary field with impact, the presence or absence of theory does not necessarily dictate the importance or relevance of EG as a research domain. Bannister and Connolly (2015) explore whether the criticism about the lack of theory is true and warranted. They note that there is a wide use of 'imported theory' in EG and resist the claim that EG is 'under-theorized'. Furthermore, they question whether or not there even can be native theory in EG and state that "deep theorization of a multi-disciplinary field may not be possible" (Bannister and Connolly, 2015, p.10). This debate is still ongoing. Many top EG conferences have now devoted specific tracks to the development and application of theory in EG which both directly and indirectly explore the nature and validity of EG as a research field.

It does appear to be the case that there is a clear need and interest for research papers that attempt either to argue for or against the relevance and necessity of theory for the field of EG; this paper supports an argument

in the affirmative. Whilst EG is impactful and more of an applied research area than other fields, the importance of understanding the phenomena being studied by scholars of EG cannot be underestimated. These phenomena studied within the field of EG are complex, unpredictable, and non-linear and do not fit within any other discipline (Lips, 2012). Given this situation, it is plausible that the existence of the field of EG is, in fact, necessary, as it provides a way to study EG phenomena within their own unique environment. This is a view that has been also offered by others who note that traditional ways of studying the complex issues within the field of EG often fall short in dealing with the actual complexity at hand (Pardo and Gil-Garcia, 2005).

This paper argues that many of the issues studied by scholars of EG are complex adaptive systems (CAS), and that theories related to this, such as complexity theory, provide new insights and ways of thinking for scholars and practitioners within the field of EG. In line with this, this paper argues for the importance of systemic, holistic, and context-aware approaches in EG studies due to their usefulness in studying complex and open systems. In order to better understand and demonstrate the relevance of this approach to the study of EG, the paper asks the question "How can a CAS perspective contribute to the theoretical development of the field of EG?". By answering this research question, this paper aims to make two core contributions. Firstly, to demonstrate the relevance and usefulness of CAS for the field of EG. Secondly, the paper offers some initial propositions about the nature of EG studies.

2. History and Background of EG Studies

What the field of EG studies is still up for debate. Contributors to the field come from a wide variety of backgrounds (Gil-Garcia, Dawes, and Pardo, 2018; Scholl, 2016, 2009) and this leads to a situation where there is no shared understanding or an agreed upon vocabulary in the field. Unless we have strong philosophically and epistemologically grounded shared definitions, scholars in the field are not actually talking about the same thing. Thus, it is of the utmost importance to begin to develop this shared and agreed upon understanding. In order to explore this conceptual ambiguity, some core papers that discuss and analyze the field of EG are presented in the following paragraphs.

In 2005, Grönlund and Horan published their paper "Introducing e-Gov: History, Definitions, and Issues"; this paper aimed to provide a description of the history of EG and the current research content within the field. The authors note that there are multiple definitions in use for EG research, and that these definitions widely vary based on the background of the researcher, though they note that there is a large information systems and IT research dominance in the field (Grönlund and Horan, 2005). The paper does not state directly any criticisms with the EG field, but it does bring to light the issues which are touched upon in future papers: multiple backgrounds, lack of agreement on definitions and terminology, and a heavy focus on information systems while ignoring important issues such as governance. The authors additionally highlight the importance of continuing to develop a body of theory if EG hopes to develop as a discipline.

In Heeks and Bailur (2007), the authors reviewed eighty-four papers published in Information Polity, Government Information Quarterly, and conference proceedings from the European Conference on e-Government and find that only a single paper used any theory and a majority were based around models or frameworks. Furthermore, none of the 84 papers had any reference to a research philosophy. This controversial paper finds that EG needs to develop its own theory, apply theory from other fields, encourage the use of research philosophy and a movement away from positivist works, and try to develop rigor among EG work (Heeks and Bailur, 2007).

Three years later, in 2010, Grönlund published another review of the EG field, titled "Ten Years of eGovernment: The 'End of History' and New Beginning" where the author states that "there is no explicit EG theory, but there are several definitions" (p. 14). The author notes that there is almost no theory within the EG field and the reason for this is largely due to a strong information systems focus in the field, and due to this information systems focus the importance of organizations, governance, and government is overlooked (Grönlund, 2010). Though the field is likely to continue producing research as new ICTs continue to be invented and applied to government, in order to improve the field must better "understand the relation between technology, organization, and government values" (Grönlund, 2010, p.23).

As many argue that it seems to be true that there is a lack of rigor within the EG field and that when it comes to native EG theory there is little to none, it raises the question of whether EG needs native theory. Opponents of

EG as a research discipline, and the need for theory in EG, may point out that one would be hard pressed to argue that the field has had no impact; if the field is having positive impact on society and government transformation, is theory necessary? Meanwhile, proponents of the EG discipline and the need for theoretical development are likely to argue that in its current shape the EG field needs the development of theory and an increase of methodological and academic rigor.

One of the main reasons for the lack of theory in the EG field is due to the multidisciplinary nature of the scholarly community, which has thus far prevented mutual agreement among scholars about definitions and theoretical constructs. This multidisciplinarity, then, acts as a hindrance rather than a strength and thus encourages to fragmentation within the field. A potential first step to fix this fragmentation would be to adopt a shared set of definitions among EG scholars (this has been discussed in great detail by Waller and Weerakkody 2016). Another potential way to bridge the gap between disciplines would be for EG to adopt theory where definitions are clearly outlined and described so that it could then be applied by EG scholars. EG deals with both IT and government, though this duality is often ignored or forgotten; thus, what occurs, is a large amount of published work taking on a heavy techno-centric and information systems focus that appears to be self-promotional, ignoring the importance of the non-technical aspects of the field such as context, institutional beliefs, or government systems (see, for example, Bekkers and Homburg, 2007; Castelnovo and Sorrentino, 2018; Norris and Reddick, 2013; Pollitt and Bouckaert, 2011; Yildiz, 2007)

Reflecting back on the history and development of EG as a discipline, a research gap does appear to exist. Scholars argue that there is a lack of theory in EG, that more rigorous work is needed, and that the study of EG is complex. Compleixty, here means that relationships are important, systems are important, relationships between parts of the system are important, and that it is not simply about IT and government, but, rather, it is about the relationship between IT and government. If the phenomena being studied by EG scholars are complex, then a theory or lens that can help to make sense of this complexity would be rather beneficial for developing EG as an academic discipline.

3.   Overview of Systems and Initial Propositions

This idea that government is a system and that it is complex is not new. For example, in Aristotle's Metaphysics[1] it is already argued that a system is more than the sum of its parts (Cohen, 2016). It is not possible to understand a system by looking at its individual parts, but only by looking and studying the behavior of the whole is it possible to understand the system. This theme is also constant throughout Aristotle's Politics[2] where the city-state is viewed as a system that exhibits different behavior at different scales (politis, koinônia, and polis) (Clayton, 2019).

Moving forward to the 19th century, Hegel's Philosophy of Right (Hegel, 1820) also discusses this notion, where he describes the State as an evolving organism. To Hegel, the State contains different organs, which all play a role in how a State functions and governs (Duquette, 2018). What Hegel is describing is the emergent behavior of the State as it slowly changes, adapts, and improves how it is governed over time learning from the failures of previous administrations, laws, and experiences.

Other authors have also made a name for themselves when it comes to studying and analyzing the systemic nature of the State, governance, and society. Scholars such as David Easton have proposed a model for analyzing political systems. Easton (1953), proposed that a political system takes inputs (demands and support) and outputs decisions or policies; this system takes place within an environment and the outputs provide feedback to the inputs (Easton, 1953). Niklas Luhmann advances the idea of society as a social system and claims that social systems are autopoietic and exist in their current form due to evolution (Luhmann, 1992; Brans and Rossbach, 1997). There are additional systemic approaches to the study of governance and organization as well, such as: living systems theory (Miller and Miller, 1995), system dynamics (Forrester, 1958, 1968; Meadows, 2008), or cybernetics (Wiener, 1948; Beer, 1972, 1979). Thus, there is a large strand of literature from many different disciplines that all are based around the same idea, which is conceptualized below as the first proposition for this paper:

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[1] http://classics.mit.edu/Aristotle/metaphysics.html
[2] http://classics.mit.edu/Aristotle/politics.html

P1: Government should be thought of as a systemic process, it is made up of many interacting parts, and it is in a state of constant co-evolution with its environment.

In the past, there was an attempt to approach EG development in a linear manner as suggested by the much cited paper by (Layne and Lee, 2001). In practice, this development is not linear and takes place in a variety of different ways. For example, in Estonia, electronic government developed in a fairly bottoms-up manner owing its success to co-creation, informal networks, and active participation from a wide variety of sectors (Kattel and Mergel, 2018). However, this approach differs from those adopted by other countries such as Denmark or the UK where the development has been much more top-down. This is a key point, context matters. Empirical studies within the field of EG should pay careful attention to the unique context and environment that play a role in the co-evolution of the object being studied. This would suggest a more interpretivist or pragmatic epistemology may be useful for EG scholars.

By taking a most contextually aware approach to EG studies, it is possible to notice two things. Firstly, the systemic nature of government implies the existence of feedback loops, which, in turn, leads to non-linear, dynamic, behavior. This dynamic behavior makes the creation of models, reductivism, prediction, and deductive research unlikely to be successful across a wide variety of contexts. Secondly, as these feedback loops and these systems are highly influenced by context, in order to explain some phenomena within the field of EG, one must first create understanding. Though understanding government and theorizing on the topic is hard due to its nature as a complex system, by understanding the system, the simple rules at play, the connections and relations between the agents, the environment that it operates in, and the different influential contextual factors, it is possible to begin to develop a new way of interpreting systemic developments. As electronic government, the object of study rather than the field, is part of government, and as P1 claims that government is a system, we arrive at P2:

P2: Electronic government initiatives will exhibit feedback mechanisms, dynamic non-linear behavior, and are highly influenced by co-evolutionary dynamics.

3.1 Complex Adaptive Systems

Complexity studies and complexity theory provide a different way of looking at and understanding the world (Cairney, 2012; Cairney and Geyer, 2017). Complexity theory sees the world as being made up of many complex systems and provides a toolkit for understanding and looking at said CAS (Bar-Yam, 1999). The study of systems is generally believed to have originated following the work of Ludwig Von Bertalanffy and his proposal for a general systems theory. Von Bertalanffy posited that "the fundamental character of the living thing is its organization, the customary investigation of the single parts and processes cannot provide a complete explanation of the vital phenomena" (Von Bertalanffy, 1972, p. 410), this is the original proposal for the study of systems as we know it today. Systems are more than the sum of their parts; they are made up of elements and interactions, and the interactions lead to the system's function or emergent behavior (Meadows, 2008). Though the proposal for a general systems theory has largely been viewed as a failure (Checkland, 2000), the idea of systems thinking and systems science has led to many new fields, such as cybernetics and complexity. Complex adaptive systems are systems that consist of numerous interacting agents that behave independently, engage is co-evolution, and complex behavior emerges as a result of their interactions (Anderson, 1999; Cairney, 2012). It should also be noted that, in this paper, the authors adopt a more interpretive and pragmatic perspective on CAS, rather than a positivistic (Heylighen, Cilliers, and Gershenson, 2006; Ison and Schlindwein, 2006; Knight and Halkett, 2010).

Though there are many properties associated and ascribed to complex adaptive systems, there tends to be wide agreement at least on the following: Emergence, Edge of Chaos, Co-Evolution, Connectivity, Self-Organization, and Feedback loops (Fryer, n.d.; Janssen and Kuk, 2006). While these properties are now assigned to complex adaptive systems, many of these concepts can trace their origins to other fields. For example, the existence of self-organization and feedback have all been heavily theorized by cyberneticians (Ison and Schlindwein, 2006) and, in the case of feedback, system dynamics has also invested heavily in developing an understanding of this concept (Sterman, 2002).

Though CAS and complexity studies are based on old ideas, they take these ideas and apply them in a new way, offering practitioners in the field a new and diverse way for approaching, understanding, and studying complex problems. In order to begin to use this new approach, it is paramount to understand better the properties that

are often associated with CAS and believed to be necessary parts of any CAS. A brief description of each of these properties follows:

- **Emergence -** Emergence is arguable the most important part of a CAS, this is what happens when a system operates, it is the behavior of the system (Crawley, Cameron, and Selva, 2015), it refers to "the existence or formation of collective behaviors - what the parts of a system do together that they would not do alone" (Bar Yam, 2011) . In order to understand and study emergence, the collective behavior of the CAS must be studied in vivo, or within the system and environment itself (Bar-Yam, 1999).
- **Edge of Chaos -** The term "edge of chaos" was first offered up by a biologist named Stuart Kauffman who found that systems, contrary to popular belief, behave better when they are not structured and ordered (Kauffman, 1991). Adaptive and self-optimizing behavior naturally occurs at the "edge of chaos" as systems here have enough room to respond to shocks in creative ways that is otherwise limited by strict rules and structures.
- **Co-Evolution -** CAS are in a constant state of co-evolution with their environment; if the environment changes it effects the behavior of the system, and this change in system behavior also alters the environment (Anderson, 1999; Kauffman, 1991). These evolutionary changes do not happen in a linear fashion and thus CAS and the relationships within the system may be understood as non-linear (Fryer, n.d.).
- **Connectivity** - All agents within a CAS are connected yet acting independently. These relationships and interactions take place in a non-linear fashion and are governed by simple rules. Looking at the connectivity and relationships is key to understanding CAS (Bar-Yam, 1999).
- **Self-Organization** - CAS are self-organized in a bottom-up process which leads to the idea that CAS are the results of non-linear interactions rather than planning and design (Kaisler and Madey, 2009).
- **Feedback loops -** A CAS is dynamic, receiving both positive and negative feedback on its behavior. Traditionally, the field of system dynamics has made it an effort to understand and study these loops (Forrester, 1994). Feedback loops may be either balancing or reinforcing. Balancing loops focus on moving a CAS towards some objective, for example towards a more favorable evolution, whereas reinforcing loops aim to reinforce changes within the system.

Understanding the different parts of CAS allows for scholars to approach the study of EG in a unique and more informed way.

4. EG as a Complex Adaptive System

It is widely agreed that the ideas of government and governance are complex and a new approach is needed that allows for a better understanding of the new paradigm that is taking shape. Social science fields such as political science and public administration have toolsets, frameworks, and theories for dealing with these environmental and systemic factors, thus it follows that EG could learn from these fields by studying their approaches towards studying and understanding complex governmental phenomena. This is exactly what has been argued in a recent paper by Gil-Garcia, Dawes, and Pardo, 2018, where the authors conclude that there is still much work needed in terms of cooperation between scholars who write about EG phenomena. Interestingly the authors also note that one potential way forth for driving this cooperation is through adopting a systems based sociotechnical approach, as advocated by (Dawes, 2009).

There is a clear call for more cooperation, synergy, and information exchange between scholars of public administration, information systems, and EG, and, at the same time, there are also calls for a more systemic approach to EG. Thus, it is interesting, and yet not surprising, that one area where the application of complexity theory and CAS has been rising over the past years is within the field of public administration. One of the first concrete efforts by a public administration journal to bring complexity and CAS into the field was when a 2008 special edition in Public Administration Review on complexity theory and public management was released. This edition was edited by Geert R. Teisman and Erik-Hans Klijn and contained seven articles that each explore the benefits of complexity theory and CAS for public management research (Teisman and Klijn, 2008).

More recently, in 2017, another special issue has been released by another public administration journal, Public Management Review. This journal was edited by Elizabeth Anne Eppel and Mary Lee Rhodes, the issue notes that there is rising interest in how complexity theory and CAS may be applied to the public administration field and subsequently asks authors to explore how these ideas may contribute to public administration theory and

practice (Eppel and Rhodes, 2017). On the political and policy science side, there is also much work focusing on the application of complexity theory and CAS to the field and how these ideas may generate new understanding of political and policy processes (Geyer and Cairney, 2015). It has been stated that the public policy-making systems are, in fact, complex systems and that one reason policy implementation often fails is due to policy makers' tendency to ignore the policy making environment and the different dynamics that are at play (Cairney, 2012).

One of the most prominent papers discussing the movement from traditional government and governance to the new "E" or "digital" paradigm, is the paper "New Public Management is Dead - Long Live Digital-Era Governance" by (Dunleavy et al., 2006). Here the authors note that public management is a complex system and that, due to the introduction of ICT and digital age technologies, we are currently experiencing an evolution or shift in said system. Specifically, the authors note that ICTs have been introduced into public administration and, as such, have influenced and effected the system in a variety of ways, varying from organizational to cultural changes (Dunleavy et al., 2006). The authors claim that the introduction of new ICTs and digital era technology to the public administration system has led to a phase transition, a change in the state of the system that has changed the system's operation and behavior. In other words, the introduction of ICT and other digital technologies to the environment changed it in such a way that the "governance" system had to respond and "co-evolve" with this change.

Due to the relative newness of the field, a common definition and understanding of what is being studied by EG scholars is still being sought. Table 1 provides three different approaches that have been suggested by scholars as the core focus of EG studies.

Table 1: Different Understandings of the Purpose of EG Research. Source. Author.

Understanding of EG Research	Source
"The purpose and role of government Societal trends Changing technologies Information management Human elements Interaction and complexity"	(Dawes, 2009)
"Information use Technology use Public Policy Government Operations Government Services Citizen Engagement"	(Scholl, 2007)
"Wide social domain including stakeholders in politics, administration and society A wide technical domain not limited to any particular technology A focus on several issues specifically to do with government values, such as accountability, legitimacy, and responsibility"	(Grönlund, 2010)

All three approaches note that the field is quite broad and needs to account for a multitude of different elements, the importance of relationships and interactions between different elements is also highlighted. While discussing his idea of the central research question of EG, Hans Jochen Scholl notes that "transformation is central to the understanding of EG" and that the core questions of EG:

- "have to account for the six high-level variables [information use, technology use, citizen engagement, government services, government operations, public policy];
- have to address their complex interrelationships and the processes between them;
- which typically involve more than one discipline; and
- further important aspects in the relationships between those variables may even fall outside the scope of any one discipline" (Scholl 2007, p. 74-75).

Similarly, Grönlund writes that EG research needs to become "deeper" and devote more attention to the understanding of the relationships between different variables, such as technology, organizations, and government values and that, as a result of this direction of study, EG may be able to better contribute to better

governance (Grönlund, 2010). In Dawes' work, she notes that the EG scholars should take a big picture approach and look at eGovernment as a "dynamic open socio-technical system" (Dawes, 2009). What begins to become clear is that though there is no widely agreed upon research direction and focus inside the EG field, there are certain aspects that appear in multiple understandings. For example, most scholars are likely to agree that the relationships between actors is important in EG research, that a big picture or holistic approach is needed, and that traditional approaches to the study seem to be falling short.

This also mirrors what has been written in both policy studies and public administration. Scholars from those fields have begun to state that governance and public administration may indeed be viewed as a CAS and that by adopting a complexity and CAS based framework new insights could be gained for the study of governance. One potential area where CAS and complexity is likely to provide a large benefit to scholars is when it is applied to the study of wicked problems (Klijn and Klijn, 2008). Scholars also note that the application and introduction of complexity theory may allow a bridge to be built between disciplines allowing for new discussions to take place (Cairney and Geyer, 2017). Though benefits have been touted, many barriers have also been pointed out. One of the most common weaknesses that is pointed out is that there is a need to understand how to operationalize the application of CAS and complexity theory to real-world phenomena (Cairney and Geyer, 2017; Klijn and Klijn, 2008). Secondly, some scholars also wonder if the benefits from CAS are actually realizable, or if, rather, they simply represent hype and represent new terminology for issues that have been understood for some time (Cairney and Geyer, 2017). While taking into account the potential barriers and weaknesses, the potential benefits from CAS and complexity theory for the field of EG should not be ignored and effort should be directed at understanding how they can aid EG scholars.

5.   Discussion

Integrating theories from complexity studies and drawing on core concepts from CAS into the field of EG leads to several interesting propositions. Firstly, one of the inherent properties of CAS is change. To this end, the field of EG should position itself in such a way that it is able to develop as a field and maintain its relevance as, in the future, perhaps the "E" from EG is removed. This is, already, beginning to occur with some scholars saying that EG should be, rather, known as digital government as the "E" in electronic government is often associated with older, outdated, technologies not in line with the current technological environment. One way that the field of EG could do this is by adopting a common definition for the field that is able to retain relevance as technology and governmental systems continue to develop. Such a definition should acknowledge that the field of EG studies complex issues and that a phase shift in the future is inevitable. To offer an initial suggestion, the following definition is proposed:

- "The field of EG studies the co-evolutionary relationship between ICT and government under the premise that this relationship takes place within a dynamic and changing environment".

This definition moves away from the traditionally techno-centric definitions that have dominated the field of EG, and shifts the focus towards relationships, context, environmental factors, and interactions. That is to say, whether we are studying big data or social media or blockchain, it is not necessarily the technology itself that is important, but, rather, how the introduction of such technologies changes the relationships and interactions between agents in the system, and how the environment and emergent behavior of said system adapt and change in response. This idea is supported by the CAS framework where it is noted that individual actors or parts are not likely to tell you anything about the system, but, rather, what must be studied is the interactions between the different parts. Taking these factors into account, it is possible to raise some initial propositions that naturally emerge from adopting a CAS approach in the field of EG. These propositions are:

- Any theory within the field of EG should be compatible with the properties of CAS
- The study of individual parts is not likely to provide new or promising insights to the field of EG, research should rather focus on the whole system, relationships, and emergent behavior
- As CAS operate at the edge of chaos, it is likely that we will see a movement towards less ordered government strategies, such as networked, adaptive, or agile government configurations
- It is unlikely for there to be predictive theory within the field of EG due to the non-linear relationships and evolutionary characteristics of CAS

These propositions may serve as an initial starting point for future research within the EG field that aims to use a CAS framework. One potential area of interest where a CAS framework is likely to already provide a high level of value, is in the study of wicked problems.

Wicked problems are those problems that have no correct answer, description, and their solutions remain aloof (Head and Alford, 2015) (In the context of EG, wicked problems may be related to internet voting, technological literacy, personal data ownership, electronic health records, etc...). There have been arguments by some that new ICTs and digital technologies (such as artificial intelligence and big data) have the potential to create new ways to understand and attack wicked problems (Zhang et al., 2016). At the same time, others have also noted that there appear to be similarities between CAS and wicked problems (Klijn and Klijn, 2008), and have proposed that taking a complexity approach towards wicked problems allows for them to begin to be unraveled (Zellner and Campbell, 2015). When talking about wicked problems, arguably, the seminal work comes from Rittel and Webber where they identify and state that there are 10 main attributes or characteristics of wicked problems:

1. "There is no definitive formulation of a wicked problem.
2. Wicked problems have no "stopping rule" (i.e., no definitive solution).
3. Solutions to wicked problems are not true or false, but good or bad.
4. There is no immediate and no ultimate test of a solution to a wicked problem
5. Every (attempted) solution to a wicked problem is a "one-shot operation"; the results cannot be readily undone, and there is no opportunity to learn by trial and error.
6. Wicked problems do not have an enumerable (or an exhaustively describable) set of potential solutions, nor is there a well-described set of permissible operations that may be incorporated into the plan.
7. Every wicked problem is essentially unique.
8. Every wicked problem can be considered to be a symptom of another problem.
9. The existence of discrepancy representing a wicked problem can be explained in numerous ways.
10. The planner has no "right to be wrong" (i.e., there is no public tolerance of experiments that fail)" (Rittel and Webber, 1973, p. 136-144).

There are obvious overlaps between CAS and the characteristics in wicked problems. For example, "Wicked problems have no stopping rule" and "solutions to wicked problems are not true or false, but good or bad" relate closely to the notion that CAS are in a constant state of co-evolution at the edge of chaos and that they learn and adapt based on positive or negative feedback. What the CAS framework allows for is a way to take the traditional understanding of wicked problems, and translate it into a complex system or problem, keeping the problem intact, while, at the same time, providing a potentially clearer conceptualization of the problem and providing researchers with a new mindset and thought patterns that may allow for new and potential solutions to emerge.

Naturally, there is a follow-up question, which is, how to operationalize the insights provided by CAS and complexity studies. In the case of the field of EG, one of the most likely methodologies to be adopted is case study research; case studies may potentially be beneficial, however, they must make sure to take into account context, time, and look at systems in their own environment (Koliba et al., 2014). Generally speaking, the purpose of studying CAS is to understand the behavior of the system and look at how the relationships and interactions between agents effect the complex behavior of a system (Bar-Yam, 1999). Therefore, other methodological approachmust also be able to take into account non-linear behavior, self-organization, interactions, context, relationships, the simple rules of the system, and acknowledge the time dimension.

6. Conclusion

This article embraces the idea that the field of EG studies issues that are complex, and, as such, puts forth the idea that an approach drawing on insights from CAS and complexity studies will be beneficial for the field. The article initially starts by exploring and providing an overview of numerous meta-analyses that have examined the state of the EG field and the use, or lack thereof, of theory within EG articles. It was noted that one reason or the lack of theory and agreement within the field is due to its multidisciplinary nature. Since the field is multidisciplinary, it would make sense that an approach that is capable of building a bridge between disciplines would aid the EG field, and this paper proposes that CAS and complexity theory can build this bridge. The paper explores the properties of CAS and derives some initial propositions that are applicable to issues being studied by scholars in the EG field. It does indeed seem that CAS and complexity theory are useful for the research of EG scholars and, additionally, for developing the discipline. The proposition that is likely to be the most valuable is as follows: "*The field of EG studies the co-evolutionary relationship between ICT and government under the premise that this relationship takes place within a dynamic and changing environment*". This frames the study of EG in a way where relationships, trends, evolution, and interactions are more important and valuable for the

discipline rather than individual parts. Ultimately, this paper aims to provide the initial foundation for the application of CAS in EG research. Future work is needed, and potentially beneficial directions may include empirical research using CAS as the theoretical lens, native theoretical development that builds off of CAS building blocks, and work that tries to understand and conceptualize the EG system in a concrete form. Once the system is conceptualized, it is possible to better explore and delve deeper into relationships and begin to move towards a point where the EG field may make even more scientific and practical contributions than it currently does.

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