

Spatial Data Infrastructure (SDI) and E-governance: A Quest For Appropriate Evaluation Approaches

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Abstract: *A spatial data infrastructure (SDI) can be conceived as the geo-information technology realm of e-governance. SDI evaluation approaches are maturing with a steady increase in research instruments, from questionnaires to case studies to the use of theoretical grounding and, most recently, to theory generation. Still, however, there is considerable difficulty with identifying and measuring benefits, as well as the challenge of managing the increasing complexity as we move from an SDI data-centric to a service-centric and, finally, to a governance-centric perspective in SDI evaluation. The primary objective of this paper is to explore the question, “Which SDI evaluation approaches are appropriate in the dynamic and volatile environment of e-governance?”*

We introduce a taxonomical lens from information-systems evaluation research to classify existing SDI evaluation approaches as “control,” “learning,” “sense-making,” and “exploratory” evaluations. We review the e-governance literature with emphasis on the still nagging disagreement regarding the implications of information technology in governance. We suggest that governance-centric SDI evaluation should be exploratory in nature, at least in the first instance, and should encompass the degree of convergence of rationalities and interests among different spheres of governance.

INTRODUCTION

The *Oxford English Dictionary* defines evaluation as “*the action of evaluating or determining the value of something or somebody, or the action of estimating the force of probabilities, evidence.*” Evaluation is a natural activity for human beings. Most people are inclined to consider carefully before deciding on a course of action, and often individuals and organizations need to demonstrate that decisions made were rational.

Evaluation is endemic to human existence. Whether consciously or not, people evaluate the products and processes of their labour. Food, drink, appearance, social interactions etc. are constantly being evaluated by someone or something. . . . Evaluation is undertaken as a matter of course in the attempt to gauge how well something meets a particular expectation, objective or need. People, it seems, have an insatiable appetite or curiosity for such things. . . . Evaluation is apparently an important and intrinsic property of the process of understanding, which in turn is a prerequisite for, or a prelude to, a carefully considered action. (Hirschheim and Smithson 1999, 381)

The growth of information system (IS) evaluation research comes as no surprise. In commercial organizations, the sheer size of information technology (IT) investment and management’s expectation for the highest possible future gains account for the unabated interest in IS/IT evaluation (e.g., Willcocks and Lester 1999). Specialized academic journals have provided a forum for

academics and practitioners to debate evaluation theories, methods, and data relevance. Despite decades of attention to IS/IT evaluation, however, evaluation research seems unable to achieve a soft landing (Berghout and Remenyi 2005).

Public-sector organizations face similar concerns. E-government and e-governance initiatives require extensive IS/IT investments to make the full range of government activities available electronically. Investments in information technology for government in most industrialized nations are estimated to be greater than 1 per cent of the gross domestic product (Petricek et al. 2006). However, attempts by either international organizations (e.g., OECD 2003) or by private-sector consultancies (e.g., Accenture 2003, 2004) to assess e-government internationally are considered methodologically questionable and too narrowly focused on government electronic services (Petricek et al. 2006). Bannister (2004) refers to evaluations by international organizations as “beauty contests” of countries trying to measure how they are doing against the competition with the result that what gets scored is what can be easily measured, or even measured at all.

Evaluation research has also received considerable attention in the geographic information community (Clapp et al. 1989; Didier 1990; Johnson 1995; Krek and Frank 2000; Krek 2000; Lopez 1998, 1997; Nedovic-Budic 1998; Rodriguez et al. 2002). With the reconceptualization of interorganizational GIS as spatial data infrastructures (SDI) in the 1990s, the complexity of the object of evaluation, SDI, increased substantially. SDIs have emerged as a significant area of development with geographic information underpinning wider government strategies and initiatives such as

e-governance. SDI evaluation approaches have matured with a steady increase in research instruments, from questionnaires to case studies to the use of theoretical grounding (e.g., Craglia and Johnston 2004; Crompvoets et al. 2004; Delgado et al. 2005; Hyman et al. 2001; Masser 2000, 1999; Onsrud 1998; Pavlova et al. 2002; Rodriguez 2005; Steudler 2003). However, there is still considerable concern related to the difficulty with identifying and measuring benefits, and the increasing complexity as we move from a SDI data-centric to a service-centric point of view (JRC 2006, Grus et al. 2006). Furthermore, with SDI now broadly understood as the geo-IT realm of e-governance, we contend that a shift to a governance-centric SDI evaluation is warranted.

The remainder of the paper is organized as follows. We first introduce a taxonomy of IS/IT evaluation orientations proposed in the information systems literature. Then we classify SDI evaluation approaches using this lens and review the e-governance literature. We outline a governance-centric SDI evaluation perspective and present some brief conclusions and suggestions to develop further research.

INFORMATION SYSTEMS AND EVALUATION

The most widely accepted definition of IS/IT evaluation in the literature (Doherty and King 2004, Walter and Spitta 2004, Willcocks 1992) is: *“process of establishing by quantitative and/or qualitative techniques the worth (or value) of IS/IT projects to the organization.”*

Academics and practitioners in IS/IT are in widespread agreement about the need to evaluate. The vehicle for undertaking such an evaluation, however, is still far from clear. Over the years, many organizations have met with considerable difficulty when attempting to estimate ex ante the benefits of IT adoption in the hope of justifying related expenditures (Farbey et al. 1999, Weill and Broadbent 1998). The same difficulty arises whenever project managers are obliged to show ex post the financial benefits already reaped from implementing such systems and technologies (Farbey et al. 1999a, Irani 2002). Effectively, organizations often find themselves unable to estimate and provide evidence for the benefits that resulted from adopting information systems and technologies (Avgerou 2000a, Parker et al. 1988). When benefits are reported in financial analyses, the assessment of nonfinancial and intangible benefits, which are apparently more extensive than the tangible ones, is limited or omitted. Thus the process of evaluating the consequences and impacts of adopting these systems and technologies is flawed and the justification of investing in such actions is hindered (Renkema and Berghout 1997, Smithson and Hirschheim 1998).

Numerous studies on the matter have been carried out for more than four decades. These studies have had the common goal of defining the principles and criteria for the assessment of the importance of implementing these systems and technologies (Renkema and Berghout 1997). The earliest studies on systems and technologies assessment began in the 1960s (Frielink 1961).

The most recent ones focus on the assessment of systems that offer online business support (Gengatharen and Standing 2004, King and Liou 2004). In practice, there are at least three different kinds of evaluation: *“there are formal evaluation practices promoted by organizational rules and structures, informal practices implemented by stakeholders involved, and finally academic recommendations which in many cases recognize the delicate nature of evaluation but are not ‘used’ in practice.”* (Serafeimidis and Smithson 2003, 252)

In general, IS/IT evaluation attempts have sought to measure how efficiently and accurately the proposed solutions, once they were adopted, met or did not meet the anticipated needs of the organization for which the system or technology was being developed. The complexity of present assessments is directly related to the fact that they must take into consideration the different contexts in which an adopted IS/IT solution originates. In this regard, each context seems to be conditioned by its own set of rules and characteristics and by a unique social and/or organizational culture (Lundell and Lings 2003, Serafeimidis and Smithson 2003).

Evaluation approaches in Information Systems

Many factors need to be considered when selecting a suitable evaluation approach. The first factor is related to timing. According to several authors (Doherty and King 2004, Farbey et al. 1999, Hirschheim and Smithson 1999, Walter and Spitta 2004), there are three different moments to perform evaluations: *“A priori”* (where the ex ante evaluation is defined as an assessment needed to decide whether to implement the project and—especially—to justify it), *“during”* systems or technologies development or implementation, and *“a posteriori,”* where the ex post evaluation attempts to demonstrate whether or not the adopted solutions produced the expected results and gains.

The second factor influencing the evaluation approach is its role. The role of the evaluation depends on the level (status of evaluators) at which it is carried out, or even more important, on the point of view taken in the analysis (Seddon et al. 1999). There is no single “optimal level” from which one may ideally conduct an evaluation. The level can change from one evaluation to the next. What is most important to remember is that different factors have different responsibilities, interests, and value systems, factors that can greatly influence the outcome of an assessment (Smithson and Hirschheim 1998).

The third important factor is the complexity and significance of the IS/IT evaluated. When IS/IT are complex and pervasive sociotechnical systems, such as SDI initiatives, their life cycles tend to extend over long periods of time, and the required investment appears to be defined as a program of social action (Farbey et al. 1999). In such cases, there is an ambiguity and a lack of structure in evaluation approaches to take into account the diversity of contextual situations encountered. This ambiguity is caused by two key factors: *“lack of clearly understood and agreed objectives and a lack of knowledge as to the potential impact of the IS, and hence a lack of knowledge of cause and effect.”* (Ibid., 196)

A taxonomy of IS evaluation approaches

Critical assumptions of IS/IT evaluation approaches can be defined by analyzing together the factors presented previously: the degree of clarity (or certainty) of IS/IT objectives and the degree of clarity (or certainty) regarding their potential impact. The clarity and perceived attainability of the IS/IT objectives—as well as of their evaluation—can vary from a consensual situation, where objectives are clear and widely accepted, to a nonconsensual situation, characterized by multiple interests and ambiguity. On the other hand, the impact on the organization of the anticipated investment can be perceived differently at different organizational levels, operational or strategic (Serafeimidis and Smithson 2003).

Depending on the level of uncertainty as to the objectives and as to cause and effect, four possible evaluation orientations are suggested: control evaluation, evaluation as learning, as sense making, and exploratory evaluation (Table 1). They are discussed in terms of their *nature* (as answer, learning, dialogue, and idea machine), in terms of their *purpose* (goal monitoring, experimenting, consensus building, and exploration), as well as in terms of the *evaluator role* (auditor, knowledge creator, facilitator, catalyst) in the process. Typical examples are given for each particular orientation.

Evaluation as control. In this orientation, the quantitative expected objectives of the investment in IS/IT as well as their impacts seem clear. Thus, it appears possible to establish an organizational consensus around them. Taking place at the operational level, this kind of evaluation mostly considers financial and technical issues and functions as an “answer machine.” It supports rationalistic decision models and analysis about efficiency and effectiveness of IS/IT investment (e.g., Aladwani 2002, Averous and Averous 1998, Brynjolfsson and Hitt 1999, Cameron and Whetten 1983, Chin and Lee 2000, Davis 1989, DeLone and McLean 1992, Saleh and Alshawi 2005). The objective of the evaluation is goal monitoring; evaluators act as auditors controlling, ranking, or assessing success. Mostly quantitative issues are

considered while social and intangible issues are either ignored or handled prescriptively. The classical example of “evaluation as control” is return on investment (ROI), a popular method with organizations with tight financial discipline. ROI approaches are usually performed by accounting staff for efficiency-seeking projects in well-defined circumstances, where both the goals and the anticipated affects of the investment are clear and certain.

Evaluation as learning. The expected outcomes seem clear, but their strategic achievement and impacts appear uncertain or difficult to predict. In this case, the organization needs to be flexible and open to individual and organizational learning and change (Argyris and Schön 1996, Boonstra 2004). The IS/IT evaluation operates as a feedback instrument, involving a social and critical process of inquiry, interpretation, and debate (Walsham 1999). It contributes to decreasing uncertainty of strategic changes (Symons 1993, 1991) and functions as a “learning machine.” The objective of the evaluation is to experiment, while evaluators act as knowledge creators who increase the knowledge capital through experimentation. The classical example of “evaluation as learning” is cost-benefit analysis (CBA). CBA can be conceived as a variation of ROI where the costs and benefits (effects) are difficult to quantify and are substituted by surrogate measures.

Evaluation as sense making. In this orientation, there is no consensus about IS/IT expected objectives; they seem unclear and unpredictable. At an operational level, the links between actions and their potential impacts on organization are nevertheless seen as reasonably predictable. This kind of evaluation attempts to assemble informal and tacit information as well as formal information and functions as a “dialogue machine.” The goal is to reach consensus concerning the objectives, with the evaluator acting as a facilitator in the process. Examples of sense-making evaluations are methods, such as prototyping and simulation. A prototype form of a system is used as a basis for experiments and a platform for sharing views to test and modify the system and its impacts before engineering the full version.

		Uncertainty as to cause and effect	
		Low	High
Uncertainty as to objectives	Low	<i>Evaluation as control</i> Answer machine Goal monitoring Evaluator as auditor e.g., ROI	<i>Evaluation as learning</i> Learning machine Experiment Evaluator as knowledge creator e.g., CBA
	High	<i>Evaluation as sense making</i> Dialogue machine Consensus building Evaluator as facilitator e.g., simulation, prototyping, etc.	<i>Exploratory evaluation</i> Idea machine Exploration Evaluator as catalyst e.g., Value analysis

Table 1. Orientations of evaluation adapted from Farbey et al. 1999 and Serafeimidis and Smithson 2003

Evaluation as exploratory practice. In this orientation, there is neither consensus about IS/IT expected objectives nor about their strategic achievement and impacts. In an exploratory evaluation, participants attempt to generate ideas and experiences and aim to understand and explain a highly uncertain situation. Exploratory evaluation functions as an “idea machine” for the definition of new paradigms, new organizational forms, and new behavioral norms. For Serafeimidis and Smithson (2003, 259), “*exploratory evaluation changes the schemas of the stakeholders and the assumptions that influence them.*” Exploratory evaluation becomes a key mechanism for participation and social transformation. Evaluators act as catalysts driving required changes. An example of “evaluation as exploratory practice” is value analysis, a method based on the notion that concentrating on the value added is more important than focusing on cost saved.

The premises of exploratory evaluation stand at the opposite end of the spectrum from those of control evaluation. The positivist assumptions informing control evaluation are compared with the interpretive assumptions underlying exploratory evaluation, in terms of ontology, epistemology and related research methods (Table 2).

The power of interpretive approaches has been emphatically established both theoretically and empirically in the information systems literature (Walsham, 1993), in GIS implementation in organizations (Petch and Reeve, 1999), as well as in understanding the implementation dynamics of information infrastructures that span numerous contexts spread out globally (Ciborra et al. 2000).

SDI EVALUATION APPROACHES AND E-GOVERNANCE

Evaluation research has received considerable attention in the GIS community (Johnson 1995; Krek and Frank 2000; Krek 2000; Lopez 1997, 1998; Didier 1990; Rodriguez et al. 2002; Clapp et al. 1989; Nedovic-Budic 1998). With the reconceptualization of interorganizational GIS as SDI in the 1990s, the complexity of the object of evaluation, SDI, as well as of the process of evaluation increased substantially. SDI evaluation has focused either on directly assessing actual SDI projects (Craglia and Evmorfopoulou

1999, Kok and Van Loenen 2005, Masser 2000, Pavlova et al. 2002), on following the evolution of SDI initiatives (Craglia and Johnston 2004, Crompvoets et al. 2004, Hyman and Lance 2001, Onsrud 1998), as well as on comparisons (Craglia and Evmorfopoulou 1999; Masser 2000, 1999; Nedovic-Budic et al. 2003; Pauknerova et al. 2003; Pavlova et al. 2002). Conceptual studies investigated the relationship between evaluation criteria and different SDI hierarchical levels involved (Steudler, 2003) or focused on readiness issues related to technological, economical, communicational, and organizational factors (Delgado et al. 2005), or explained the complexity and multifaceted nature of SDIs as well as of their evaluation (De Man 2005). Rodriguez (2005) proposed a structured theoretical tool that views SDI evaluation as an involved process of socially constructing the infrastructure.

However, there is still considerable concern related to the difficulty with identifying and measuring benefits, and the increasing complexity as we move from a SDI data-centric to a service-centric point of view. The methodologies, implicit and explicit assumptions, as well the generalizability of evaluative frameworks, and the importance of contextual factors in future SDI evaluation efforts are still unclear (JRC, 2006, Grus et al. 2006). With SDI now broadly understood as the geo-IT realm of e-governance, a further challenge is the shift to a governance-centric SDI evaluation. In the remainder of this section, we classify SDI evaluation approaches using the taxonomy introduced previously. We then highlight some of the ambiguities that afflict the e-governance literature.

Taxonomy of SDI evaluation approaches

SDI evaluation efforts to date have had various scopes (regional, organizational, national, global, conceptual) and various study goals (performance measurement, monitoring of dynamics, consensus building, learning lessons, understanding) and have used various methods (automatic registration of events, questionnaires, Web site surveys, computer simulation, prototyping, case studies, and theory). The focus of the evaluation has been mainly on data, services, and SDI management issues (Table 3). When governance issues, such as legal framework, financing, private-

	Research paradigms in IS/IT evaluation	
	Positivist	Interpretive
Ontology	The true nature of reality can be obtained by testing theories about actual objects, processes, and structures in the real world.	The world is produced and reinforced by humans through their action and interaction.
Epistemology	Verification of hypotheses through rigorous empirical testing. Search for universal laws and principles. Tight coupling among explanation, prediction, and control.	Understanding of the phenomenon from the participant's perspective, in its natural setting, through interpretation of its meanings and actions.
Related Research Methods	Formal propositions, quantifiable measures of variables, hypothesis testing, drawing inferences from a sample to a stated population.	In-depth case studies and ethnographies.

Table 2. Positivist and interpretive research paradigms, adapted from Khazanchi and Munkvold (2003)

Author	Scope	Goals	Methods	Focus
Onsrud (1998)	Global	Understand SDI scope, nature, and extent	Questionnaire	Data
MetroGIS (2004)	Metropolitan	Performance measurement	Automatic registration of "events"	Data
Crompvoets et al. (2004)	Global	Performance measurement of clearinghouses	Internet browsing, measurement of characteristics	Data use management
Delgado et al. (2005)	National	Monitor dynamics	Fuzzy theory, questionnaires	Data management
Vandenbroucke (2005)	Supranational	Monitor dynamics	Experts' feedback, examination of Web sites	Data services management Some governance issues
Kok and van Loenen (2005)	Organizational	Assessment of organizational context	Case studies, organizational change theory	Management
Halsing et al. (2006)	National	Cost-benefit analysis	Computer simulation	Data services management
Giff and Coleman (2003), Masser (2003)	Few developed nations	Learn lessons from others	Case study	Management Some governance issues
Weiss (1998)	National	Self-evaluation	Workshop	Management
Kuhn et al. (2000)	Subnational	Consensus building	Prototyping	Data services management
Giff (2005)	Conceptual	Evaluate funding models over time	Computer simulation	Model's sensitivity to environment
Rodriguez (2005)	Conceptual	Understand dynamics of implementation	Case studies, Delphi, grounded theory	Efficiency Effectiveness Understanding

Table 3. Summary of selected SDI evaluation approaches

sector involvement, the importance of industry associations, and political support, etc., were taken into account, the approach has been descriptive and/or normative (e.g., Vandenbroucke 2005, Giff and Coleman 2003, Masser 2003).

This summary gives a useful snapshot of the increasing diversity in terms of evaluation scope, goals, methods, and focus taken by various authors ever since Onsrud (1998) conducted the first global SDI evaluation. This summary, however, does not make explicit the gaps that should be filled by further evaluation research, especially as we move to a *holistic governance-centric SDI evaluation* perspective. We argue that the taxonomy of IS evaluation approaches, summarized in Table 1, provides a richer lens through which to view these SDI evaluation efforts. In this section, we classify these examples based on the level of uncertainty regarding the evaluation objectives and the uncertainty regarding the cause and effect. The first example given in each class can be considered an ideal type (archetype) for the class, while the other examples may have some (minor) degree of overlap and intersection with other classes.

SDI control evaluation. MetroGIS (2004) can be considered an exemplar for SDI control evaluation. MetroGIS is a regional initiative serving the Minneapolis–St. Paul (Minnesota) metropolitan area. It is a voluntary collaboration of local and regional governments, with partners in state and federal government, academic institutions, nonprofit organizations, and businesses with the purpose to facilitate widespread sharing of geospatial data. The annual evaluation is mainly based on automatic registration of specific and most easily quantifiable outcomes that include visits to a DataFinder, number of data downloaded, frequently downloaded datasets, identification of entities downloading data, the number of DataFinder publishers, etc. Performance measures of benefits to data producers have not yet been quantified, while nonquantitative instruments, such as testimonials, are expected to gauge ultimate outcomes, such as improved decision making and better service to the public (ibid.). Performance results are reported annually by MetroGIS staff to the MetroGIS Policy Board, with the board acting as auditor. The MetroGIS (2004) objective is annual performance measurement for continuing revision of the program. The cause-effect relationship is clearly

articulated, as the relationship between allocated resources and outcomes, the latter codified as ten performance measures.

The periodic assessment of clearinghouses at distinct epochs by Crompvoets et al. (2004) can also be considered a SDI control evaluation, albeit at a global scale. In this case, the complexity of “going global” was reduced by focusing on national clearinghouses as representative of national SDI initiatives. In this way, the relationship between cause (SDI development) and effect (use, management, and content of clearinghouses) was rendered clear and certain. Specific and quantifiable clearinghouse characteristics were monitored through Web browsing as well as through contacting local experts and Webmasters. A similar approach was adopted by Delgado et al. (2005) and Vandenbroucke (2005) at a national (Cuba) and transnational (European Union) level. While the issues considered in these studies were more complex—they encompassed organizational, legal, and financial aspects—the cause-effect relationship was clear and the objective certain. For example, Delgado et al. (2005) attempted to capture progress in SDI readiness through the use of questionnaires and fuzzy theory, while Vandenbroucke (2005) monitored the impact of the INSPIRE directive and the compliance of EU member states through feedback from experts, visits of Web sites, and review of reports and publications. Kok and van Loenen (2005) also assumed a clear causal relationship between the level of national SDI success and four organizational indicators, which they tested using two case studies, the Netherlands and the United States.

SDI learning evaluation. The cost-benefit analysis (CBA) of The National Map, carried out on behalf of the U.S. Geological Survey can be considered an exemplar for SDI learning evaluation (Halsing et al. 2006). The objective of the study was clear: to estimate and analyze the costs involved in building, maintaining and distributing The National Map and the various benefit streams expected from its existence. Lack of precedents for this kind of analysis necessitated a novel computational model that simulated the number of users, application innovation, and diffusion, as well as changes in the net benefits of implementing spatial data applications using The National Map. Total costs and benefits of The National Map were based on the projected implementation time, development and maintenance costs, rates of data inclusion and integration, expected usage levels over time, and a benefits estimation model. However, the lack of data to populate the economic model and the lack of literature on the value of spatial data in real-world applications resulted in an uncertain cause-effect relationship “because [. . .] a full accounting of the likely costs and benefits was not feasible” (ibid. 14).

The studies by Giff and Coleman (2003) and Masser (2003) can also be considered as SDI learning evaluations, although the evaluation “format” was “comparative case studies” instead of a computational simulation of a complex reality. These studies identified appropriate role models (countries at similar levels of development) and extracted lessons from their experiences. For the Canadian study by Giff and Coleman (2003), the role models were Germany, the Netherlands, and France. The lessons learned

included the importance of sustained political support and a strong coordinating body, as well as the advantages of a phased implementation to demonstrate benefits. For the European study by Masser (2003), the role models were Canada, Australia, and the United States. Lessons learned included the importance of industry associations and of state-level initiatives for SDI development in these countries. In both cases, the lessons learned diminished some of the uncertainty related to cause and effect.

The workshop convened by the Federal Geographic Data Committee in Kansas City can also be considered a SDI learning evaluation (Weiss 1998). The workshop’s explicit objective was to answer the question, “*How do we know how we are doing at building the NSDI?*”, a classical instance of high uncertainty related to cause and effect. Instead of a computational model, the workshop format allowed participants to contribute, listen, and think collaboratively from their distinct perspectives, identify indicators for success, clarify benefits, draft approaches to measure progress, examine critical issues, and prioritize action steps.

SDI sense-making evaluation. The first-ever global SDI survey conducted by Onsrud (1998) may be considered exemplary for SDI sense-making evaluation. It was spurred by the recognition that knowledge was lacking of the approaches pursued in each nation as well as of the elements and characteristics that appear to be foundational and common in most efforts. The purpose of the evaluation was to decrease this uncertainty and to articulate common approaches and characteristics shared across as many nations as possible globally. The method consisted of soliciting official and unofficial responses from individuals *within* each nation to provide a platform for sharing differing views and for building consensus as to SDI scope, nature, and extent—in other words, consensus related to a minimum set of SDI objectives. The cause-effect relationship was one of high certainty, for the intent was to encourage library-like widespread sharing of spatial data.

Experimental methods such as prototyping and modeling can also be considered instruments of sense-making evaluations. For example, Kuhn et al. (2000), in examining the technical feasibility of the SDI reference model of North Rhine–Westphalia in Germany, recognized that a key issue was to ensure its acceptance through consensus building. The authors initiated a dialogue by suggesting procedures to ensure consensus processes *within the SDI project*, with project partners expected to give their feedback to the rules and specifications of the reference model within three weeks after the dissemination of each new version of the reference model. They also suggested consensus-building processes *within the GI market* of North Rhine–Westphalia. Giff (2005) used simulation modeling to evaluate SDI funding models over time and to observe the models’ response to changes in key variables operating within the specific implementation environment.

SDI exploratory evaluation. The interpretive study by Rodriguez (2005) can be considered exemplary of exploratory SDI evaluation. Rodriguez’s structured theoretical tool for the assessment of SDI initiatives is based on a participative, formative, transforma-

tive process that empowers all stakeholders involved in the social construction of spatial data infrastructures while at the same time changing the schemata of stakeholders and the assumptions that influence them. His conceptual framework examines data systems–centered efficiency and services–centered effectiveness, but above all it takes into account the dynamic interplay of social contexts with the technical implementation process of geographic information infrastructures.

In assessing efficiency, Rodriguez’s framework accepts that performance monitoring and quality improvement of data and systems are essential components of SDI evaluation, under the condition that suitable needs, expectations, and objectives are defined in regard to each particular context. In assessing effectiveness, it recognizes the importance of evaluating the SDI’s potential for producing and delivering the intended geospatial products and services to users, according to their interests, capabilities, and capacities. In proposing understanding of cultural and sociopolitical interactions surrounding SDI implementation as part of the evaluation, Rodriguez’s framework anticipates that stakeholders will be conflictive and critical, but also sees conflict as an opportunity to reconcile interests and generate more appropriate SDI ideas, concepts, applications, and services to citizens.

In summary, the focus of SDI evaluation has broadened to include data, services, SDI management issues, as well as some governance issues. From the point of view of epistemology, there is a shift from positivist to interpretive evaluation. However, a holistic governance-centric SDI evaluation perspective is still missing. To tackle the question, “Which are appropriate SDI evaluation approaches in the dynamic and volatile environment of e-governance?”, we now turn our attention to e-governance, a new and turbulent field, still in the phase of finding and refining its research agenda and its accepted standards and methods (Scholl 2005).

Governance and E-governance

Governance at any level—urban, regional, or national—can be conceptualized as “the interactions between actors in three distinct but interrelated spheres: the political, the public administration, and the society spheres” (Grönlund 2004, 2005). Figure 1 illustrates Grönlund’s democratic governance model. The three spheres are represented by circles indicating domains of control. Arrows indicate influence. Intersections of circles indicate “transaction zones” where control is negotiated by e.g., lobbyists and media on the left-hand side, commercial service deliverers on the right-hand side, and government boards and committees on the top side. “Governance” (electronic or not) concerns all three spheres, while “government” (electronic or not) can be taken to mean either just the administrative or the political and administrative in combination.

When governance becomes e-governance, in other words, when the full range of government activities—internal processes, policy development and decision making, and services to citizens—are made available electronically, then the domains of control and the transaction zones may change dramatically (Margetts and Dunleavy 2002). Universalist scenarios of gov-

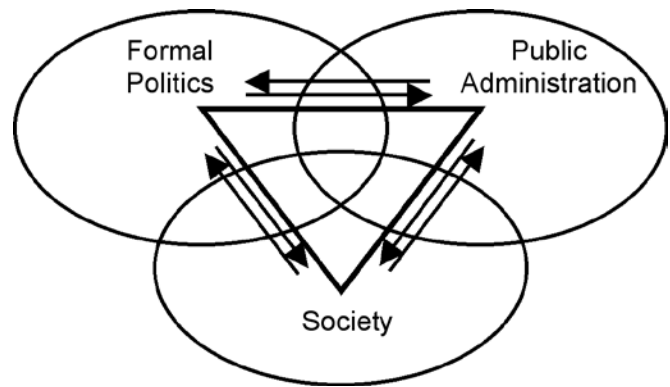


Figure 1. Grönlund’s model for a governance system (2004, 2005)

ernance transformation through IT mark two extremes, the hypermodernist and the antimodernist (Margetts 2003). The hypermodernists argue that the electronic revolution will take government to new levels of rationality, bring a new civilization peopled by information workers in intelligent buildings full of electronic offices organized in networks rather than formal hierarchies. The antimodernists concur with the hypermodernists’ view of the transformative role of technology for governance but emphasize the malign consequences, with technology becoming an instrument of social control (ibid.).

E-governance research goes back at least to the 1970s (Danzinger and Andersen 2002), with the older literature concerned mainly with IS implementation within government, while more recent studies are concerned with external use, a problematic trend because of its excessive emphasis on electronic services to citizens (Grönlund 2004, Petricek et al. 2006, Zouridis and Thaens 2005). However, while research on IS implementation in commercial organizations has produced many theories (e.g., Avgerou 2000a), research related to the implications of IS implementation in government organization has fallen short of furnishing full-blown, generalizable theories. For example, the editors of the influential handbook *Public Administration in the Information Age* claim under the slightly alarming heading “Faltering Foundations” that despite decades of scholarly attention to the implications of informatization in government, scholars are still “both empirically and theoretically challenged” (van de Donk and Snellen 1998, 14).

Empirically, e-governance research has focused mainly on individual government organizations and specifically on the impacts of IT on the capabilities of single government units. The analysis by Danzinger and Andersen (2002) of empirical research reported in more than 1,000 issues of research journals, published between 1987 and 2000, reveals a high concentration on single government units, mostly at the local administrative level. In terms of impacts of IT use in government, the study concludes that “the clearest positive impacts generated by IT on

public administration are in the areas of efficiency and productivity of government performance, in both internal and external (service) functions [while] negative impacts from IT are reported in such areas as citizens' private and legal spheres, citizens' interaction with government, and public employees' work environment and power relationships." (Ibid., 617)

Theoretically, e-governance research is fraught with dilemmas and ambiguities. Public administration scholars use the conceptual lens of "informatization of public administration" to study the shifts within the administration and political spheres as well as their changing position vis-à-vis the societal sphere of governance. Van de Donk and Snellen (1998) argue that the Information Age is leading to an erosion of the system of "checks and balances" between the powers of the state, between the layers of government, and within the authorities of public administration that has traditionally served as a guarantee of civil liberties (ibid.). Zouridis and Thaens (2005) study the "locus" and "focus" of governance to understand the control shifts between the three spheres brought about by e-governance.

With respect to "locus," Zouridis and Thaens find e-governance to concentrate mainly on the operational level of public administration, as a result of the emphasis on citizens as consumers of the products and services of public administration. According to these authors, e-governance initiatives give little attention to the executive and strategic parts of public organizations. In the policy process, e-governance appears to be primarily concerned with policy implementation and not in agenda setting and formulation of policy. In the sphere of politics, e-governance is used to support democratic supervision and representation and has little affinity with propagation and consideration of ideas and political decision making (Table 4).

With respect to "focus" of e-governance, Zouridis and Thaens find initiatives in Western liberal democracies to be primarily contributing to the economic and professional rationality of public administration, with political and legal rationality largely ignored (ibid.). They come to the conclusion that the "locus" and "focus" of e-governance in liberal Western democracies is not only limited but also slanted towards increasing the influence of the public administration sphere.

In developing countries, the situation is even more uncertain. Heeks (2001) estimates that e-governance projects are 35 percent

total failures, 50 percent partial failures, and 15 percent successes. He attributes failure to the gap between "hard rational design" and "soft political realities" caused by the three-way association of IT, universalist modernization, and Western rationalism. Avgerou (2000b) similarly argues that universalist visions of economic and institutional development accompanying efforts to promote the diffusion of technology downplay the path dependence and historical contingency of the development process and frustrate efforts to make sense of locally meaningful ways of accommodating information technology in socioeconomic activities.

The empirical and theoretical challenges in e-governance research in liberal Western contexts, reported by Margetts (2003), Scholl (2005), Zouridis and Thaens (2005) among others, suggest that a pragmatic research approach is understanding of e-governance on the ground, in specific institutional settings, while acknowledging the path dependency and historical contingency of trajectories towards e-governance, especially in developing-country contexts, where failures by far outnumber successes. In the next section, we outline how geo-information infrastructures underpinning e-governance could be conceived and evaluated in the light of these challenges.

TOWARDS A GOVERNANCE-CENTRIC SDI EVALUATION

The taxonomy of SDI evaluation approaches in the previous section shows that SDI evaluation research has matured in a number of ways. Firstly, different evaluation orientations—with the purpose to either control, or experiment, or develop consensus, or to explore—have been developed, depending on the perceived certainty as to the objectives and the cause-effect relationship of SDI investments. Secondly, several evaluation instruments have been deployed, ranging from questionnaires to comparative case studies to prototyping and simulation to the use of theoretical grounding, and, most recently, to theory generation. Thirdly, SDI evaluation has moved from a data-centric to a service-centric perspective and is also increasingly concerned with management and governance issues. Finally, a paradigm shift has taken place in the literature, from positivism and mainly quantitative tools towards interpretivism and mainly qualitative instruments (Rodriguez 2005).

Governance	Political Sphere	Public Admin. Sphere	Society Sphere
Locus	Policy process (agenda setting, policy formulation, political decision making) <i>Democratic supervision</i> <i>Representation</i>	Policy process (<i>policy implementation, managerial control</i>) Executive and strategic level <i>Operational level</i>	Citizens as rulers (voters and participators in policy processes) <i>Citizens as ruled</i> (subject to authority, consumers of services)
Focus	Political rationality	<i>Economic rationality</i> <i>Functional rationality</i> <i>Legal rationality</i>	Individual or community welfare and emancipation

Table 4. The locus and focus of governance adapted from Zouridis and Thaens (2005) and Grönlund (2005). Italics are used to highlight those locus and focus that are transformed by e-governance.

The question now can be raised as to “Which are appropriate SDI evaluation approaches in the dynamic and volatile environment of e-governance?” In the turbulent environment of e-governance, uncertainty with respect to the implications of making the full range of government activities made available electronically is the only certainty. Consequently, the obvious choice of approach is “exploratory evaluation,” at least in the first instance, that is, when we are concerned with understanding the totality of implications of the transition from governance to e-governance. With decreasing uncertainty in both dimensions, other evaluation orientations may become increasingly useful. For instance, when the evaluation scope is limited to interactions between the public administration and society spheres, and the focus is geo-services to citizens (as consumers), a control evaluation approach may be warranted. When the evaluation scope is limited to interactions between the political and society spheres and the focus is citizen (as rulers) participation in territorial planning, a sense-making evaluation may be appropriate.

Exploratory evaluation is more appropriate for understanding *holistically* existing e-governance arrangements and for cultivating an e-governance geo-information infrastructure in a specific institutional setting. Grönlund’s (2004, 2005) conceptual framework suggests that e-governance information infrastructures may achieve long-term success when they sufficiently well reconcile the rationalities and interests of stakeholders in the three spheres of a governance system, shown in Figure 1. In this paper, we shall only illustrate the meaning of reconciliation of rationalities and interests by means of an exemplary e-governance geo-information infrastructure initiative, the Bhoomi land-records information infrastructure in India.

The Bhoomi (meaning *land*) land-records infrastructure was implemented in the southern state of Karnataka in India, and was launched in all districts of the state in 2001. By October of 2004, more than 22 million farmers had accessed Bhoomi since its inception (De’ 2005). Bhoomi aimed at digitizing land records providing ownership information required by individual farmers for a variety of reasons, for example, such as to make loan applications to banks or to obtain an electricity connection. Before these records were digitized and computerized, the ownership certificates had to be obtained from the local patwari, a junior official in the land-records department located at the subdistrict level. In addition, these records were not regularly updated (such as incorporating transfer/sale deeds into the existing records). Copies of these records can now be obtained on payment of about 30 cents (U.S.), and without long waiting periods or the need to make several visits, and also “unofficial payments” to the patwari. Bhoomi is an exemplary land-records infrastructure that caters to a massive societal need. It has been deemed so successful that the state of Delhi has decided to replicate the initiative.

Nevertheless, a few years after its inception and use, Bhoomi can be seen to exhibit the malaise afflicting all large infrastructural systems, such as the power of “installed base,” conflicting stakeholder interests, and the difficulty of second-guessing the final user behavior, which may eventually cause the infrastructure

to “drift” (Ciborra and Associates 2000). Rahul De’s (2005) nuanced reading of conflicting interests of politicoadministrative and societal stakeholders of the Bhoomi land-records infrastructure helps understand the (partial) resistance to Bhoomi as conflicts of interests and rationalities among stakeholders of the infrastructure. For efficiency reasons, politicoadministrative stakeholders of Bhoomi favored a single format for land records in one language, while farmers prefer multiple languages and formats, including *all* the data of the analog records that were suppressed during computerization. For effectiveness reasons, the politicoadministrative stakeholders of Bhoomi decided not to include cadastral maps in the digitized land records, arguing that the highly time-consuming activity of computerizing cadastral maps would have delayed the entire computerization process. Farmers resented the exclusion of cadastral maps, arguing that their inclusion would have made transparent the huge inequities in land tenure that had cropped up ever since Karnataka had undergone the last official land survey in 1978. For transparency reasons, politicoadministrative stakeholders favored the open availability of land records to all, while the farmers preferred privacy of land records to avoid becoming targets of land sharks. These conflicts resulted in cases now being filed in court (*ibid.*, 34).

From this illustrative example, it appears that the long-term success of e-governance geo-information infrastructures rests on two premises:

- understanding the rationalities and modes of operation in all three spheres, formal politics, administration, and society, in a specific political, administrative, sociocultural-historical context;
- cultivating and scaling up existing geo-information infrastructures that best and most constructively reconcile diverse rationalities and interests in the transaction zones of governance systems, where control is negotiated.

Exploratory, interpretive evaluation of e-governance geo-information infrastructures should encompass primarily the degree of convergence of rationalities, interests, and modes of operation achieved among different spheres of governance. In a second step, evaluation might attempt to reflect “good governance” outcomes, such as subsidiarity, equity, efficiency, transparency and accountability, civic engagement and citizenship, security, etc. Exploratory, governance-centric SDI evaluation would involve understanding through in-depth case studies and ethnographies the interwoven dynamic relationship over time between the politicoadministrative, sociocultural, historical context and the technical implementation, through interpretation of the meanings and actions of participants and stakeholders. By understanding how the infrastructure came to be what it is now and how it is incrementally assuming infrastructural characteristics and becoming an open and shared resource will allow us to devise cultivation strategies that are context-specific and, thus, potentially more successful (Georgiadou et al. 2005).

CONCLUSION

In this article, we presented a taxonomy of SDI evaluation orientations to date and argued for the need to pay more attention to conducting exploratory evaluation of SDI implementation in specific institutional contexts, based on the premises of an interpretive epistemology and methods. We argued that such a shift is warranted with SDI now broadly understood as the geo-IT realm of the turbulent field of e-governance. We suggest that the long-term success of geo-information infrastructures hinges on cultivating and scaling up existing initiatives with the purpose to constructively reconcile diverse rationalities and interests in the transaction zones of governance systems, where control between spheres is negotiated. We also suggest that exploratory evaluation geo-information infrastructures should encompass the degree of convergence of rationalities, interests, and modes of operation achieved among different spheres of governance.

For further research, we propose conducting longitudinal, interpretive, in-depth case studies, with the purpose to enrich the theory and practice of exploratory SDI evaluation. Such research should focus on governance-centric SDI evaluation, especially in so-called developing countries. The questions as to how to establish interdisciplinary teams to conduct such research, what kind of longitudinal designs are appropriate to study and evaluate the dynamics of SDI implementation, and how to operationalize an interpretive research philosophy in practical terms to conduct empirical SDI evaluation research are all areas for further exploration.

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