The Human-Information-Processor Model View of e-Government

Full paper

Martin Ndici
Mississippi State University
mng120@msstate.edu

Ali Vedadi
Mississippi State University
av540@msstate.edu

Abstract

Without a universally accepted definition of what e-Government really is, e-Government research has focused on Government e-services; which are but a peripheral part of e-Government. ICT use in provision of Government e-services and the attendant issues are not unique to e-Government; rather, they are part of any other deployment of information systems and technologies.

This treatise is a two-level conceptual discussion in which, first, a proposed approach to defining e-Government using the Stimulus-Organism-Response Model is proposed. And second, a representation of e-Government using the Human Information Processor Model is demonstrated. The cognitive mapping of Government functions onto the Human Information Processor model presents new lenses through which a holistic view of e-Government emerges - with the potential of providing a shared cognitive focal view for e-Government research.

Keywords


Defining e-Government

The term e-Government has not received a universally accepted definition (Almarabeh et al. 2010; Ndou 2004; Yildiz 2007). With a myriad of definitions, e-Government research has either incorrectly specified or taken a narrow view of e-Government as merely the delivery of Government services through information and communication technologies (ICTs), especially the Internet. On the other hand, some research studies have viewed e-Government through the “broadest definition, encompassing all aspects of Government activity” (Field et al. 2003 p. 63) which has the “capacity to transform public administration through the use of ICTs or indeed used to describe a new form of Government built around ICTs” (Field et al. 2003 p. 64).

Ndou (2004) and Yildiz (2007) reviewed several definitions and both noted this lack of a generally acceptable definition as a limitation in e-Government research. However, they do not offer a remedy to the status quo. Instead, Yildiz (2007) calls for a focal shift with a view to improve technology deployment. Conversely, Ndou (2004) mentions three transformational areas (internal, external and relational) and benefits that can result from e-Government.

Given the importance of a clear definition and an understanding of a desired outcome (Pounds 1965), the present study examines these two research questions: (1) Could this apparent lack of clarity as to what e-Government really is have led to diverse conceptualization and implementation (Grant et al. 2006; Ndou 2004) of e-Government programs? And (2) could it also be the reason for failed e-Government initiatives, which have been reported in literature as chaotic and unmanageable (Layne et al. 2001) and characterized by high project failure rate?

This paper presents the point of view that, although definitions may differ in semantics, commonly used and comprehensive definitions bear three common elements: an existing Government, a set of problems,
and interaction between the Government and its constituency. These common elements should then be the basis of defining e-Government. Table 1 samples commonly used and comprehensive definitions.

<table>
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<th>Definition</th>
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<td>1. The term &quot;e-government&quot; focuses on the use of new information and communication technologies (ICTs) by governments as applied to the full range of government functions. In particular, the networking potential offered by the Internet and related technologies has the potential to transform the structures and operation of government.</td>
<td>OECD Field et al. (2003)</td>
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<td>2. &quot;...government use of information communication technologies to offer for citizens and businesses the opportunity to interact and conduct business with government by using different electronic media such as telephone touch pad, fax, smart cards, self-service kiosks, e-mail / Internet, and EDI. It is about how government organizes itself: its administration, rules, regulations and frameworks set out to carry out service delivery and to co-ordinate, communicate and integrate processes within itself.&quot;</td>
<td>Almarabeh et al. (2010) p. 30</td>
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<td>3. Electronic government refers to government’s use of technology, particularly web-based Internet applications to enhance the access to and delivery of government information and service to citizens, business partners, employees, other agencies, and government entities. It has the potential to help build better relationships between government and the public by making interaction with citizens smoother, easier, and more efficient. Indeed, government agencies report using electronic commerce to improve core business operations and deliver information and services faster, cheaper, and to wider groups of customers.</td>
<td>Layne et al. (2001) p. 123</td>
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| 4. 'electronic Government' means the use by the Government of web-based Internet applications and other information technologies, combined with processes that implement these technologies, to—  
   (A) enhance the access to and delivery of Government information and services to the public, other agencies, and other Government entities; or  
   (B) bring about improvements in Government operations that may include effectiveness, efficiency, service quality, or transformation | E-Government Act of 2002 § 3601. (3)                  |
| 5. “...the use of ICT tools to reinvent the public sector by transforming its internal and external way of doing things and its interrelationships with customers and the business community.” | Ndou (2004) p.3                                       |

Table 1 – A sampled commonly used definitions of “e-Government”

Regardless of words used in a definition, to completely define e-Government, it should encompass an Information System that applies and utilizes technologies for/in:

1. **An existing Government.**  
   Government existence is independent of technology and the definition of a form of Government should not be coupled with a specific technology (Yildiz 2007). In e-Government, ICTs are being deployed to transform Governments so that they can better fulfill their *raison d’etre*, yet they come to be through political means and their existence heavily influenced by politics (Bekkers et al. 2007).

   Inclusion of the existing Government in defining e-Government should be to focus on governance benefits associated with e-Government such as improving the setting of objectives, improving the monitoring of performance, greater emphasis on planning, improving management, improving transparency, improving efficiencies, informing Citizens’ choices (Curristine et al. 2007) and
improved accountability (Wong et al. 2004). These benefits will accrue as a result of transformational application of ICTs in governance to form an e-Government entity.

Since technology only impacts (but does not replace) the governance function, the resulting e-Government will only be as good as the existing Government; i.e. e-Government by itself alone cannot be panacea for poor governance (Misuraca 2009). Politicians and bureaucrats will continue to make and change policies and shape development agenda while administrators implement policies in pursuit of the political agenda (Bekkers et al. 2007).

2. A set of problems: Government’s and Citizen’s problems,

Governments, as institutions, are a problem solving mechanism (Bardach 2011). They are normally tasked with establishing and regulating the interrelationships of individuals, groups, and organizations within the boundaries of some territory (Beynon-Davies 2007). Citizens look up to the Government for solutions, but the Government has its own set of problems, such as need for more efficiency, better services to Citizens, and improved democratic processes (Grönlund et al. 2005). These problems stimulate Governments to act in search of solutions, both for its problems and the Citizens’ problems. This creates an important dual role that is significant in e-Government research and practice.

This dualism adds to the complexity and dynamics that e-Governments must address if Governments and Citizens are to benefit from e-Government’s power to transform not just service delivery (West 2004) but the entire Government business (Hazlett et al. 2003)

3. The Interaction between a Government and its Constituency: Government e-services

Successful application of ICT in provision of public services (Government e-services) would not only solve social problem but the duality of issues that face a Government as mentioned above (and indeed the three issues identified by (Ndou 2004). In the process of providing e-services, an e-Government also collects vital data that can be used either inputs to other processes or feedback for organizational learning (Irani et al. 2005).

The orientation of an ICT application can be either push or pull. However, most initiatives have been pull forces as a result of demand (Gupta et al. 2003; Henriksen et al. 2007). The broader e-Government on the other hand – hallmarkd by transformation of Government business – should produce e-services leading to push demand. An example (as a result of internal transformations) could be the Internal Revenue Services (IRS) in the USA implementing an extensive initiative to replace postal communication with online communication (Warkentin et al. 2002).

On the basis of these elements, application of the stimulus-organism-response (S-O-R) model is an apropos conceptual framework. It provides a foundation on which the definition and understanding of e-Government can be erected. As such, a definition that articulates the three elements (within an e-Government function context) should suffice and considered to adhere to the theoretical tenets of the S-O-R model.

![Figure 1 – Proposed basis of defining e-Government and e-services](image-url)

It is worth noting that, like many other models, the S-O-R model can deceptively appear to describe rigid, static, and simple relationships. However, it imbibes a fluid, dynamic process influenced by a multitude of phenomena (Jacoby 2002) – a phenomenon that aptly describes e-Government and its three constituent elements.
Defining e-Government from the S-O-R point of view presents e-Government as an Information Technology artifact, which is a “representation” of an underlying reality (Wand et al. 1993; Wand et al. 2004). Applying the S-O-R model as such not only clarifies the vagueness of definition but also helps us to envision the system as a whole and therefore make approximate predictions of gross system behavior (Card et al. 1983) as presented in the discourse carried in the next section.

**The Human Information Processor Model in e-Government**

Now that an S-O-R conceptualization of e-Government has been established, the second phase in this treatise is to focus on the organism (in the S-O-R model) and ascribe explanatory theory (Gregor 2006) to the organism’s processes involved in receiving and processing stimuli to ultimately respond with appropriate responses.

The relationship between a Government and its citizens is a problem solving relationship as citizens look up to the Government to solve their sociopolitical problems. Management literature (Bazerman 2006; Mintzberg et al. 1976; Simon 1960) portrays decision making and problem solving to be complex and often context-dependent processes that are hard to grasp (Sterman 2006). However, the Human Information Processor (HIP) model (Card et al. 1983) provides a fitting cognitive map in the current quest to explain how a Government goes about receiving, processing, and responding to problems. The HIP model encompasses adequate complexity and thus is an appropriate parallel for the complex Governance structures required in sociopolitical decision making.

Governance is to a large extent political (Gronlund 2005). However, information technology plays a key role in the acquisition, processing and dissemination of information used in the execution of administrative processes, policy formulation and decision making. Heavily researched issues relating to application of ICT in Governments include trust (Bélanger et al. 2008; Carter et al. 2005; Warkentin et al. 2002), technology acceptance, and adoption (Ebrahim et al. 2005; Kumar et al. 2007), privacy (Soliman et al. 2006; Tolbert et al. 2006). However, extant e-Government literature lacks a comprehensive framework to espouse the application of technology in Government to create an e-Government. The HIP model lends itself as appropriate antidote.

In HIP, three subsystems – cognitive, perceptual and motor systems – which work in tandem, are responsible for receiving signals, processing them and responding. We posit that Governments mimic this process in the execution of their mandates and internal problem solving. As such we apply the HIP model as a conceptual model by overlaying HIP’s three interacting subsystems to Government functions.
Figure 2 – The Human Information Processor Model based on, but extending, that of Card et al. (1983)

**The Perceptual System**

In the HIP model, the perceptual system is described as the system responsible for carrying sensations of the physical world (detected by the sensory system into internal representation of the mind) by means of an integrated sensory system (Card et al. 1983). The visual system is an excellent example to elaborate. The retina is sensitive to lights intensity, wavelength, and other characteristics, which it then codes for the cognitive system to decipher and respond appropriately. An organism has multiple specialized and independent perceptual organs, which are loosely coupled and as such can influence each other (Gureckis et al. 2006). They engage in operations of the collective (the organism) as well as operations of the individual (the single system). Communication between them is more or less indirect and dynamic.

In e-Government, this would refer to Departments that make up a Government. Each has a specialized function and enjoys a certain level of autonomy, but at the same time each relies on other Departments. As in the human model, operation of the collective and the operation of the individual are dynamic and capable of being explained through the S-O-R model.

To function, the perceptual system has processors and memories. This is logical because they are specialized and differentiated and thus should have capacity for independent operation. For instance, the Department of Agriculture has a different mandate from the Department of Health, but both serve Citizens under one Federal Government. As they perform their tasks over and over, learning is expected to occur and a localized memory exists to store the learned perceptions. This localized memory is also a short term buffers for data received as they are being encoded for transmission the cognitive system or to the motor system.

When likened to e-Government, the localized memories would be the collection of specialized knowledge within a department. That knowledge influences the data that is being transmitted between the federal government and departmental agencies, and vice versa. Card et al (1981) demonstrates the functioning of perceptual system using eyes and ears which pick up sensory signals from the environment and encodes them for the cognitive system. Similar to the specialization of eyes and ears, Government departments are specialized and are designed to work in a similar fashion. Such a view of the impact of technologies deployed in receipt, encoding, and decoding sensations, and transmission to the other systems would prove to be useful in e-Government research.
**The Motor System**

Like in the human model, this is the external, tangible part of the system that interacts with external parties. The motor system is connected to both the cognitive system and the perceptual system. From the cognitive, thought is translated into action by activating patterns of motion (Card et al. 1983). It is important to understand that the mechanical reflexes may be volitional or non-volitional to the organism, but the motor system only implements instructions from the cognitive system with little to no control of its own. Medical research (Conditt et al. 1997) has shown that the motor system is without capacity to control itself. The cognitive system applies collective operations (Gureckis et al. 2006) to carry out a task that would involve more than one motor system. For instance a basketball player’s hand being raised is coordinated with jumping feet to score a basket.

In e-Government this overlays Government to Citizens interactions as the Government provides e-Services (including submission of documents, information kiosks, providing news and instructions over the internet, voter registration and voting, registration services and issuance of Government documents, and all other interactions with Government workers). These e-services are characteristically structured and standardized, but implementing agencies often lack discretion, as they are expected to enforce rules and regulations determined elsewhere.

Since the three systems are interconnected (Card et al. 1986), a close coupling exists between the sensory system and the motor system. In the model human, nerves endings are placed on fingers and feet so that they transmit sensation back to the brain. Likewise, Citizen data are collected when Citizens interact with Government agencies. Through e-Government, the data should be transmitted to the appropriate recipients.

Because this is the public face of Government and where performance actually takes place, the desire to conduct research in this area is understandable. However, without acknowledging the limitations inherent in this system, findings and conclusions drawn may suffer from lack of validity.

**The Cognitive System**

The simplest way to describe what the cognitive system does is that “it serves to connect inputs (encoded stimuli) from the perceptual system to the right outputs (responses) of the motor system” (Card et al. 1983) p. 35. The process of accomplishing one task is however more complex than that (Churchland et al. 1988; Strogatz 2001). Studies in complex networks (Sporns et al. 2004) and human brains have started to influence Information Systems research (Dimoka et al. 2009; Dimoka et al. 2010; Dimoka et al. 2011), and future research will lead to better understanding of how cognition works to complete the S-O-R cycle.

Like the perceptual system, the cognitive system has two important components: memory and processors. Understanding the memory is relevant when it comes to mapping e-Government onto the HIP model. Memory in the HIP model is divided into two types:

1. **Working memory** - This type of memory holds intermediate representations from the perceptual system and the intermediate thinking (internal processes triggered by the intermediate representation from the perceptual system). In e-government structures, a working memory represents the basis of making short term decisions.

2. **Long term memory** - This type of memory holds the mass of available knowledge (Card et al. 1983) – the cognitive capacity of the entire organism. If capacity lacks here, the organism cannot respond appropriately to the stimulus thereby being unable to solve the problem it faces – unless by chance. Tracing this concept onto e-government, long term memory would be represented by enduring policies and guidelines that command how the government conducts its business.
There is an intimate working relationship between the working memory and long term memory, which the relatively new field of NeuroIS (Dimoka et al. 2009; Dimoka et al. 2010; Dimoka et al. 2011) has started investigating at the individual level. Results so far bear witness to the complexity involved, but still an important pointer to the applicability of cognition in IS in general and we hope that e-Government research would follow suit.

Cognition for e-Government would require application of distributed cognition on the basis that systems larger than the individual human, but containing humans, are capable of cognition (Clark 2008; Clark et al. 1998; Theiner et al. 2010). Natural beings that can think are said to have Natural Cognition (NC), while artificial/mechanical things possessing natural thinking capabilities are said to have Artificial Cognition (AC). Distributed Cognition (DC) emanates from natural cognition of human members in a group or organization or a combination of both natural and artificial cognition (Harnad 2005). Government functions employ both humans who think and machines that are capable of natural cognition; as such, distributed cognition exists in e-Governments but research focusing on cognition in e-government is scarce.

To relate cognition specifically to e-Government, policy makers and their supporting bureaucrats bring their natural cognition to bear in public policy and in serving the Government of the day. This natural cognition is at the helm of receiving, processing, and disseminating information for decision making and problem solving. Different departments feed the Government with information, just like perceptual systems do in the HIP model. The ability to combine inputs from diverse sources of the distributed system is an indication of distributed cognition capability built into the system (Gureckis et al. 2006). This results in a robust information transmission across the diverse subsystems that make the entire e-Government. A Government that applies technology to achieve these enhanced distributed cognitive capacities, which are utilized in the provision of public services, can be said to be an e-Government.

**Communication of Stimuli and Responses**

In the HIP model transmission of sensations is said to be a function of the perceptual system. However, being a universal function that happens within and amongst the subsystems, we think it should take greater prominence. Deficient communication between or within any of the subsystems would be perilous to the organism. In humans, the nervous system has evolved to maximize the usefulness of neural communication (Sporns et al. 2004). The role of transmitting information in any system or organization cannot be overemphasized. Stimuli and responses are communicated from source to sink in multiple stages. Neural networks have in the recent past received increased research interest (Strogatz 2001), and e-Government would be good research context to explore not only due to its complexity but also the similarities to a human model as demonstrated here.

In e-Government, this is the role played by data and transmission media, such as the Internet, fiber optics, etc. They play a critical role of interconnecting the entire system. They are such an integral part of e-Government that level of connectivity, mobile communication, and Internet penetration are some of the indicators (Chinn et al. 2006; Chinn et al. 2010) used to assess e-Government maturity (Layne et al. 2001).

**Cognitive Mapping of the HIP onto e-Government**

The preceding discourse has laid out our basis of broadly defining e-Government, within the Stimulus-Organism-Response model, and we have discussed how the Human-Information-Processor model provides an organismic framework for receiving, processing and responding to the received signal according to preset criteria. After September 11, 2001, there were calls for Government Departments to share information (Kapucu 2006) to improve decision making. In a natural setting, it is often true that the organ which receives a certain perceptual sensation is not responsible for acting on it. For instance, the eye might see fire and the nose smell smoke but they are not responsible for raising an alarm or running away. Inability to transmit
these sensual signal received by a part of the system is perilous to the entire organism. The thrust of this treatise is the provision of a framework to support that establishment of an integrated e-Government that functions as the components of the HIP are intended.

![Diagram of the Human Information Processor Model](image)

Figure 3 – Mapping Government onto the Human Information Processor Model

It is worth noting that this view of Government function is at a high level of abstraction; where it is possible to conceive the subordinate yet interrelated relationship between policy and decision making organs, specialized departments and agencies. We argue that implementers should cognitively take such a view of e-Government in the deployment of ICTs in Governments to form an e-Government. That will lead to sought after outcomes of e-Government such as effectiveness, accountability, responsiveness to constituency needs etc. Layne et al. (2001).

Just like the cognitive system plays a crucial role in decision making, policy makers role is important for the HIP based e-Government to function. Making decisions to solve a problem requires cognition (Agarwal et al. 1996; Frederick 2005; Vessey 1991), which could be either Natural Cognition (NC), Artificial Cognition (AC), or Distributed Cognition (DC) (Harnad 2005). An e-Government would rely on distributed cognition since it will involve human specialists using technology.

Further, cognition does not function alone in the problem solving process or indeed in accomplishing any one given task because, in a very simplistic sense, cognition merely serves to connect inputs to the right outputs (Card et al. 1983). Departments and Agencies execute decisions made and policies formulated at by policy makers. Departments and agencies also play a crucial uptake role because they are in touch with the constituency that the Government serves. The complete cycle is very elaborate and intricately complex; and although neuroscientists have made major strides, there is still more work to be done to understand intricate details of how cognition and the human brain really work (Churchland et al. 1988; Norman 2002). We don’t suggest that the government system is simple, but IS can borrow from advances made in neurosciences to develop and improve e-Government applications.
Conclusion

Given the breadth of e-Government, defining it need not be a hindrance to research efforts. The Stimulus-Organism-Response model provides a foundation on which to view a Government as a problem solving mechanism can be erected. By mapping the Human Information Processor model to a Government model facilitates a new lens to view e-Government, highlighting a potential new approach for researchers in e-Government. With the holistic view proposed here, it will be now interesting to pursue some inquiries such as:

- How does information technologies impact Governments’ responsiveness to Citizens’ issues?
- The role of distributed cognition (Goldstone et al. 2009; Gureckis et al. 2006) in Government functions,
- How organizational learning (Schön 1992) occurs in an e-Government and how it would affect Government e-service delivery,

By adopting this point of view, performance evaluation and Key Performance Indicators (KPIs) can be developed by adopting the extensive measures developed by Card et al. (1986), thereby providing the bases to plan e-Government design and implementation.
REFERENCES


