

Understanding Interorganizational GIS Activities: A Conceptual Framework

Zorica Nedovic-Budic, Ph.D.

Jeffrey K. Pinto, Ph.D.

Abstract: Widespread diffusion of geographic information systems (GIS) and related proliferation of spatial databases in digital form have prompted the practice of joint development and sharing of geographic databases. The ultimate benefit from the coordinated GIS developments and database sharing is reduced redundancy and duplication of effort and establishment of data partnerships and networks which are the building blocks of the National Spatial Data Infrastructure (NSDI). However, the multi-participant GIS activities are found to be much more challenging than the implementation of internal, single-agency systems and databases. To date, there has not been sufficient knowledge about the factors and processes that influence development and use of interorganizational GIS and databases. This paper provides a systematic literature review and builds a conceptual framework for better understanding and effective management of the interorganizational GIS activities.

Introduction

Previous research provides only partial evidence about the trends in interorganizational development and sharing of geographic information systems (GIS) and databases, the obstacles and facilitators of interorganizational activities, and the benefits derived from the joint activities. Anecdotal evidence is provided primarily through conference presentations, usually as a discussion of multi-participant or enterprise-wide developments and data sharing issues (Burton et al. 1998; Di Pollina et al. 1998; Ehler and Petrecca 1998; Hatton 1997; Reed 1998). Those sources provide a foundation for initial recognition of the relevant issues, but they stop short of systematic examination of factors and processes that permeate the efforts in digital spatial data development and sharing. The current GIS literature is scarce

in evaluating the effectiveness and suitability of different sharing mechanisms in varying organizational and interorganizational contexts. Based on the literature in organizational studies, inter-group dynamics, exchange theory, political economy and research on GIS implementation and diffusion, we propose a comprehensive framework for understanding interorganizational GIS activities. First, we review the experiences in multi-participant GIS and database developments, and related mechanisms, policies, and outcomes.

Sharing Practices

Redundancies in data developed and managed by individual agencies have long been recognized as issues of concern in both the private (Harralson et al. 1988) and public sector (Eichelberger 1986). Due to the widespread belief in the benefits associated with distributed databases, multi-participant GIS projects are being established along with single-user systems. Trends toward multi-participant or shared GIS projects have been evident in both the US and UK local governments (French and Wiggins 1990; Budic 1993; Masser and Campbell 1994; French and Skiles 1996; Warnecke et al. 1998). These sharing arrangements range from the manual exchange of digital data and "access only" policies, to fully shared distributed or centralized GIS and databases. Longitudinal data on UK authorities acquired by Masser and Campbell (1994) suggest a change in the rate of diffusion of the multi-participant GIS projects. Their data shows a decrease in the proportion of multi-departmental systems from over one half in 1991 to under one half in 1993, suggesting to them that sharing during that

Zorica Nedovic-Budic is assistant professor of urban planning and geographic information systems (GIS) at the University of Illinois at Urbana-Champaign. Her main research interest is in diffusion and implementation of GIS technology in local governments, evaluation of GIS technology in local governments, and evaluation of its impact on the urban planning process and decisions.

Jeffrey Pinto is the Samuel A. and Elizabeth B. Breene Fellow in Management and associate professor of management in the School of Business at Pennsylvania State University - Erie. He is the author or editor of seven books and more than 90 scientific papers in the areas of project management and organizational studies.

time period becoming increasingly problematic. During the same period there was a shift from corporate GIS projects involving all departments, to smaller scale ventures involving two to three participants.

With respect to coordination efforts, GIS developments in state agencies in the United States have evolved from the early, department-specific systems, through informal multi-departmental arrangements, to multi-agency, cross-departmental, and statewide foci (Croswell 1994). Several states have taken a proactive role in stimulating and coordinating GIS diffusion and modernization of land records at the local and regional government level where they can offer the financial and/or the technical support needed (Warnecke et al. 1992; Warnecke 1995). Increased practice of data sharing has prompted some states to initiate development of a common statewide base map. Texas Orthoimagery Program (Decker and Seekins 1997) is one example of such statewide effort.

At the federal level, efforts supporting the development and distribution of digital spatial data have been long-standing, beginning with the initiation of the National Mapping Division Digital Cartography Program in 1979 by the US Geological Survey. While the individual agencies have been using GIS technology for specific projects for more than two decades, until recently there were few pronounced mechanisms for coordinating spatial data resources at the federal level. Development of the GBF/DIME and TIGER files were significant advancements in data sharing. These projects that promoted data sharing among more than three hundred local planning agencies and successfully overcame bureaucratic inertia (Sperling 1995). Most recently, a significant step forward in advancing the comprehensive provision and exchange of reliable data among a variety of users, including all levels of government, private sector, and educational institutions is the initiative for development of the National Digital Geospatial Data Framework and Clearinghouse. (FGDC; Frank et al. 1996; Coleman and Nebert 1998; Smith and Rhind 1998)

Sharing Obstacles and Facilitators

Both technological and organizational difficulties are more likely to be encountered in building interorganizational GIS and databases. Campbell and Masser (1995) point out the following specific problem areas: a) variations in priorities between participants; b) differences in the ability to exploit GIS facilities; c) differences in the level of awareness and spatial data handling skills; and d) agreements over access to information, leadership, data standards, equipment, and training (p. 236). Azad (1998) proposes the functional diversity among various participants as the major challenge in developing enterprise-wide systems.

On the technical side, there have been problems in coordinating system requirements (Croswell 1991; Calkins and

Weatherbe 1995b); lacking common data definitions, formats, and models (Frank 1992; Dawes 1996); differences in data quality (Frank 1992); and networking costs. While those problems tend to cause less than desirable system performance, they have been gradually alleviated through technical solutions toward interoperability and open systems (Bishr 1998; Laurini 1998; Voisard and Schweppe 1998), distributed data processing in heterogeneous environments (Abel et al. 1998), integration of federated databases (Devogele et al. 1998), and the use of World Wide Web for data distribution and viewing (Heikkila 1998).

Data confidentiality, liability, and pricing are further constraints to interorganizational GIS efforts. Data access policies established by individual organizations are ultimately going to affect data exchange activities and benefits accruing to various data users and producers (Lopez 1996; Onsrud et al. 1996). In her survey of inter-agency information sharing, Dawes (1996) finds inadequate planning and consultation about data use, and insufficient staff and technical resources as frequent obstacles. Other external obstacles include institutional disincentives, historical and ideological barriers, power disparities, differing risk perceptions, technical complexity, and political and institutional culture (Citera et al. 1995). With a similar set of factors operating in the state government agencies, Sperling (1995) adds staff turnover, lack of resources, archaic systems, and lack of support and commitment from managers and officials, as preventing effective development and sharing of geographic databases.

Organizational settings and interorganizational relations significantly complicate the implementation of multi-participant GIS projects and can jeopardize the benefits of the joint database development and sharing. Organizational reluctance to share GIS files due to a fear of losing autonomy, control over information sources, independence, and organizational power is widely acknowledged (Bozman 1989; Pinto and Azad 1994; Azad and Wiggins 1995; Meredith 1995). Interorganizational systems increase interdependencies (Azad and Wiggins 1995), create the potential for power shifts (Stern and Craig 1971), and frequently invoke "turf" (Dawes 1996). Those relationships are dominated by interorganizational politics (Azad 1998).

A recent study on data resource management (DRM) in distributed computing environments identifies four conditions that need to come to a congruent "gestalt fit" in order to secure system success. This fit is present in "organizations represented by a well-blended configuration of high intersite data dependence, high centralization of IS decisions, high concentration IS resources at the central site, and low DRM-related autonomy granted to local sites" (Jain et al. 1998, p. 1). Azad (1998) suggest the utmost importance of management, while Evans (1995) notes that teamwork and joint interest in applications, flexibility of the system development, and willingness to incorporate

institutional learning are necessary conditions for GIS data sharing to be successful.

These are all difficult prerequisites when compared to the advantages of a single user approach that presumes more independence, autonomy, and control (Campbell and Masser 1995). To make the interorganizational strategies easier to implement, it is of great importance to identify organizational factors that influence the efforts to coordinate GIS activities across organizational boundaries. Such attempts have already been made in several fields (policy implementation, organizational studies, management), including the contributions made so far through the National Center for Geographic Information and Analysis (NCGIA) Initiative 9 on Institutions Sharing Geographic Information (NCGIA).

Benefits from Sharing

The existing evidence concerning the benefits from multi-participant GIS and databases is generally positive, but in some cases ambiguous, due to a greater complexity of implementation and difficulty in achieving the operational impacts (Campbell 1991; Azad and Wiggins 1995). Sharing the cost of implementation among several participants, and boosting of productivity and decision-making through exchange of information are two main potential benefits from multi-participant approaches (Brown and Brudney 1993). In the past databases shared by many users were found to be cost effective (Levinsohn 1989), promulgate savings, improve data quality (Harralson et al. 1988), and yield the highest returns on investment (Tveitdal and Hesjedal 1989). French and Skiles (1996) find that distributed and centralized multi-participant systems are perceived as more effective and their users are more satisfied than the users of single-agency systems. Respondents to Dawes' (1996) survey recognized benefits in better and more integrated planning and policy development, problem solving and relationship building, with positive impact increasing with more experienced users. In her survey of southeastern planning agencies, Budic (1994) suggests that GIS sharing contributed to reduced time spent in data collection and decision making, inclusion of more diverse maps, and increased availability of data.

Some system benefits stem from the process of coordination itself. Coordination can offer a number of intangible advantages, such as improved morale, learning, self-confidence, and confidence in others. Coordination can also generate some frustration, lower confidence in the other participants, and create extra work (Tjosvold 1988). There are a few other impacts that are related to organizational interdependencies. For instance, Brown et al. (1998) report that productivity, performance, and decision-making are all negatively related to greater resource interdependence. Dawes (1996) found a limiting effect on the professional discretion in policy design and program decisions. Given

the contradictory evidence from the fields of interorganizational relationships, organizational studies and information systems research, the impact of coordination in development and use of GIS databases is hard to predict.

Conceptual Framework

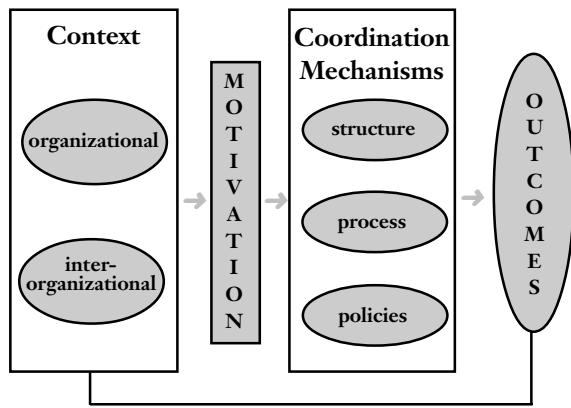
It is of ultimate importance to provide empirical evidence of the organizational and behavioral factors related to sharing of spatial databases and other joint geographic information system activities. The literature on organizational interdependencies, organizational internal and environmental factors, interorganizational relations, and policy implementation provide a number of useful concepts and paradigms to guide studying and managing joint development and sharing of geographic data. Drawing on his extensive professional experience, Kevany (1995) provides a comprehensive list of the factors relevant to GIS data sharing. Those factors include sharing classes; organizational environment; need for shared data; opportunity to share data; willingness to share data; incentive to share data; impediments to sharing; technical capability for sharing; and resources for sharing. A conceptual framework presented here builds from Kevany's ideas, but draws on a broader literature base to derive four general theoretical constructs on coordinated GIS developments and database sharing. Those constructs include context, motivation, coordination mechanisms (structure, process, and policies), and outcomes (Figure 1).

Interorganizational Context

Interorganizational context refers to the organizational factors and interdependencies that influence coordination and decisions about joint GIS and database activities. Despite the limited ability to manipulate the contextual factors, and in particular when considering the prospective scale of the NSDI, the context is very important in understanding the geographic information relationships and activities. Those relationships and activities can only be examined with respect to their context. Interorganizational systems and databases are manifestations of the interorganizational relationships (Kumar and Dissel 1996) and models of government (Westin 1991). Relating the context and GIS activities should help assess the applicability and functionality of sharing structures and policies in various interorganizational settings and under different organizational circumstances. Azad (1998) maintains that "working the context" is necessary for raising the odds of an enterprise-wide GIS implementation success.

The building blocks for studying GIS sharing as reviewed by Azad and Wiggins (1995) include: organizational exchange theory (Cook 1977); interorganizational relationship determinants (including necessity; asymmetry; reciprocity; efficiency; stability and legitimacy Oliver 1990); organizational interdependence (Thompson 1967); and or-

Figure 1



ganizational relations intensity (with coordination implying the highest intensity, preceded by collaboration and cooperation) (McCann 1983). Levine and White (1969) define exchange as “any voluntary activity between two organizations which has consequences, actual or anticipated, for the realization of their respective goals or objectives” (p. 120). Exchange is usually sought with the minimum loss of organizational autonomy and power, and depends on the availability of alternative resources.

Thompson (1967) identifies three types of organizational interdependencies, from lesser to increasing complexity: pooled; sequential, and reciprocal interdependency. Meredith (1995) postulates that already existing organizational interdependence will reduce the resistance to interorganizational sharing. This is particularly true for cooperative interdependence (Tjosvold 1988). However, increased interdependence and need for cooperation can in some situations lead to conflicts over authority, jurisdiction, and distribution of power. On those lines, Kumar and Dissel (1996) relate the type of interdependency and interorganizational system and potential for conflict (Table 1). An adversarial view of other actors “coupled with a short-term, gain-taking mentality can result in opportunistic behavior by one or more participants” (Kumar and Dissel 1996, p. 280).

A number of researchers have examined the types of factors that can influence the quality of interorganizational relations. Meredith (1995) identifies ambiguity and complexity as important determinants of the level of resistance to interorganizational ventures. Craig (1995) finds that institutional inertia can contribute to resistance to cooperation. Many other environmental factors can affect interorganizational exchange, including: organizational structure, resources, stability, culture, quality of relationships, bureaucratization of rules and procedures, incentives, and leadership (Cummings 1980; Van de Ven and Ferry 1980; Tjosvold 1988; Calkins et al. 1991; Obermeyer 1995;

Pinto and Onsrud 1995; Brown et al. 1998). Finally, interdependence and greater mutual resources also tend to increase the number of joint decision points, and thus constrain the decisions and the probability of successful joint implementation (Aiken and Hage 1968; Pressman and Wildavsky 1984).

Motivation for Interorganizational GIS

Underlying the discussion of the value of coordinating interorganizational GIS and database activities is the need to identify the motivations that would impel organizational units to get actively involved in relationships with other organizations. A number of factors contribute to the perceived need to seek out interorganizational geographic information relationships. Coordination can be based on:

- authority, i.e., deriving from a sense of duty;
- common interest of organizations that value the same goals); or
- exchange inducements when returns are expected or received (O’Toole and Montjoy 1984).

Participation can be voluntary or mandated (Cummings 1980). The amount and contents of interorganizational interaction are often determined by the primary function of an organization (Levine and White 1969). In the GIS literature, the following reasons are cited as motivating the GIS related interaction: organizational needs, capabilities, and cost (Calkins and Weatherbe 1995); power relationships; appeals to professionalism and common goals (Obermeyer 1995); incentives, superordinate goals, accessibility, and resource scarcity (Pinto and Onsrud 1995).

Cost saving has been the major reason for interorganizational engagements. Governmental agencies often form partnerships as a vehicle to streamline their costs under the circumstances of fiscal pressures (Brown et al. 1998). In the case of GIS, the main saving is achieved through reduced duplication of efforts in developing digital databases (Larsen 1976). While the economic arguments are most common in the literature on interorganizational systems, Kumar and Dissel (1996) alert to the importance of technical and socio-political arguments in explaining collaborative alliances. Creating synergisms for better insights is an example of such non-economic argument (Craig 1995).

The bottom line of successful interorganizational endeavors, however, is the participants’ willingness to form partnerships, to share both the benefits and the risks, and to reach agreement on many practical issues. The success depends on the internal motivational factors, i.e., on the spirit of cooperation and commitment to sharing (NGDPF 1993; Meredith 1995).

Coordination Mechanisms: Structure, Process and Policies

The central element in the conceptual framework presented here is the geographic information relationship. The

relationship assumes interorganizational structures and policies employed, and the history and process undergone in coordinating multi-participant GIS and in establishing sharing relationships. Isolating and learning about the most robust coordination mechanisms and the most functional policies used would be of extreme utility in understanding and effectively managing geographic information relationships. Establishing formal standards, agreements, and coordination structures are necessary preconditions to any distributed GIS (Meredith 1995). Formalization tends to facilitate institutionalization of joint behavior, binding, and commitment (Brown et al. 1998).

Structure

Any joint GIS-related activity involves redefinition of existing tasks and structures and creation of new ones (Azad and Wiggins 1995; Azad 1998). Structure of an interorganizational relationships is established by specifying roles, obligations, rights, procedures, locations, information flow, data, analysis and computational methods used in the relationship (Kumar and Dissel 1996). Structure reduces the ambiguities by formalizing the form, process and content of the relationship, and by implying a level of agreement about mutual expectations.

Godschalk, et al. (1985) describe three models with regard to distribution of computing equipment and responsibilities: 1) distributed processing, 2) centralized processing, and 3) decentralized processing. Clearly, only the first two models involve sharing and coordination of system's development and use, although, theoretically, the third model does not exclude interaction. Jain et al. (1998) suggest centralized configurations are likely to result in more successful data resource management.

Azad and Wiggins (1995) propose another typology of multi-participant GIS settings. Their classification reflects the dynamic relationship between the involved organizations, direction and reciprocity of data exchange: a) "one way" relationships in which one agency is the provider of data at nominal cost to one or more consumer agencies; b) "somewhat one-way" relationships in which there is a limited exchange/return of products from the user agencies; and c) "two way" relationships which entails joint building and maintenance of geographic databases. Calkins and Weatherbe (1995a) identify four modes of spatial data sharing, including user-driven random transfer, owner-driven random transfer, cycle-driven transfer, and cycle-driven exchange.

Dueker and Vrana (1995) identify three forms of database integration, including core database integration, database constellation, and marketplace integration. Core database integration happens by coordination at the interorganizational level, while the other two are incidentally compatible. Although the NSDI initiative is primarily concerned with access to data and integration of local data

to seamless national datasets, it requires networking capability and organizational structures to facilitate the electronic data transfer. Database is, therefore, only one of several possible components of integrated information systems. In addition to data, information about data (metadata, data dictionaries), system functionality (software, hardware), personnel (Nyerges 1989), applications, and space are candidates for sharing.

In summary, there are numerous ways to structure interorganizational GIS and database activities. These various configurations in developing and exchanging GIS resources often depend on the given institutional, technical, and economic constraints (Dueker 1987). According to Meredith (1995), less complex and unambiguous structures will diminish the resistance to interorganizational sharing, although Brown et al. (1998) find that simple structures do not unambiguously lead to better outcomes. They suggest, however, that "more complicated relationship structures will likely impact negatively on implementation capacity".

Process

GIS implementation in organizational settings is in itself a complex process that involves installing, maintaining, and using a system in environments that have diverse functions, tasks, resources, motifs, interests, and goals. Obviously, for GIS and databases to be jointly built or shared, there needs to be a critical mass of participants interested in the geographic information relationship (Azad and Wiggins 1995). The participants take various roles, such as information providers, service providers, distributors, and users (de Brisis 1995).

Interorganizational GIS activities raise the opportunities for complications in establishing partnerships, and require negotiations over cost, accuracy, responsibility, and many other issues involved (PTI/ICMA, 1991). Reaching the agreements on those many issues is the greatest challenge. Azad (1998) refers to coordination as the key vehicle for coping with setbacks and problems, guiding relationships, and managing production and use of the common datasets. The NSDI initiative recognizes the process of coordination among various public and private organizations as an inherent part of developing the information network.

Interorganizational relationships develop through three sequential phases: problem setting, direction setting, and structuring – each phase corresponding to gradually more intensive forms of interaction – collaboration, cooperation, and coordination (McCann 1983; Azad and Wiggins 1995). Coordination, obviously implying the closest interaction, is necessary in joint GIS activities. The type and level of the coordination process applied depends on the nature of the interorganizational relations (Cummings 1980) and the type of interdependencies existing between organizations (March and Simon 1958). Kumar and Dissel (1996) suggest that pooled interdependence requires coordination

by standardization; for sequential interdependence it is appropriate to apply coordination by plan; and with reciprocal interdependence coordination is pursued by mutual adjustment (Table 1). Examining the development of the interorganizational relationships and the process of coordination over time is important for understanding the current rationales and circumstances of joint GIS and database activities.

Policies

Policies are necessary for establishing and maintaining interorganizational GIS activities, and, therefore, have to be clearly defined. A summary of the issues for which policies will need to be developed, agreed upon, and implemented if some level joint GIS and database activity is to be exercised is provided below. The issues are grouped into five broad categories: data, responsibility, ownership, contribution, and incentives.

1) **Data:** The need for standards increases with intensified practice of GIS and data sharing activities. The standards are necessary for determining the fitness of data for different users (Rushton and Frank 1995). If well developed and adhered to by various parties, standards can reduce the cost of sharing (Bossler 1995). Interorganizational systems require standards on data models; data formats; data quality; categories of spatial data; contents of specific data layers; metadata; data dictionaries; output requirements; and data transfer. The standardization can extend to the whole database design (Calkins and Weatherbe 1995b). Various GIS-related standards are adopted or developed at international and national levels (Salge 1998), as well as among regional and local clusters of GIS data users and producers (Nedovic-Budic and Pinto 1998). The more generic standards are, i.e. the more independent they are from existing data models and software formats, the more useful they are in facilitating data sharing. For example, Arctur et al. (1998) criticize the Spatial Data Transfer Standard (SDTS) for limited applicability across multiple data models, and suggest ramifications for this unintended shortcoming.

2) **Responsibility:** Further policies need to be established to guide responsibilities for database development; deposition of data; database maintenance; data usage; distribution of data; user support; and decision-making. The importance of agreements on not only data delivery but on maintenance aspects can not be overemphasized (Frank 1992; Nedovic-Budic and Pinto 1998). Azad (1998) confirms that "even if an enterprise GIS is launched in a multi-participant setting and a useful spatial database gets built (internally or outsourced), the issue of keeping the data up to date and current becomes an independent challenge which can overwhelm the institutional apparatus with the best technical staff and the most progressive managers "(p. 1-4)

3) **Ownership:** Besides the responsibilities, it is important to clarify data ownership. The ownership-related policies need to be very specific and unambiguous. Vaguely defined policies could lead to many problems related to unresolved ownership issues. Equally important to the actual ownership is a sense of ownership, which can best be instilled through user involvement (Leonard-Barton and Kraus 1985; Hunton and Beeler 1997). Security features, such as additional routers, firewalls, and passwords are often necessary to support the agreements on responsibility and ownership (Lopez 1998).

4) **Contributions:** Funding of database development and maintenance; pricing for data distribution; charges for user support; hardware, software, and staffing expenses all need to be resolved and coded as an interorganizational policy. Equitable and fair cost allocation is crucial for a multi-participant system to be sustainable (King 1995; Nedovic-Budic and Pinto 1998). The method used in allocating the costs, however, is challenging to determine. In addition to the monetary contributions, bartering (Bossler 1995) and in-kind contribution of available assets and skills (King 1995) are also useful and effective means of exchange.

5) **Incentives:** Given that spontaneous coordination in interorganizational policy and projects are rare (O'Toole and Montjoy 1984), incentives are crucial instruments for stimulating interorganizational GIS activities. Chau and Tam (1997) find that the organizations tend to be more "reactive" than "proactive" in adopting open systems technologies. Therefore, the agencies need to be "pulled" or "pushed" into the sharing relationship (Azad and Wiggins 1995). Incentives do not necessarily need to be monetary (Bossler 1995). Minimizing cost and generating valuable social outcomes are two general incentives assumed by many organizations exchanging data (Taupier 1995). Craig (1995) suggests that expanded organizational mandates can secure change and counter institutional inertia. May and Burby (1996), however, alert that cooperative policies are more effective than coercive mandates in sustaining long-run implementation commitment in local governments. In addition to possible external incentives (or mandates), coordinating agencies can also use a set of internal incentives to realize joint GIS and database sharing goals.

Policies between organizations involved in joint GIS and database activities can be: a) formalized, documented, and guided by prescribed procedures and designated cross-organizational entities; or b) implemented as unwritten rules and verbal understanding of mutual conduct and obligations with no coordinating cross-organizational entity. The most common documents that are used to formalize interorganizational GIS activities are memoranda of understanding and intergovernmental agreements. The joint activities are usually coordinated by establishment of overarching bodies in form of multi-agency bureaucracy or

Table 1. *Interorganizational Interdependence, Coordination Mechanisms, Structurability, and Potential for Conflict (Adopted from Kumar and Dissel 1996)*

CONFIGURATION OF INTERDEPENDENCE	POOLED	SEQUENTIAL	RECIPROCAL
COORDINATION MECHANISMS	STANDARDS & RULES	STANDARDS, RULES, SCHEDULES & PLANS	STANDARDS, RULES, SCHEDULES, PLANS & MUTUAL ADJUSTMENT
STRUCTURABILITY	HIGH	MEDIUM	LOW
POTENTIAL FOR CONFLICT	LOW	MEDIUM	HIGH

management structure. Those overarching bodies have an important role in coordinating implementation activities; promulgating standards; developing data and cost sharing agreements; ensuring participation and compliance with interorganizational activities; preventing individual organizational approaches to collide; and escaping the “bureaucratic void” (Stage 1995; Ventura 1995).

Outcomes

The outcomes are the effects of the interorganizational GIS and database activities on the substantive application areas, as a measure of the value and social utility of geographic information (Onsrud and Rushton 1995). GIS sharing benefits cannot be separated from the value of final decisions and social outcomes to which they contribute (Taupier 1995). In theory, the interorganizational geographic information relationships appear to offer notable benefits in:

- efficiency (i.e., cost savings and productivity benefits from existing operations being performed at lower per-unit cost);
- effectiveness (enhanced capabilities for unit; new and better quality products; improved policy and decision-making);
- enterprise benefits (new responsibilities; broader mission); and
- public service (Brown and Brudney 1993; Dueker and Vrana 1995; Dawes 1996; Nedovic-Budic 1998).

Several criteria commonly employed for measuring the impact of information systems in organizations are (DeLone and McLean 1992): system quality, information quality, information and system usage, user satisfaction, individual impact (i.e., contribution to decision-making), and organizational performance (i.e., efficiency and effectiveness). While all six criteria can be applied in the evaluation of GIS benefits in interorganizational settings, the main difficulty remains in separating the effects of database sharing from the other general impacts of automating geographic

data resources. Efficiency, effectiveness, and decision-making impacts are discussed below in more detail.

When one organization is able to make direct contact with another party who possesses needed information, there is far less likelihood of replication of effort in creating and maintaining databases (Grimshaw 1988). Savings may also accrue during hardware and software acquisition and assignment of the personnel in charge of a GIS (Campbell 1990; Campbell 1991). An organization’s efficiency is enhanced through this sharing process. Gillespie (1991) suggests that one measure of enhanced efficiency would be to compare the difference in variable costs (labor, time, and money) of producing all necessary information in-house versus retrieving that information from other sources who have, in all likelihood, already produced the needed information. It is readily apparent that in avoiding the duplication of effort from information reproduction, organizational sharing aids in improved efficiency.

Effectiveness has been defined as the case when GIS programs “increase the quality of the output or produces a new output” (Gillespie, 1991: p. A-85). Gillespie suggests a decision rule for determining the increased effectiveness to be derived from information sharing. The rule has three requirements: first, considering how GIS output and accessibility are different given our ability to share and borrow data from other sources; second, questioning if this new data matters, that is, does having access to such data also mean that members of our organization are using it; and finally, is this data useful to our work? Is the overall effect of its use “valuable” to our department? If the answer to any of the above questions is “no,” Gillespie argues that our data has failed the test of enhanced effectiveness.

With regard to decision making, Zwart (1991) argues that unless we can determine that utilization of geographic information has led to enhanced or better decision making capabilities, its impact is minimal. As a result, if information that is shared between organizations does not lead one party to actively reassess decision priorities or value struc-

tures, the third criterion of outcome (decision making) is not fully addressed.

Finally, numerous other impacts, and unexpected benefits are also possible (Gillespie 1991, 1992; Taupier 1995). Interorganizational cooperation can, for instance, strengthen work relationships and morale and thus contribute to productivity, task completion (Johnson et al. 1981; Johnson et al. 1983), and satisfaction of information users (Ives et al. 1983). Public service (Brown and Brudney 1993) and equity (Epstein 1995) are data sharing benefit that extend beyond organizational boundaries, and are related to broader societal outcomes.

Conclusion

The challenge of improving the efficiency and effectiveness of geographic information sharing rests firstly on our better understanding of the motivations and processes that are likely to influence such exchanges, either positively or negatively. Research to date offers glimpses of the problems associated with such data sharing, as well as some opportunities for those organizations that are able to override issues of organizational inertia, mistrust, and "turf." One common point raised by much of the work done to date suggests that resistance to data sharing is typically not related to technical issues; that is, incompatible systems or data structures. Rather, we continue to find that these challenges are first and foremost "people" challenges; they represent the need to better isolate and address the human factors that are likely to impede free data sharing across organizational boundaries. As a result, this paper offers a number of research opportunities and testable propositions for those interested in better understanding and ultimately, facilitating the exchange of geographic information.

The paper presents a comprehensive literature review and a conceptual framework for understanding various aspects in the process of developing and sharing digital data generated with geographic information system (GIS) technology. The framework includes organizational and interorganizational context, motivation, coordination mechanisms, and outcomes of sharing GIS and databases. The framework relates several important concepts into a coherent model:

- The most important concepts relevant for understanding the multi-participant GIS context have to do with intensity and quality of interorganizational relationships, organizational interdependence, resources, structure, stability, culture, politics, and leadership.
- Motivation for interorganizational GIS activities ranges from economic and socio-political to technical arguments. Joint efforts result from the sense of duty, common interest, or exchange inducements, and are pursued as voluntary or mandated.

- Coordination mechanisms are manifested through established interorganizational structures, processes, and policies. Structure is defined through organizational forms; channels, direction, and methods of information flow; and level of shared components (i.e., database, hardware, software, personnel, space, and applications). Coordination process can be undertaken through standardization, joint planning, or mutual adjustment. Formal or informal policies are established to address data-related issues, responsibilities, ownership, contributions, and incentives.
- Finally, the outcomes of interorganizational GIS activities can be assessed using a number of criteria, including efficiency, effectiveness, decision-making impact, societal equity, and public service. The effect on developing and strengthening regional and local networks and partnerships, however, is one of the most valued expected benefits from building the National Spatial Data Infrastructure (NSDI).

Our understanding of GIS and database sharing needs to draw on all those concepts as they determine and affect the decisions, processes, and effects of interorganizational activities. Changing technological environment, such as the development of open systems, advances in networking and distributed data processing, and the use of World Wide Web for data distribution and access, make it difficult to study the continuously evolving multi-participant GIS implementation settings. However, many of the non-technical factors addressed in this review paper, are more stable, and will continue to pervade the efforts to integrate and share geographic information systems and digital spatial databases across organizational boundaries. Better insight into those factors will help eliminate redundancies in database developments, and will lead to more effective interorganizational GIS implementation strategies.

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