International Journal of Spatial Data Infrastructures Research, 2006, Vol. 1, 65-104.

[1]Understanding how and why practitioners evaluate SDI performance

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Abstract

Practitioners around the world are building frameworks for spatial data interoperability and cross-agency coordination, referred to as spatial data infrastructure (SDI). In this study, we attempt to understand how and why SDI practitioners 'on the ground' are evaluating their 'own' efforts in developing such frameworks. For this purpose, we mobilize concepts from 'control' evaluation, as well as from public sector evaluation research, because 'control' evaluation appears to be the approach most favored by SDI practitioners, and SDI evaluation is unfolding within public sector settings. 'Control' evaluation emphasizes operations, supports rationalistic investment decisions and efficiency analysis, and typically is based on measures such as ratios, percentages, and indexes; evaluators act as auditors, controlling, ranking or assessing success.

We examine and classify several recent examples of SDI 'control' evaluation by using the concepts of 'timing', 'perspective', 'formal demand', 'use', and 'input specificity'. Our study reveals that the most comprehensive practices have resulted when 'control' evaluations have been in compliance with a *demand* from an executive agency, such as a central budget agency, and when there has been *specificity of inputs.* We anticipate that these dimensions are key to the institutionalization of SDI evaluation and point to the need for further research to understand how such evaluation practices emerge.

Keywords: spatial data infrastructure, efficiency, evaluation, performance measurement, institutionalization

1. INTRODUCTION

Public managers of geographic information systems, since the early 1990s, have emphasized the need for a framework for data interoperability and cross-agency coordination, referred to as spatial data infrastructure (SDI). At the same time, researchers have stressed the need for evaluation to monitor and assess SDI progress over time (Craglia and Nowak, 2006; Grus et al, 2006; Masser,

2005). Evaluation of SDI efforts can be seen as the cornerstone of SDI implementation, especially when improved efficiency is a primary stated SDI objective. For example, a review of the US National Spatial Data Infrastructure (NSDI) and the Federal Geographic Data Committee (FGDC) underscores the importance of evaluation (NAS, 2001, p.74):

> "[t]he success of future partnership programs should be assessed by determining, in a rigorous fashion, how these NSDI partnerships have reduced redundancy in geospatial data collection and maintenance; reduced overall costs in performing these tasks; improved access to geospatial data; and improved the accuracy of the data used. Because much of the FGDC's effort has been devoted to promotion of the NSDI, there has been little opportunity to develop programs that can monitor long-term effects. The FGDC should develop metrics that can be used to monitor long-term progress in the adoption of the principles and programs of the NSDI among agencies at all levels of government, academia, and the private sector… Such procedures would be of great value in assessing whether the NSDI program succeeds in moving beyond the missionary phase, and in arguing for future funding allocations."

SDI evaluation research is maturing with a steady increase in research instruments, from questionnaires, to case studies, to the use of theoretical grounding (e.g. Onsrud, 1998; Crompvoets et al, 2004; Delgado et al, 2005; Masser, 1999, 1999; Rodriguez, 2005; Steudler, 2003). At the same time, a growing number of SDI practitioners[2] are conducting SDI evaluation, though the practice still is not widespread. Surprisingly though, few evaluations by SDI researchers or practitioners address specific agency inputs, despite the popular justification of SDI as a guarantor of improved efficiency, which is a ratio of inputs to outputs. In some cases, costs are estimated, but these, at best, are done with a broad stroke at the onset of a project; the estimates may provide a figure for particular service or activity, but they do not identify which agency is contributing what portion to the activity, which is what input specificity does. Furthermore, when SDI evaluation is discussed, the tendency has been to dwell on the difficulty of measuring benefits or impacts, not the costs or actual inputs, with the assumption being that costs or inputs are more easily quantified (Craglia and Nowak, 2006, p.14, p.52). However this is not the case (Rhind, 2000). In most SDI evaluations, cost estimation has focused only on staffing and set-up costs rather than the less immediately visible indirect and organizational costs. Similarly, inputs have been overlooked, because they typically are sunk, indirect, or concealed in program budgets. Complicating matters further, SDI inputs span

[2] SDI practitioners are managers of public geographic information assets developing an SDI, a framework for interoperability and cross-agency coordination.

multiple agencies, each having different budgeting and accounting practices, resulting in a lack of budgetary interoperability (Lance, 2005).

The drive to evaluate SDI is consistent with a longer-running pursuit to evaluate the broader sphere of information systems/information technologies (IS/IT). After close to four decades of investigation, IS/IT evaluation has become a veritable industry, with specialized academic journals such as the Electronic Journal of Information Systems Evaluation and conferences such as the European Conference on IT Evaluation. IS/IT evaluation has been defined as "a process, or group of parallel processes, which take place at different points in time or continuously, for searching and for making explicit, quantitatively or qualitatively, all the impacts of an IT project and the program and strategy of which it is a part (Farbey et al, 1999a)." While much of the IS/IT evaluation research has focused on commercial settings, where organizations are driven to attain significant future gains, IS/IT evaluation is becoming prevalent in the public sector as well. In the public sector, "the use of scarce resources has to be monitored, in order to maintain a correct relation between inputs and outputs, in respects of economic efficiency (Dameri, 2005, p.109)."

Despite the multitude of IS/IT evaluation studies, the results are inconclusive. Researchers and practitioners, noting the static productivity and rising IS/IT expenditure, have coined the term "IT productivity paradox" (Roach, 1987; Brynjolfsson, 1993). While this predicament causes concern, it may have more to do with flaws in evaluation than actual IS/IT impacts. Bannister and Remenyi (1999) pointed out "[i]f the economists are right, this [investment] is an act of collective ineptitude on a massive scale. Few, however, would argue that so many managers and organisations are so irrational." Even so, the debate over IS/IT impacts continues.

However, there is general agreement that IS/IT evaluation, as a process, has value and facilitates implementation in different ways. Evaluation can serve: as a basis for decision-making, control or accountability; legitimization of a decision already taken; to gain and retain commitment from stakeholders; as a learning process for the organization and its partners; and as a starting point for negotiation and collective decision-making (Farbey, 1995, p.207-8). Although rarely explicitly stated as such, IS/IT evaluation is inherently associated with IS/IT success and failure (Beynon-Davies et al, 2000). Most importantly, evaluation should be an institutionalized process, since "it is only through effective evaluation that an organization may develop an effective knowledge base on which to found successful development practice (ibid, p.2)." The institutionalization of evaluation refers to the establishment of rules, procedures, and organizational arrangements by which evaluations are produced (Boyle and Lemaire, 1999).

In this paper, we attempt to understand how and why SDI practitioners 'on the ground' are evaluating their 'own' efforts in implementing SDI. For this purpose, we draw upon concepts from IS/IT 'control' evaluation, since 'control' evaluation appears to be the approach most favored by SDI practitioners. We also draw upon public sector evaluation research, since SDI evaluation usually unfolds in public sector settings. Our approach is consistent with Grover et al (1996) in establishing a more cumulative tradition, taking prior research into account as a basis of learning and avoiding reinvention of concepts already well established in the literature.

The rest of the paper is organized as follows. In section 2, we review the IS/IT 'control' evaluation and public sector evaluation literature and identify dimensions that pertain to comprehensive 'control' evaluation within a public sector setting. In section 3, we use these dimensions to examine concrete examples of SDI control evaluation carried out by SDI practitioners. Section 4 is devoted to an analysis of the findings. In section 5, we summarize some conclusions.

2. IS/IT EVALUATION AND PUBLIC ADMINISTRATION RESEARCH

IS/IT evaluation has been an area of scrutiny by practitioners and researchers over the past four decades. Originally IS/IT evaluation focused on commercial sector practices, fueled by the need of managers to balance large IT investments, limited organizational resources, and the expectation for the highest future gains (Willcocks and Lester, 1999). More recently, IS/IT evaluation has grown in prominence in the public sector as well (e.g., Yu and Wang, 2005; Atkinson, 2004; Lin and Pervan, 2003; Sedera et al, 2001). Public agencies are under increasing pressure to improve the efficiency of the services they deliver. In the drive to achieve this, various commercial sector management techniques have been introduced, under reforms often coined as 'New Public Management.' While some commentators have expressed doubts regarding the uncritical import of evaluation approaches from the commercial to public sector, the push for efficiency and the evaluation thereof is comparable in both commercial and public sectors (Bannister, 2001).

The specific approach to IS/IT evaluation depends on the degree of clarity (or certainty) of IS/IT objectives and the degree of clarity (or certainty) regarding the potential impact, resulting in four evaluation orientations: 'control' evaluation, 'learning', 'sense-making', and 'exploratory' evaluation (Serafeimidis and Smithson, 2003). Table 1 summarizes these four orientations, while further details can be found in Georgiadou et al (2006). With control evaluation, evaluators act as auditors, controlling, ranking or assessing tangible aspects of progress; the objectives and the impacts of the information system in question are clearly defined. In contrast, 'learning' evaluators increase knowledge through critical processes of inquiry, debate, and interpretation; they are more concerned

with intangible IS/IT outcomes. This approach is typical of situations in which there are clear IS/IT objectives, but there is uncertainty of cause and effect. 'Sense making' evaluators work under the inverse situation, in which there is clarity as to the envisioned end results, but limited consensus as to means to achieve them; they use prototyping or simulation to facilitate dialogue among stakeholders. In the fourth evaluation orientation, 'exploratory' evaluators are confronted with high uncertainty for both the objectives and the impacts; they rely upon interpretive methods and attempt to generate ideas and experiences to understand and explain the ambiguities. The boundary between the evaluation orientations is not necessarily crisp, and some evaluations may exhibit characteristics of another class, but the taxonomy still is useful when discussing evaluations in the context of one another.

Table 1. Orientations of evaluation, after Farbey et. al. (1999b, p.208) and Serafeimidis and Smithson (2003).

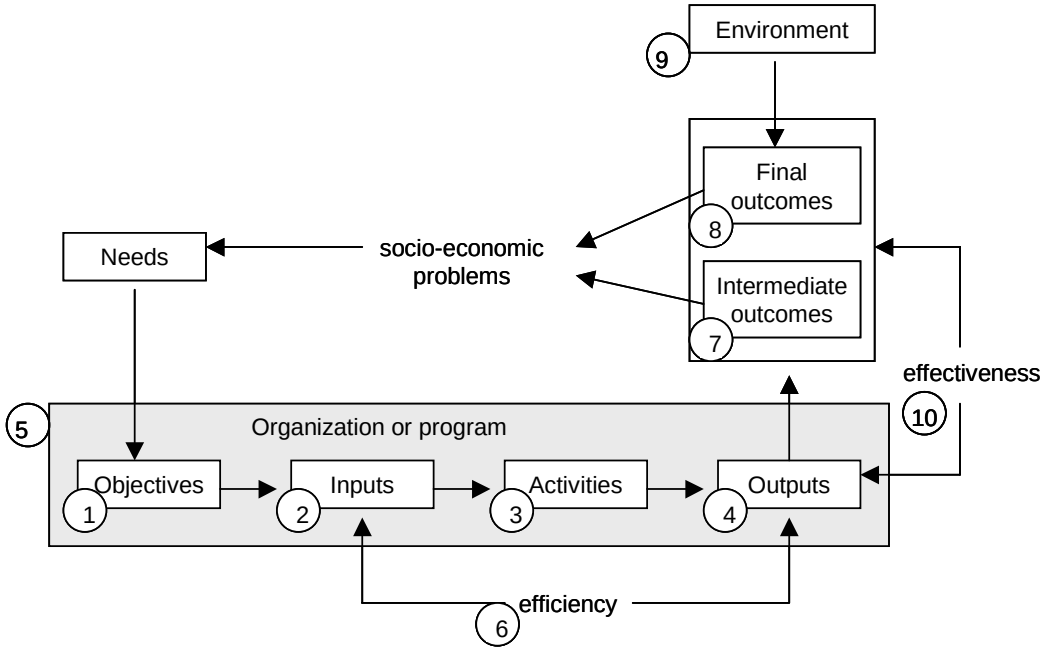
		Uncertainty as to impacts & strategies	
		Low	**High**
Uncertainty as to objectives	**Low**	*Evaluation as control* Answer machine Goal monitoring Evaluator as auditor e.g. Return-on-investment	*Evaluation as learning* Learning machine Experiment Evaluator as knowledge creator e.g. Cost-benefit analysis
	High	*Evaluation as sense-making* Dialogue machine Consensus Evaluator as facilitator e.g. Simulation, prototyping, etc.	*Exploratory evaluation* Idea machine Exploration Evaluator as catalyst e.g. Value analysis

Each of the four evaluation orientations has its merits, depending on the IS/IT lifecycle (Willcocks and Lester, 1999). Nevertheless, 'control' evaluation is most commonly conducted by IS/IT practitioners, who tend to justify their efforts based on cost savings or cost reduction (Willcocks, 1992; Ward et. al., 1996; Hinton and Kaye, 1996), rather than the realization of more intangible benefits. 'Control' evaluation typically considers financial and technical issues using tangible, quantifiable measures.

Figure 1 represents the logical model that underpins 'control' evaluation. The figure, based on van Dooren's (2006) analytical framework for evaluation in the public sector, also helps clarify the definition of terms used for control evaluation. Each public agency or program is shaped by a complex socio-economic environment, and to the extent possible, management controls are used to

influence the behavior of employees. Only program objectives (1), inputs (2), activities (3), and outputs (4) are under direct control, denoted by the box shaded in gray (5). 'Control' evaluation focuses on measurable inputs and outputs and is popular for efficiency-oriented projects, with efficiency (6) referring to the ratio of inputs to outputs. The actual outcomes of a program (7, 8) largely depend on the impulses of society (9) and most often are intangible. Effectiveness (10), which is the ratio of outputs to outcomes, also is influenced by environmental conditions.[3] To assess outcomes and effectiveness, a different evaluation orientation would be needed, one that is sensitive to ambiguities and social transformation (e.g., learning or exploratory evaluation).

Figure 1. Analytical framework for control evaluation in the public sector, after van Dooren (2006, p.29) and Pollitt and Bouckaert (2004, p.106).



Efficiency, rather than effectiveness, is more commonly stated by SDI initiatives as their objective, as indicated in Appendix A. It does not come as a surprise, then, that 'control' evaluation is popular with SDI practitioners, just as it is with IS/IT practitioners. Since we aim in this study to understand and classify SDI

[3] Pollitt and Bouckaert (2004), whose work is the basis for van Dooren's model, originally characterized effectiveness as the ratio of outputs to objectives, which would put effectiveness under the realm of control. However, the concept of effectiveness is mixed in the literature (Bannister, 2001), and we concur with van Dooren whose definition of effectiveness takes unintended effects or externalities into account.

evaluation practices 'on the ground', we look further to IS/IT 'control' evaluation and public administration literature for appropriate concepts in the following sub-sections.

2.1 'Control' evaluation in the IS/IT literature

'Control' evaluation supports rationalistic decision models and analysis about efficiency of IS/IT investment (e.g.: Saleh and Alshawi, 2005; Aladwani, 2002; Chin and Lee, 2000; Brynjolfsson and Hitt, 1999; DeLone and McLean, 1992; Davis, 1989; Cameron and Whetten, 1983). It has its emphasis on operations and fits well with bureaucratic environments (Serafeimidis and Smithson, 2003). The objective of control evaluation is goal monitoring; evaluators act as auditors, controlling, ranking or assessing success. Common types of measurements include ratios, percentages, and indexes. Mostly quantitative issues are considered, while social and soft (intangible) issues are either ignored or handled prescriptively. The classic example of evaluation as 'control' is Return-On-Investment (ROI), a method requiring tight financial discipline.

The IS/IT evaluation literature discusses two dimensions, 'timing' and 'perspective', that influence how control evaluations are conducted. With respect to 'timing,' authors differentiate between three moments: 'a priori', 'a posteriori', and 'during' (Doherty and King, 2004; Farbey et al, 1999b; Hirschheim and Smithson, 1999; Walter and Spitta, 2004). 'A priori' evaluation is essentially an ex ante assessment, conducted to aid the decision as to whether to implement an IS/IT project and, especially, to justify it. 'A posteriori' evaluation is an ex post attempt to demonstrate whether the adopted IS/IT solutions produced the expected results and gains. 'During' evaluation focuses on the routine monitoring of IS/IT implementation and performance over time. 'During' evaluation, better known as performance measurement, can be viewed as a management information system that assists the control of organizational functions, resources or other responsibilities (Heeks, 1998). Specific targets or referents are used, and the process serves as a *feedback loop* that strengthens accountability (ibid, p.3).

Most research and practice has centered on ex ante IS/IT evaluation (Frisk and Platén, 2004); comparatively little ex post evaluation is being done (Ward et al, 1996; Gwillim, 2005), even though many organizations "pay lip service to the concept (Farbey et al, 1999c, p.216)." According to Lin and Pervan (2001), organizations are focusing on justifying the investment through exante evaluation, rather than ensuring a planned benefits management approach. Researchers have recommended that, instead, an integrative approach to evaluation be applied across the full IS/IT life-cycle – covering ex ante, expost, and 'during' evaluation – as this would improve the delivery of results (Willcocks, 1992; Peters, 1996).

Control evaluation may be conducted from various 'perspectives.' Combining multiple perspectives yields a more balanced or comprehensive evaluation and allows an organization to align organization goals and internal business processes (Kaplan and Norton, 1992). Existing IS/IT evaluation frameworks can be seen to converge on five perspectives (Yu and Wang, 2005; Shang and Seddon, 2002; Applegate et al, 1999; Kaplan and Norton, 1992). These perspectives are: 'platform improvements', 'operational', 'financial', 'beneficiaries', and 'learning and growth'. The 'platform improvements' perspective addresses the improved technical ability to share information and communicate; the 'operational' perspective refers to improved efficiency of day-to-day operating activities and supply/distribution channels; the 'financial' perspective refers to upgrades in economic control and improved allocation of resources (benefits from financial management as opposed to those derived directly from the platform or operational perspective); the 'beneficiaries' perspective reflects the enhanced collaboration and commitment of stakeholders and the degree to which their needs are being met; 'learning and growth' addresses increased functionality, flexibility, and useful/future life of IT infrastructure. The classification is not watertight; the perspectives may overlap and there is ample room for interpretation, but together, the perspectives provide a framework for a comprehensive evaluation.

The perspectives are relevant to both public and commercial IS/IT initiatives, though the emphasis for each may be slightly different. For instance, from a financial perspective, evaluation of commercial IS/IT may center on revenue generation and profitability, whereas the primary financial concern of public IS/IT evaluation may be appropriations and transparency. Table 2 summarizes the five evaluation perspectives, the measurement focus, and the emphasis of evaluation depending on the setting (commercial/public). Table 2 also includes, for illustrative purposes, quantifiable measures commonly used to align or assess goals and outputs from the different perspectives. Measures may be inventory-based, transaction-based, time-based, cost-based, budget-based, use-based, and option-based (Young, 2001; Applegate et al, 1999).

Table 2. Convergence of IS/IT control evaluation frameworks, after Yu and Wang (2005), Shang and Seddon (2002), Applegate et al (1999), Kaplan and Norton (1992), Young (2001).

Perspective	Description	Measurement focus	Commercial sector emphasis	Public sector emphasis	Measures
Platform improve-ments	Improved ability to share information and communicate	Technical functionality	Quality, reliability	Quality, reliability	Inventory-based: system content, system quality, degree of interoperability. Transaction-based: number of sessions, downloads, patrons, domain and host addresses
Operational	Improved efficiency of day-to-day operating activities and supply/distribution channels	Processes, transactions	Productivity, efficiency	Productivity, efficiency	Time-based measures: session length/duration; decreased time needed due to IS/IT service. Cost-based measures: cost/expenditure for staff, training, maintenance, site licenses; cost reduction, cost savings, cost avoidance
Financial	Improved allocation and control of resources	Resource allocation/ business results	Revenue generation, profitability, shareholder value	Appropriations, funding longevity, transparency, accountability	Budget-based measures: source of investment, resource flows, resource inter-dependency, alignment of resources to priorities
Beneficiaries	Enhanced collaboration and commitment	Use	New customer acquisition, customer retention	User satisfaction	Use-based measures: user activities, sessions/patron, user satisfaction
Learning and growth	Increased functionality, flexibility, and useful/future life of IT infrastructure	Human resources	Competencies, innovation	Competencies, cultural change	Option-based measures: extent of partnerships, added value, research, depth of contributors to services, educational offerings, human capital
	Added value to products and services				
	Leveraged the level of information literacy				

2.2 Evaluation research in public sector settings

The literature on public sector evaluation suggests three further dimensions of evaluation, in addition to those of 'timing' and 'perspective' discussed in the previous section. These are 'formal demand', 'use' of evaluation results, and the 'specificity of inputs'. These additional dimensions are thought to be determinants of institutionalization of evaluation practices in the public sector.

The first dimension is 'formal demand' from government, providing a motivation for conducting the evaluation. As MacKay (2006, p.5) stressed, "[s]ubstantive demand from the government is a prerequisite to successful institutionalization [of evaluation]." Experience has shown that "without effective demand, that is demand based on real pressures on governments, any effort to institutionalize public sector evaluation will quickly lead to lack of interest and evaporation [of the effort] (Guerrero, 1999, p.2)." Formal demand can be internal, such as meeting managerial needs or fulfilling an organizational directive, or external, driven by accountability to, for instance, the central budget agency and complying with regulatory oversight (Guerrero, 1999). External demand also can arise from social pressure from stakeholders who are not part of management, but who still induce a formal, obligatory response. Some commentators have pointed out that the distinction between internal and external determinants for evaluation is too simplistic and should be elaborated further in order to understand interrelations between various internal and external drivers (Hill and Lynn, 2005; Forbes and Lynn, 2005). However, in this paper, we use the internal-external dichotomy to keep the analysis concise.

The second dimension is that of the intended 'use' of the evaluation results, which is closely associated to the 'formal demand'. Five distinct 'uses' have been articulated (Treasury Board Secretariat, 2005): supporting expenditure and resource management decisions such as ongoing program funding and justification for new funding; substantiating the need to review policy or strategic direction for a program; steering service delivery design or implementation; improving relations with stakeholders; and strengthening accountability and reporting regimes.

The third key dimension in public sector evaluation, particularly for cross-agency initiatives, is 'specificity of inputs' across agencies. This means that individual, agency contributions to activities are documented and known. This goes much further than estimating costs of activities. Rather, this involves the integration of evaluation with other mainstream tools of governance, such as investment planning, budgeting, and auditing (Boyle, 2003; Pollitt, 2001). The actual inputs – investment and risks – that each agency commits to an SDI initiative are made transparent. This is important because the inputs influence the power-relationship between agencies and hence the structure of the

partnership. Identifying and acknowledging interdependencies, the level of power each partner has in the relationship, and the perceived fairness in terms of risk or input from each partner, is critical for inter-organizational synthesis (Pitsis et al, 2004; Keast et al, 2004). To ensure synthesis, "much work has to be done at the front end of the collaborative relationship (Pitsis et al, 2004, p.56)." Practitioners need to establish how to share inputs in terms of risk and resources and match them to outputs and outcomes. The specification of inputs can be seen as mechanistic and "basic plumbing" (Schiavo-Campo, 2005, p.11), but "the first order of business should be expenditure tracking – not in the sense of value-for-money, but in the pedestrian but critical sense of following the money step by step (ibid)."

3. SDI 'CONTROL' EVALUATION

SDI evaluations span all four of the IS/IT evaluation orientations mentioned earlier – 'control', 'learning', 'sense-making', and 'exploratory' (Georgiadou et al, 2006). However, 'control' evaluation is the focus of our analysis, because it appears to be the approach most favored by SDI practitioners. In this section, we examine SDI 'control' evaluation practices using the lens of the five dimensions described in the previous section. The 'timing', 'perspective', and 'input specificity' dimensions point to 'how' the evaluation is being carried out, while 'demand' and 'use' point to 'why' the evaluations are being carried out.

3.1 Survey methods

Between February and April 2006, we conducted a global review of websites, searching for evaluations in which the input and/or outputs were articulated. We also corresponded with SDI experts to identify potential examples. In some instances, we relied on annual reports, which researchers have used as a proxy for the extent of 'control' evaluation (Boyne and Law 1991; Hyndman and Anderson 1995; Johnsen, 1999). The annual reports confirmed that performance measurement has been adopted; however, the reports could not provide insight into how performance information was used. Thus, we also relied on e-interviews for some qualitative perspective. Conducted online, these conversations constituted a text-based virtual ethnography (Crichton and Kinash, 2003; Clarke, 2000).

Overall, despite the number of SDI initiatives underway worldwide, the available evidence of evaluation practices was limited. Originally the idea was to focus on 'control' evaluation of SDI at the macro (whole-of-government) level, but due to the paucity of findings, we extended the search to meso (sectors, administrative unit) and micro (specific services) levels. There were a number of examples of 'control' evaluation of GIS for particular applications, but unless the examples focused on issues of interoperability, data standards, data access, and inter-

organization coordination, they were omitted. We also omitted SDI 'control' evaluation studies conducted by authors for research purposes (Booz Allen Hamilton, 2005; Crompvoets et al, 2004; Crompvoets and Bregt, 2003; van Orshoven, 2004; Vandenbrouke, 2005; Pavlova et al, 2002, Delgado et al, 2005; Abdel-salam and Mostafa, 2005; Kok and van Loenen, 2005), since they were not management control instruments, conducted by SDI practitioners evaluating their 'own' efforts.

The next section provides a brief description of the 'control' evaluation examples from our review. We focused on the evaluations that have been conducted in the past two years, since they reflect current practice best. Earlier work over the past decade (KPMG Peat Marwick, 1991; Tomlinson Associates, 1993; Price Waterhouse, 1995; OXERA, 1999; M-NCPPC, 1999; Baltimore County, Maryland Office of Information Technology, 2001; Warnecke et al 2001; Berends et al 2001; ECORYS-NEI, 2002; GeoAnalytics, Inc., 2003. Ayan, 2003) mainly consisted of ex ante evaluations.[4]

3.2 SDI control evaluation examples

We identified eleven evaluation examples, from the following ten SDI initiatives: Oregon Statewide GIS Utility (USA), Thailand NSDI, Gigateway (UK), Western Australian Land Information System (WALIS), Spatial Data Warehouse Ltd. (SDW)/ AltaLIS) (Canada), MetroGIS (USA), Public Sector Mapping Agencies (PSMA) Limited (Australia), National Geo-data Repository of The Netherlands (DINO), Geospatial One Stop (USA), and Geoconnections (Canada). Each example fulfills the criteria of a 'control' evaluation by having clarity of objectives and clarity (or perceived clarity) of impact (Serafeimidis and Smithson, 2003). Appendix A details the specific SDI objectives and explicit measures used for evaluation in each one of the case studies. Table 3 provides a summary of the evaluation examples and indicates each example's comprehensiveness based on which perspectives were covered. We discerned which perspectives were covered through an analysis of the measures used (Appendix A) and their correspondence to a given perspective, as shown in Table 3. For example, a time-based measure such as 'reduced time involved in data development and acquisition' corresponded to the operational perspective. The comprehensiveness of the evaluation can be further viewed in the context of timing, demand, use, and input specificity, as explained in the descriptions below and summarized in Table 4 at the end of the section. The details were up-to-date

[4] Some of these SDI control evaluations were incorrectly identified as a cost-benefit analysis (CBA), which is a method representative of learning evaluation (see Georgiadou et al, 2006). To be considered learning evaluation rather than control evaluation, the studies either would have analyzed costs and benefits between alternative scenarios, thus providing insights, or they would have measured intangible benefits in more than a cursory manner, which was not the case.

at the time of publication of this paper; however, activities and procedures are susceptible to change with time.

Table 3. SDI 'control' evaluation comprehensiveness based on types of measures used.

	Inventory & transaction-based measures	Time & cost–based measures	Budget-based measures	Use-based measures	Option-based measures	Comprehen-siveness
	P	O	F	B	L	Perspective
Oregon Statewide GIS Utility	x	x				P, O
Thailand NSDI	x	x		x		P, O, B
Gigateway (UK)	x			x		P, B
WALIS (Australia) - during		x		x	x	O, B, L
SDW/AltaLIS (Canada)	x	x	x			P, O, F, B
MetroGIS (USA)	x	x		x		P, O, B
PSMA (Australia)	x	x	x	x	x	P, O, F, B, L
DINO (The Netherlands)	x	x	x	x		P, O, F, B
Geospatial One Stop (USA)	x	x	x	x	x	P, O, F, B, L
WALIS (Australia) – ex post		x		x		O, B
Geoconnections (Canada)	x	x	x	x	x	P, O, F, B, L

Key: Platform improvements (P), Operational (O), Financial (F), Beneficiaries (B), Learning and growth (L)

Oregon Statewide GIS Utility (USA)

The Oregon Statewide GIS Utility initiative is meant to establish and maintain an administrative and operational structure to support effective creation, maintenance, sharing, and access to geographic information. Its overall impact should be the reduction of costs and duplication of geographic information management while delivering tangible benefits to a large community of users statewide. The 2005 ex-ante business case study was a one-time evaluation requested by the Oregon Geographic Information Council (OGIC) and Information Resources Management Division (IRMD), Department of Administrative Services, State of Oregon. The evaluation confirmed the short-term and long-term benefits of the GIS Utility and justified the investment in time and resources to initiate the program and bring the GIS Utility to a full operational status (Oregon Geospatial Enterprise Office, 2006). The evaluation focused on platform and operational aspects and quantified expected efficiency gains, cost savings, and cost avoidance. Inputs also were quantified, but as a collective

estimation, not according to investments that individual state agencies would need to make.

Thailand NSDI

The 2004 ex-ante evaluation was requested by and prepared for the Deputy Prime Minister to inform an investment decision regarding Thailand's NSDI (Environmental Systems Research Institute, 2004). The NSDI was seen as a means to develop a better environment for the integration and sharing of information across all government sectors and society at large. The evaluation focused on platform and operational impacts. The automation and sharing of the fundamental geographic datasets was seen as largest area for benefit. Thus, measures focused on quantifying the benefits of having datasets in digital form, rather than manual, such as reduced time involved in data development and acquisition, reduction in ongoing data maintenance and dissemination, reduction in computing infrastructure allocation, and reduction in staff training allocation. The evaluation was circulated to all public stakeholders for review and comment; a large committee comprising representatives from all the agencies worked closely with the consultants who conducted the study. Inputs and benefits were quantified, but as a collective government-wide estimation, not according to costs and benefits to individual agencies. One of the consultants who worked on the Thailand NSDI evaluation explained, *"Perhaps more valuable than the actual numbers to me was the exercise of defining costs and benefits which got everybody thinking and talking to each* other (e-interview with Mark Sorensen, September 1, 2005)."

Gigateway (U.K.)

The objective of the Gigateway is to maintain a metadata service that is seen as a vital part of the national spatial data infrastructure (May, 2005). The Association for Geographic Information (AGI) implements Gigateway under a contractual agreement with the Ordnance Survey, who in turn receives funding for this activity through the Office of the Deputy Prime Minister's National Interest Mapping Services Agreement (NIMSA). Performance measurement is a new, annual activity with set targets, largely based on quantifiable outputs. Use cases also will be used to demonstrate tangible benefit. The evaluation is being administered by AGI under the terms and conditions of the agreement. It was recognized at the mid year point that many of the statistical targets agreed for delivery in 2004/5 were not going to be met, so the Operating Plan for 2005/6 is focusing on ensuring quality is given precedence over quantity, and that the provision of core datasets is the main objective around which the Gigateway team is targeting their energy. For this revised approach to evaluation, platform-based measures will be used and the beneficiaries' perspective will be measured with quantifiable business benefit statements. Evaluation is seen as critical to demonstrate that Gigateway is a useful service. If not, then 'national interest' public funding for the metadata service will be seriously challenged.

Western Australian Land Information System (WALIS)

Established in 1981, WALIS is the longest standing, land information system (LIS)-geographical information system (GIS), cooperative arrangement in Australia. It is designed to build networks of people and technology to share information, mostly by Western Australia government agencies, and improve information usefulness and accessibility. The Department of Land Information (DLI) is a lead agency in WALIS, and WALIS's offices are situated within the DLI organizational structure. DLI is legally required to submit to Parliament an annual report (Department of Land Information, 2005). In 2003, WALIS undertook a Performance Evaluation Project (Deloitte Touche Tohmatsu, 2003), and followed up this study with another independent assessment in 2004. The objective of this ex-post study was to identify the value contributed by WALIS to both users and producers of spatial data, as represented by efficiency savings and willingness to pay (ACIL Tasman, 2004). The results of the evaluation study serve as a basis for educational and promotional material aimed to advance the wider appreciation and use of the Western Australia SDI throughout the community of Western Australia (ibid, p.vii).

The 2003 Performance Evaluation study also led to the establishment of key performance indicators and targets for annual evaluation, which are included in the annual report. Operational benefits are assessed by a measure of the cost for delivering different results; in this way, inputs are part of the evaluation. However, only the inputs of DLI to WALIS are included, not the inputs of the full range of contributors. The beneficiaries' perspective is assessed with measures of awareness and acceptance. The Auditor General independently audits the WALIS performance indicators. Although the performance indicators are in place, the process is more of a formality for accountability purposes than a tool for service delivery improvement (e-interview with Genevieve Gongora-Mesas, May 30, 2006). However, it is likely to become more rigorous once the Shared Land Information Platform (SLIP) becomes operational (ibid). The SLIP, driven by DLI, was endorsed by the State Cabinet in 2005. The SLIP governance arrangements include the development of a cross-government reporting framework. Also, DLI is transitioning to becoming a land information statutory authority with commercial powers. As a statutory authority, DLI is meant to deliver a greater return to government and the community on the State's land information assets.

Spatial Data Warehouse Ltd./AltaLIS (Alberta, Canada)

The Spatial Data Warehouse (SDW) is a self-financing, not-for-profit organization formed in June 1996 when the Government of Alberta discontinued its traditional role of funding and managing Alberta's digital mapping (Spatial Data Warehouse Ltd., 1998; Chorel, 2001). SDW is meant to maintain and promote the broadest possible distribution of provincial digital mapping that meets the

immediate needs of the Alberta market place and preserves the mapping systems for the long-term benefit of Albertans. SDW has a Board of Directors with representatives from provincial government and local utility and communications companies who are the largest users of Alberta's base mapping information. In 1998, AltaLIS Ltd. ("AltaLIS"), a joint-venture company, signed a long-term contract with SDW for the management, marketing and distribution of Alberta's base mapping, property mapping and terrain information. AltaLIS keeps statistics on its performance, as well as accounting records, which are audited by SDW annually. AltaLIS provides SDW with detailed monthly production reporting and invoicing on work completed. SDW's role is to monitor performance, costs, and profit to ensure all contract agreement terms are met (Schlachter, 1999). The performance statistics are for AltaLIS and SDW internal use only and are communicated through a management committee. Various aspects of service are monitored with hard/quantifiable measures, while others are monitored by user feedback. There are a couple of External Advisory Groups run by SDW that solicit and encourage user feedback on data quality and other data related issues. Although the general user community does not have access to internal measures or financials, they can assess performance directly by observing the reduction in delivery times, update cycles, and pricing, as well as increased data and service quality.

MetroGIS (Minneapolis/St. Paul, Minnesota, USA)

MetroGIS is a voluntary regional geographic information systems initiative serving the seven-county Minneapolis-St. Paul (Minnesota) metropolitan area. It was initiated in 1995 to improve participant operations, reduce costs, and support cross-jurisdictional decision-making. In April 2001, the MetroGIS Policy Board adopted a Performance Measurement Plan to enable the organization to more clearly state to its stakeholders what it expects to accomplish, and to demonstrate accountability for results (Richardson, Richter & Associates, Inc., 2002). The demand for the plan initially came from within. As the manager of MetroGIS explained, "*To sustain continued support for MetroGIS's collaborative environment, we believed that a systematic mechanism was needed to demonstrate progress. The Policy Board concurred and authorized the creation of the current performance measurement program* (e-interview with Randall Johnson, July 5, 2006)." Performance measurement now is an ongoing annual activity, largely based on automatic registration of platform-based "events" 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 non quantitative instruments, such as testimonials, are expected to gauge intermediate outcomes, such as improved decision making and better service delivery the to public (MetroGIS, 2004; MetroGIS, 2005). Since 2003, performance results have been reported annually by MetroGIS staff to the MetroGIS Policy Board, with the Policy Board acting as

auditor. The Performance Measurement Plan recommends that the organization review performance results prior to building the annual budget and work plan (MetroGIS, 2002, p.5). Thus, performance information is meant to support the budgeting process, and while it may be used to modify activities and policies, and the performance report demonstrates accountability for results, the primary use and preoccupation of performance measurement is to clearly state accomplishments to stakeholders. The availability of performance information helps "*demonstrate that MetroGIS is serious about making a difference and conducting its operations as a mainstream organization, with accountability mechanisms in place* (e-interview with Randall Johnson, June 12, 2006)."

Inputs are not covered in the annual evaluations. The focus is on what the organization delivers in terms of products and services (outputs), rather than what resources allocated or expended (inputs). Meanwhile, the 2005 performance measurement report mentioned that the reporting process helps with understanding the "causal relationship between resources allocated to specific activities and desired outcomes." The MetroGIS Staff Coordinator acknowledges that the report is flawed in this respect and explains, "*The simple answers are: 1) the MetroGIS community has yet to define a sufficient means to accurately measure the breadth of resources allocated to MetroGIS by the various organizations performing custodial roles, and 2) regarding the matter of causal relationship, in addition to not having a good handle on the resources involved, not enough historical perspective has yet been accumulated through the performance program thus far to draw definitive causal relationships* (e-interview with Randall Johnson, June 12, 2006)." Over time, however, the plan is to incorporate efficiency measures that show what has been achieved in relation to the input of resources (MetroGIS, 2002, p.4).

MetroGIS also submits an annual report to the Metropolitan Council, MetroGIS's primary sponsor. The annual report must accompany MetroGIS's annual funding request to the Council and must outline how MetroGIS's efforts are beneficial to Council. To verify that MetroGIS contributes to the Metropolitan Council's operations, the Council recently conducted its own detailed evaluation of MetroGIS. The Council concluded that it benefits substantially more than its annual contribution. This study was the first and only time an individual stakeholder conducted an in-depth evaluation of its cost versus benefit for participating in the joint MetroGIS activity.

National Geo-data Repository of The Netherlands - DINO (The Netherlands)

The Netherlands Institute of Applied Geoscience (TNO) is the central geoscience institute in the Netherlands for information and research to promote the sustainable management and use of the subsurface and its natural resources. Five ministries provide financial support, and public and private agencies are obligated to provide their data to TNO. The national geo-data

repository (Dutch acronym: DINO), which is managed by TNO, is meant to contain all relevant data and information of the subsurface of the Netherlands. This data and information should be easily accessible and almost free of charge. To ensure the continued financial support to DINO, the manager proactively established a balanced scorecard with measurable targets with which to assess performance, many of which are automated (Kuipers, 2005; 2004). In turn, this created the current formal internal demand from the participating ministries for performance information. TNO also gathers information from users via interviews and questionnaires. Given that the primary drivers for the establishment of TNO were to promote investment in the country, share costs of data development, and reduce costs of data storage, the broad benefits of DINO to the economy were evaluated in 2003. Also, there is a strong financial perspective to the annual evaluation of DINO and careful accounting of DINO's costs. However, the operating costs incurred by contributing public and private agencies for data development are not part of the assessment.

PSMA (Public Sector Mapping Agencies) Australia Limited

PSMA (Public Sector Mapping Agencies) Australia was established in 1992 as an unincorporated joint venture. It started as a project and since has developed into a business with the incorporation of the entity in June 2001. The initial business plan was developed in 1998 to support the incorporation process. The company constitution adopted at that time requires the company to prepare an annual program each year and deliver this draft program to the shareholders, prior to the commencement of the financial year. The annual program must be approved unanimously by shareholders. The degree of completion of the annual program along with responses to opportunities and circumstances during the year constitutes the measure of success on an annual basis. This is reflected in the annual report (PSMA, 2005), which is for the benefit of the shareholders and is required for the company under corporation law.

More analytical measures are made at the Board level to assist with strategic planning, but these measures are not in the public domain. PSMA Australia is not profit driven despite being a commercial entity, so revenue is not a key measure per se, but rather how broadly the datasets built and maintained by the company are being used. However, since PSMA uses Value Added Resellers (VARs) for data distribution, and VARs are profit driven, returns to PSMA Australia are a surrogate for measuring success. With ubiquity being a key goal, increasing PSMA's markets and market penetration are seen as important feedback from existing clients. In the last few years, this feedback has been structured into surveys so that definitive measurements can be made. As the PSMA manager explained, "*Like any other business we need to be able to measure that we are achieving* (e-interview with Dan Paull, July 7, 2006)."

PSMA Australia's Annual Program 2005-06 has inspired a new approach in the structure of the annual planning document. The new project based structure provides clearer understanding of the planned activities and superior connectivity between the Strategic Plan and the Implementation Program within the PSMA Australia national office. Individual performance contracts are developed with key performance indicators being derived directly from the Implementation Plan. Staff can readily identify how their activities relate to the company's strategic outcomes.

Geospatial One Stop (USA)

Geospatial One-Stop (GOS) is a geographic information system (GIS) portal that serves as a public gateway for improving access to geospatial information and data. The portal went "live" in 2003. GOS is one of 24 e-government initiatives sponsored by the Federal Office of Management and Budget (OMB) to enhance government efficiency and to improve citizen services. GOS uses several different measures to fulfill its reporting requirements to OMB. Some are based on WebTrend data and others revolve around participation in the portal and partnerships formed because of the portal. GOS identifies milestones that it plans to achieve, against which OMB and an Intergovernmental Board assesses progress. The portal also has a statistics portlet, which is a reporting area showing usage of the GOS portal. This portlet provides statistics on-demand so that stakeholders can readily evaluate the services that GOS offers. The system includes tools to generate reports on contents and activity of the portal and its underlying databases on a daily, weekly, and monthly basis. A number of agencies contribute to GOS, and each is required to report annually to the Office of Management and Budget, as established through the OMB Circular A-11. Each agency that contributes to GOS reports its GOS expenditures in its respective reporting, and these figures are meant to match the figure that is used in the collective GOS report. Currently, government agencies are discussing a joint budgeting and reporting process that would be broader than just GOS. It is part of the new Geospatial Lines of Business initiative focusing on shared resources under a service-oriented architecture. The GOS Technical Lead contemplates that in due time, "*A shared funding algorithm will have to be developed and agreed to by the partners, as well as a shared performance measurement process* (e-interview with Robert Dollison, May, 31, 2006)."

Geoconnections (Canada)

GeoConnections Phase I was a seven-component, sunset program of the Canadian government, funded for five years starting in 1999. The primary objective of Phase I was to develop the infrastructure that enables greater use of geo-information by users that apply the infrastructure to new products and services and to leverage investments to increase the supply of geo-information on the Internet and accelerate technology development and commercialization by the private sector. The Program itself did not make user applications available;

rather it built the infrastructure to enable and others to develop applications more flexibly and efficiently. NRCanada had the responsibility to implement the program. A Management Board, consisting of 17 members from federal, provincial and municipal agencies, industry and academia, recommended targeted deliverables and reviewed performance measures for evaluating GeoConnections. Geoconnections now is in Phase II, but at the end of Phase I, before signing off on a second phase, the Treasury Board conducted a comprehensive ex-post evaluation of each of Geoconnections' components. The evaluations covered the full range of perspectives and were performed using evidence gathered from interviews and reviews of strategic documents including key project reports (i.e., proposals, progress reports, final reports, and analysis documents) and other relevant material. Particular emphasis was given to the leveraging of public financial resources. Earlier on in the project a Performance Management and Evaluation Framework was prepared to guide short-, medium- and long-term performance measurement, as well as the planning of evaluations and reporting on progress (Andari Consultants, 2001). With the start of Phase II in 2005, GeoConnections established a new Value Management Office (VMO), which will provide more rigor and flexibility for future evaluations of both inputs and outputs. Geoconnections also will pursue other evaluation orientations to assess broader SDI outcomes.

Table 4. Summary of SDI control evaluation: dimensions of institutionalization.

SDI Initiative	Perspective	Formal Demand	Primary use	Input specificity across agencies	Evaluation formality, periodicity
A priori/ex ante evaluation					
Oregon Statewide GIS Utility (USA)	P, O	Fulfillment of an organizational directive	Expenditure decision – supporting new investment	n/a	One-time contracted evaluation requested by Oregon Geographic Information Council (OGIC) and Information Resources Mgt. Division (IRMD), Oregon Department of Administrative Services
Thailand NSDI	P, O, B	Fulfillment of an org. directive	Expenditure decision – supporting new investment	n/a	One-time contracted evaluation requested by and prepared for Deputy Prime Minister; report circulated to public stakeholders for review and comment.
During/performance measurement					
Gigateway (UK)	P, B	Fulfillment of an org. directive	Steering service delivery	n/a	Evaluation administered under terms of contractual agreement between AGI and Ordnance Survey.
WALIS (Australia)	O, B, L	Compliance with regulatory oversight	Strengthening accountability	n/a	Legally required annual reporting to Parliament with independent audit by the Auditor General.
SDW/AltaLIS (Canada)	P, O, F, B	Fulfillment of an org. directive	Steering service delivery	n/a	Formal annual reporting and financial audit under terms of contract.
MetroGIS (USA)	P, O, B	Fulfillment of org. directive	Documenting benefit / Improving relations with stakeholders	n/a	Formal annual reporting to stakeholders; obligatory annual report to Metropolitan Council as part of budget request.
PSMA	P, O, F, B, L	Fulfillment of an org. directive	Informing stakeholders	n/a	Formal annual reporting to shareholders, required under corporation law.
DINO (The Netherlands)	P, O, F, B	Fulfillment of an org. directive	Steering service delivery	n/a	Formal annual reporting and financial audit.
Geospatial One Stop (USA)	P, O, F, B, L	Compliance with regulatory oversight	Expenditure decision - continuing program funding	Cross-agency specification of inputs	Formal, mandated annual reporting to OMB and on-demand web-based reporting to stakeholders.
A posteriori/ex post evaluation					
WALIS (Australia)	O, B	Response to stakeholders	Improving relations with stakeholders	n/a	One-time contracted study of value of WALIS; extension to 2003 performance review.
Geoconnec-tions (Canada)	P, O, F, B, L	Compliance with regulatory oversight	Expenditure decision - continuing program funding	Cross-agency specification of inputs	Formal 'budgetary sunset' evaluation by Treasury Board Secretariat for each of project's seven components.

Key: Platform improvements (P), Operational (O), Financial (F), Beneficiaries (B), Learning and growth (L)

4. ANALYSIS

The eleven 'control' evaluation examples explored in the previous section help us understand how and why practitioners 'on the ground' are evaluating their own SDI implementation efforts. 'How' the evaluation is being carried out points to aspects of 'timing', 'perspective' and 'input specificity" in the evaluation process. 'Why' the evaluations are being carried out points to issues of 'demand' for and 'use' of the evaluation results. In this section, we analyze each of the five dimensions - timing, perspective, demand, use, and specificity of inputs.

'Timing': 'During' evaluation, or performance measurement, increasingly has been conducted since 2002. This trend reflects a growing recognition of the need for more management controls in order to achieve SDI objectives. It is in line with suggestions from IS evaluation literature that a more integrative approach to evaluation be applied across the full IS/IT life-cycle. Prior to 2002, few performance measurement examples existed. The majority of 'control' evaluation examples were ex ante, driven by the need to justify investment and secure funding. Examples of ex-post evaluation are scarce. This is understandable, because most SDI initiatives still are in their infancy and post-implementation evaluation of SDI is premature. The two cases of ex-post SDI evaluation from our survey were for efforts that have been underway for many years. WALIS was established in 1981 and Geoconnections was a project funded to support the Canadian Spatial Data Infrastructure, whose origins date back to 1996.

'Perspective': Practitioners are using several evaluation perspectives (and related measures) resulting in more comprehensive evaluations. The examples show that operational concern such as productivity or efficiency is not the only aspect that is addressed. In several instances, the 'beneficiaries' perspective such as user satisfaction is included, presumably in response to concerns that services should be user-driven. Still, overall, the operational perspective is dominant, with the consequence of time and cost-based measures being most frequently used. Although evaluations incorporating multiple perspectives are more comprehensive, this does not mean that a universally-relevant set of indicators is desirable or meaningful. Practitioners identify measures for each evaluation perspective according to their own objectives and their own perception of benefits/impacts.

'Demand': Formal demand appears to be the key trigger for the unfolding of an evaluation process. The few examples we identified in our worldwide review are in response to a formal demand. In the examples, demand most often is internal, with evaluation sought by those government agencies principally involved in the operations of the SDI initiative. Only in three examples, WALIS, GOS, and Geoconnections, is the demand external, from an executive or central agency not

directly involved in operations. In these cases the demand is enforced through legislation or administrative policy. Sunset legislation management was the basis for the Geoconnections' evaluation, requiring evaluation by the Treasury Board in order to justify the continuation of the program. Performance audits of GOS and WALIS are required by the central agencies responsible for budgetary oversight. Irrespective of whether the demand is internal or external, our results are consistent with assertions by authors emphasizing the importance of specific *push factors* in overcoming evaluation inhibitors (Gwillim et al, 2005; Seddon et al, 2002).

For MetroGIS and DINO, it may appear that formal demand was not the key trigger for evaluation and that instead, the supply of performance information by proactive managers preceded the demand. However, in both cases, there was the potential for budget cuts, and the managers' impetus for carrying out the evaluation and supplying performance measures was to ensure that funding would be continued. Thus, the uncertainty of budgetary decisions served as the demand. The respective management structures recognized that evaluation would be constructive in the validation of activities and thus sanctioned the practice. Performance measurement since has become a standard operating procedure for both initiatives. Gigateway's revision to its performance measurement approach similarly was driven by the budget situation. In order to ensure future funding, more attention was given to the 'beneficiaries' perspective of evaluation to demonstrate the relevance of Gigateway to national interests and thus its worthiness of national budgetary support.

External demand may be a contributing factor to the comprehensiveness of the evaluation. GOS and Geoconnections were two of the three most comprehensive evaluation examples. Both were formally linked to a regulatory process in which the evaluation was part of compliance with an executive agency. Evaluation "works best if it is a centrally driven initiative of a powerful finance ministry, linked closely to its main area of influence, the annual budget process (Carin and Good, 2004, p.8). Boyle (2003) concurs that evaluation should have strong central support from central government bodies. Central agencies should "provide an oversight and coordination role, and also provide guidance and advice (ibid)." PSMA also was among the most comprehensive evaluations. Although PSMA is not under the oversight of a finance ministry, the comprehensiveness of its evaluation perhaps can be attributed to the fact that it is run as a business with conventional structures for oversight. AltaLIS, too, has a similar business orientation which dictates tight monitoring of inputs and outputs and reporting to a Board of Directors. The oversight role of the central budget agency can be compared to the Board of Directors oversight of PSMA and of AltaLIS. 'Control' evaluation practices after all were honed in the commercial sector.

'Use': Since most of the evaluation examples are recent, it is too early to confirm the use and utility of the performance information. At a superficial level, we see that performance information is being used for service development, budget decisions, and accountability purposes, but ultimately, the test of utility will be signs of marked improvement in outputs over time. A further complication is that improved performance is the collective consequence of the behavior of individuals. While performance information at the organizational or corporate level can contribute to decisions about investment priorities and service delivery, most improvements eventually rely upon people choosing to change the way they carry out their work for their organization. Consequently, performance information also must be linked to human resources management. PSMA, for example, has been moving in this direction with the development of individual performance contracts with key performance indicators.

'Input specificity': Perhaps the thorniest issue with respect to how SDI 'control' evaluations are conducted involves input specificity. While practitioners are showing a clear trend in documenting outputs, the public sector evaluation literature indicates that both outputs and inputs need to be specified. However, inputs are not receiving adequate attention, in part because the information is so difficult to obtain; inputs typically are sunk, indirect, or concealed in program budgets. Also, agencies refrain from divulging their inputs, as this is seen as impinging on their autonomy." Among the examples, only GOS and GeoConnections make an attempt to identify inputs or leveraged resources from across a spectrum of contributing agencies. For GOS, agencies are obliged to report their geospatial expenditures that contribute to GOS, as well as other activities; this is part of the OMB A-11 requirement. Geoconnections has established a Value Management Office with staff trained to deal with the complexity of accounting for geospatial investments and leveraged resources by agency, program area, and locality. The other evaluation examples account only for the inputs of the SDI coordinating body, or their emphasis is on outputs alone. The lack of specificity of inputs in most examples calls into the question the interdependencies between agencies and their ability to pursue cross-agency investment planning. Moreover, without clarity about inputs, evaluation of efficiency suffers. It is not enough for the coordinating body to assess only its own inputs (and outputs), rather the discrete (or disaggregated) inputs (and outputs) of all agencies must be taken into account to determine the overall state of efficiency. MetroGIS recognizes this and envisions that more emphasis will be given to inputs in the future.

5. CONCLUSION

In this paper, we mobilized concepts from IS/IT and public sector evaluation research to analyze how and why SDI practitioners 'on the ground' are evaluating their 'own' efforts in implementing SDI. Practitioners tend to conceive SDI with a

cost savings/cost reduction objective, and in recent years, they have begun to develop control-driven performance measurement systems focusing on inputs and outputs. This convergence on 'control' evaluation pointed to an opportunity for research. By exploring control evaluation in practice – pulling lessons out of the woodwork – we aimed to move SDI evaluation research to a new level of inquiry.

'Formal demand', 'use', and 'input specificity' are thought to be determinants of institutionalization of evaluation practices in the public sector. Since SDI evaluation is unfolding in the public sector, we anticipate that these dimensions in turn will have a bearing on SDI evaluation institutionalization. As we have shown, demand for SDI evaluation can be both internal and external, but external demand from a central budget agency appears to lead to greater 'input specificity', and thus greater clarity of interdependencies between agencies, as in the examples of GOS and Geoconnections. Since these two evaluation examples also exhibit a high degree of comprehensiveness in terms of the perspectives they cover, we believe that an in-depth study of how the evaluation process in these particular examples has evolved over time is warranted. This will be the topic of further research.

Even though authors have highlighted the complexity of SDI and the intangible nature of its benefits (Georgiadou et al, 2006; Rodriguez-Pabon, 2005), hard, quantitative measures are the dominant basis for evaluation. In bureaucratic settings, practitioners are wedded to 'hard evidence' of IS/IT effects. ACIL Tasman (2004, p.15), in their SDI valuation study in Western Australia, acknowledged that "[q]ualitative values are just as real and important as those that can be quantified," but they pointed out that qualitative values "usually do not receive the same level of recognition." Similarly, Wilson (1989) noted that the observability and measurability of outputs are vital supports for understandability by non-expert 'outsiders'. This explains why executives are drawn to quantitative measures. For these two reasons, recognition and understandability, bureaucracies are likely to continue to cling to 'control' evaluation. Also, 'control' evaluation is what is most familiar, so there is a cultural lock-in for this approach. Given these predispositions, we anticipate more examples of SDI control evaluation in the coming years, provided formal demand is present. Instituting evaluation is particularly timely, not just because of the growing attention to SDI, but because public institutions worldwide are being held ever more accountable.

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Appendix A. Summary of SDI control evaluation: SDI initiative, year of evaluation, specific objectives, and explicit measures used for evaluation.

SDI Initiative	Year of evaluation	Low uncertainty as to objectives	Low uncertainty as to impacts and strategies
		specific objectives	*explicit measures*
Oregon Statewide GIS Utility (USA)	2005	Reduce the cost of geographic information gathering and access by state, regional, and local government agencies	• Operational and Efficiency Benefits: Expected gains in current personnel efficiency and productivity will allow them to carry out their work in less time with less expense • Cost Savings and Cost Avoidance: Actual savings of money (contract costs, direct expenses) or the avoidance of future costs that might be necessary to support or comply with new program requirements • Revenue Enhancement: Opportunities for additional revenue by using geographic data and technology to support more effective real property tax and fee collection, increases in federal appropriations, and the location of the revenue sources.
Thailand NSDI	2004	Develop a better environment for the integration and sharing of information across all government sectors and society at large.	Automation and sharing of the fundamental geographic datasets seen as largest area for benefit, thus measures focused on benefits of having datasets in digital form, rather than manual: • Reduced time involved in data development and acquisition • Reduction in ongoing data maintenance and dissemination • Reduction in computing infrastructure allocation • Reduction in staff training allocation.
Gigateway (UK)	2005 (new approach begun)	Provide a national metadata service as a vital part of the national spatial data infrastructure. The primary focus for 2005-6 is the inclusion in the service of discovery metadata that describe 'core' datasets, with emphasis on quality, including currency, rather than quantity.	• Number of core datasets on the service as percentage of those defined as core. • Number of organizations providing metadata as a percentage of those defined as core. • Percent of new datasets on service reaching Gigateway 'accreditation standard'. • Number of visits to the site itself; • Use cases demonstrating tangible benefit • Availability of Gigateway Data Locator and Node as a percentage of stated service level

Western Australian Land Information System (WALIS)	2003-present	Build networks of people and technology to share information and improve its usefulness and accessibility. There are six key result area: • Facilitate whole of government spatial information (SI) strategic planning and program management. • Lead in spatial information (SI) policy formulation and implementation. • Manage government SI quality (including metadata). • Lead government SI access piloting and the provision of 'free' government SI. • Facilitate and negotiating stakeholder relationships across the WALIS community. • Oversee the WALIS Program via a four-part governance framework.	• Average cost of delivering each of the key results • Awareness - Percentage increase in first time participants at WALIS functions • Awareness - Percentage increase in repeat participants at WALIS functions • Acceptance - Percentage increase in number of first time customers accessing spatial information from WALIS community members • Reuse - Percentage increase in number of return customers accessing spatial information from WALIS community members
	2004	(see above)	• Savings that government agencies achieve due to reduced duplication of work in collection of information & reduced effort required to manipulate data to make it compatible with other data sets (producer surplus) • Extra value contributed by WALIS to spatial data, as identified by the final users of that data (consumer surplus)
Spatial Data Warehouse Ltd./AltaLIS (Canada)	1998 - present	• Reduce cost of operations significantly. • Improve operational efficiency and service levels to all users. • Increase demand for SDW data by improving the product and improving the product for SDW participants. • Increase data sales to third parties by making data more available and accessible. • Increase data revenues from third parties by improving the marketing, pricing, and licensing arrangements.	• Reduction in delivery times, update cycles, and pricing, as well as increased data and service quality. • User feedback
MetroGIS (USA)	2002-present	Facilitate widespread sharing of geospatial data, by means of • Improve participant operations • Reduce costs	• Number of visits/sessions to DataFinder Web site; • Number of entities visiting DataFinder; • Number of whole or partial datasets and regional datasets downloaded through DataFinder;

		• Support cross-jurisdictional decision-making.	• Number of entities listing metadata on DataFinder; • Hours of data-producer staff time saved; and • Anecdotes or case studies about how MetroGIS's products and services have impacted stakeholder operations, systems, and decision-making.
Public Sector Mapping Agencies Australia Limited (PSMA)	2005 (new approach begun)	Coordinate, assemble and deliver national products from jurisdictional and other selected datasets and to achieve the widest possible use of the PSMA Australia datasets. Specifically, this includes: • implementation of the Spatial Data Warehouse to improve data quality, integrity and cross dataset consistency. • building of new datasets to increase the functionality and strategic importance of those datasets already under maintenance.	• Preferred supplier of national datasets • Products aligned to customer needs • Increased royalties to shareholders • Suppliers adopt PSMA enhancements • Increased number of partners • Value Added Resellers satisfaction • QA accreditation • Key partners' satisfaction • Number and range of end users • Co-branding • Number of websites/website hits • Number of market segments • Number of partners/Value Added Resellers • Increased sales
National Geo-data Repository - DINO (The Netherlands)	2002 - present	Promote investment in the country, share costs of data development, and reduce costs of data storage.	• Statistics on the actual usage of the NDR - DINOShop • Economic value of the subsurface to society (gross turn-over in EUR billions per annum) • Balance of annual investment of the information function against the accumulated value of geo-data • Savings in necessary geo-data acquisition plan • Savings on project's geo-related costs such as foundation or dike work • Time gained on a projects • Those who use geo-data benefit from the improvement in the success rate achieved by exploration activities • Better decision making • Contribution of public organization's products to the gross added value per industry sector per annum
Geospatial One Stop (USA)	2002 - present	Improve the ability of the public and government to use geospatial information by: • increasing access geospatial information • providing opportunities for collaboration, intergovernmental partnerships and reduce	• Number of data sets posted to geodata.gov • Number of Federal agencies, state agencies, and local jurisdictions posting data. • Number of data set hits on geodata.gov; number of visits to geodata.gov

		needless duplication of data investment • facilitating standardization and intergovernmental agreements on standards and interoperability.	• Number of partnership opportunities posted to geodata.gov • Number of cost sharing partnership opportunities for data collection activities posted on Geospatial One Stop. • Federal, State, Local, and Tribal participation and portal functionality • Savings achieved, by State and theme, in avoiding redundant, non-standard data collection through the Geospatial Market Place • Use of portal in G2G interactions through web site registration for access to capabilities by other portals • Reduce avg. time to access geospatial data • Use of Geospatial Acquisition Market Place and total dollars saved through partnerships; increase in state-wide and regional coordinated spatial data acquisition • Increase in GOS user base • Increase in availability of GOS application services • Improve effectiveness of customer decision-making processes. The portal automatically generates the following metrics: • Sample maps generated by the portal • Number of publications (new and updated) • Publishers by category • Cost-sharing partnerships requested • Metadata harvesting activity • Usage of data and map services • Percentage of metadata requests by community
Geoconnections (Canada)	2005	With a particular emphasis on building partnerships: • develop the infrastructure that enables greater use of geoinformation • stimulate users to apply the infrastructure to new products and services • leverage investments to increase the supply of geoinformation on the Internet; and • accelerate technology development and commercialization by the private sector.	• Leveraged investments (GeoBase; GeoInnovation; Access component) • Acceleration of making framework datasets freely available over the Internet (GeoBase) • Usage statistics of GeoBase portal (GeoBase) • Examples of GeoBase data being used by Canadian companies and governments (GeoBase) • Examples of data providing the basis for value-added business (GeoBase) • On-line access to Canadian data collections, along with tools and services (Access component) • Reduced duplication of effort and unnecessarily limited use of data (Access component) • Broad participation in an open standards (Access component)

			• Mechanisms for suppliers to advertise and distribute (Access component) • Canadian industrial capability for international geomatics markets (Access component) • Leveraged collaborative arrangements between the geomatics industry and other primary stakeholders (GeoInnovation) • Responsiveness to community of practice, the Aboriginal, remote and rural communities (Sustainable Communities Initiative) • Social, environmental and economic benefits to communities (Sustainable Communities Initiative)