GIS Database Development and Exchange: Interaction Mechanisms and Motivations

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Abstract: *The idea of sharing geographic data both within and between organizations remains largely resisted despite the obvious benefits that can be derived from data-sharing activities and Federal initiatives that promote them. The research presented in this paper examines the various properties of data-sharing activities, as well as related motivations cited by members of organizations as reasons for entering into cooperative relationships. The findings suggest that organizational members have a number of different reasons for engaging in data-sharing relationships, with common missions/goals and saving of resources being the most frequently cited motivations. Financial resources are the more important reasons for external than for internal interactions. Further, both inter- and intraorganizational activities are guided with formalized mechanisms, the former predominantly in the form of legal contracts and agreements, and the latter predominantly in form of policies and mutual rules and procedures. Informal interactions, however, continue to be significant in facilitating those interactions. We find that adoption of standards is still inadequate to enable ubiquitous data integration and exchange, but certainly appears stimulated by interorganizational engagements. In terms of contributions, the geographic data remain to be the main good exchanged. More involved interactions, such as coordinated database development and maintenance and joint applications and clearinghouses are more likely to happen only internally. The Internet, although still not prevalent, has started to facilitate communications and relationships with external partners. The implications of this research are considered as they relate to future efforts to induce wider sharing of geographic information system (GIS) data across organizational boundaries and to build spatial data infrastructures at all levels.*

Introduction

In the United States, the Federal National Spatial Data Infrastructure (NSDI) initiative calls for the development of an "information highway" to connect the variety of spatial data producers and users, including government, private sector, and academic institutions (FGDC 1994). Initiatives on data-sharing mechanisms, infrastructure, institutional arrangements, and standards, along with the improvements in the enabling tools, are crucial for assisting data-sharing practices and for building the NSDI (Nedović-Budić and Pinto 2001). Such efforts to achieve data coordination have been ongoing in the United States for many years through development and distribution of digital data. However, until recently there were few pronounced standards or mechanisms for coordinating spatial data resources between multiple levels of government, leading to rather isolated initiatives with respect to data integration. Nevertheless, some of the early data coordination projects started to lay an important foundation for future efforts in this area. The development of GBF (Geographic Base File)/DIME (Dual Independent Map Encoding) and TIGER (Topologically Integrated Geographic Encoding and Referencing) files, for instance, promoted data sharing among more than 300 local planning agencies and managed to overcome bureaucratic inertia (Sperling 1995). Most recently, the initiative for development of the National Digital Geospatial Data Framework and Clearinghouse, Geospatial One-Stop Web portal (FGDC 1994; 2003) and the National Map project of the U.S. Geological Survey (USGS 2002) are significant steps forward in inticing the comprehensive provision and exchange of reliable data among a variety of users, including all levels of government, private sector, and utilities. However, many of these initiatives lack implementation plans and tools, particularly with respect to the local and regional levels where a great majority of data production and use occurs. This situation leaves a satisfactory level of data integration across organizations and jurisdictional boundaries yet to be realized (Haithcoat et al. 2001).

GIS technology enables data integration across organizations (Campbell and Masser 1991) and can stimulate interorganizational alliances (Kumar and Van Dissel 1996; Roche and Humeau 1999; Dedekorkut 2002). Infrastructures such as the NSDI would allow for unlimited sharing of spatial data, and thus prevent duplication of effort and redundancy in developing geographic databases. Interestingly, however, the rapid increase in organizations adopting GIS technology has highlighted the fact that between and within organizations, there has been a general inability and often unwillingness to share data and information across boundaries, with concomitantly low levels of coordination (Warnecke et al. 1998). The problems here are typically not of a technical nature, reflecting instead a variety of "human" reasons why information continues to be hoarded and organizations resist seemingly obvious benefits from sharing data (Greenwood 2000; Nedović-Budić and Pinto 2000; Feick and Hall 1999). The waste caused by duplication of effort, due largely to lack of information exchange among local, state, and federal government and private sector organizations, remains a significant impediment to the more effective and efficient use of GIS throughout society, and hinders the development and utilization of the technology's full potential (Frank 1992; Warnecke 1999). Other recent work has further illustrated the incredible complexity that underscores efforts at

data coordination. Francis Harvey's (2001a) survey in Kentucky and summary update of progress toward the National Digital Geospatial Data Framework and Clearinghouse demonstrate the complexity of GIS actor networks in collaborative environments. These findings are reinforced by Tulloch and Fuld's (2001) summary of the FGDC's survey of over 800 county-level data producers. They find that the needs for and types of data created by their sample are widely diverse, suggesting that the viability of achieving a Framework data set remains highly complex.

Although recent research has offered some insights into the structure and motivations underlying information sharing across interorganizational boundaries (Nedović-Budić and Pinto 2000), empirical research to date has been primarily qualitative, relying on limited sets of case studies or anecdotal evidence. Noticeably lacking have been any larger-scale empirical research studies to investigate the nature of data-sharing activities, including their primary characteristics. Though many researchers discuss "data sharing," of paramount concern is the question as to whether there is a clear agreement on what data sharing actually implies. This paper reports on the results of a recent research project that investigates the data-sharing phenomenon across multiple public agencies on a U.S. national level. The results of this research offer an inside look at the current nature of many data-sharing arrangements, in terms of variables such as the reasons for data sharing, the extent and nature of interaction, standardization activities, and levels of participation and contribution. Further, the research findings offer evidence of a direct link between specific motivations and structural variations in the data-sharing arrangements.

Motivations and Interaction Mechanisms—Concepts and Theory

Coordinated systems and databases promise to stimulate interorganizational cooperation and collaboration and are expected to result in the provision of a better information base for management and strategic decision making. Based on case study research conducted among U.S. city and/or county governments and other associated organizations, Nedović-Budić and Pinto (2000) identifies two factors that shape the processes involved in data-sharing activities as well as their outcomes: 1) motivations for engaging in data-sharing activities, and 2) structural characteristics of the interaction mechanisms implemented by the data-sharing entities.

Motivations for Data Sharing

The underlying assumption behind data-sharing initiatives is that such interorganizational sharing processes provide a number of benefits to the involved organizations. Avoidance of unnecessary data redundancy and duplication of efforts appear to be the most important goals of data coordination initiatives. The expected benefits from sharing, however, go beyond efficiency (Nedović-Budić and Pinto 2001). Benefits that are typically identified in the literature as the primary drivers for data exchange include the following three (Nedović-Budić and Pinto 2000):

1. *Cost savings.* As consortia of agencies or independent organizations share data, they no longer need to duplicate data gathering and archiving, which leads to savings in terms of personnel, space/facilities, data acquisition and maintenance costs.
2. *Improved data availability.* A data archive could contain a larger selection of records than would be held by any one organization, thereby offering a more comprehensive library of geographic information.
3. *Enhanced interorganizational relationships.* Underlying data sharing is the larger issue of promoting greater cross-organizational communication. It is assumed that among organizations that communicate and share information, there is a stronger opportunity to develop new, joint service missions within their jurisdictions.

Although cost savings are often mentioned as the major reason for interorganizational engagements (Nedović-Budić and Pinto 1999a), expected monetary benefits are not the only motivators for the establishment of data-sharing mechanisms. In the GIS literature, the following additional reasons are cited as motivating GIS-related data exchange: organizational needs and capabilities (Calkins and Weatherbe 1995); power relationships; appeals to professionalism and common goals (Obermeyer 1995); and incentives, superordinate goals, and accessibility, as well as resource scarcity (Pinto and Onsrud 1995). O'Toole and Montjoy (1984) summarize the various motivations into three categories of inducements: 1) authority, 2) common interest, and 3) exchange (receiving something in return). It is important to consider these various types of motivations for data exchange as they can be expected to uniquely shape the structure of data-sharing agreements. However, a comprehensive, empirically-based account of reasons for establishing exchange or coordination mechanisms and impacts of such varying motivations on the nature and success of GIS development and exchange efforts are currently lacking from the respective literature.

Structural Characteristics of Interaction Mechanisms

Geographic data-sharing efforts involve redefinition of existing tasks and structures and the establishment of new ones (Azad and Wiggins 1995). The structure of an interorganizational relationship is established by specifying roles, obligations, rights, procedures, locations, information flow, data, analysis, and computational methods used in the relationship (Kumar and Van Dissel 1996). There are numerous ways to structure interorganizational GIS and database activities, and the various configurations in which GIS resources are developed and exchanged often depend on the given institutional, technical, and economic constraints (Dueker 1987) as well as the above-mentioned specific motivations.

It is important to note that structure is a multidimensional concept. Five aspects of structure have been identified based on case study results as being of particular importance for studying interaction mechanisms (Nedović-Budić and Pinto 1999a; 1999b; 2000). First, distinct forms of sharing mechanisms can be

identified based on the extent of interaction involved. Extent of interaction can vary from simple awareness of or communication about GIS activities to different forms of data exchange and, in its most sophisticated form, to joint system development and/or maintenance and sharing of resources beyond data (including personnel, facilities, and equipment). Second, interaction mechanisms can be either formal or informal in nature. Third, different standardization activities can be involved, ranging from no acceptance of standards to adoption of private, local, regional, federal, or international standards. Fourth, a specific relationship can be characterized by the participation status of the entities involved. Different forms of membership with varying level of influence or mere subscription status can be distinguished. Finally, the structure of the sharing relationship can be characterized based on the contributions of the specific entities to the joint GIS database development or data exchange activities.

A Conceptual Model of Data-Sharing Motivations and Interaction Mechanisms

Based on this review of relevant literature, a conceptual model of data-sharing mechanisms and their underlying motivations is developed (Figure 1). It assumes that the reasons for establishing data-sharing agreements range from saving resources, common mission/goals, and existing organizational dependencies to various forms of directives from higher levels, disaster or emergency response/management, or a sense of duty for an authority. Further, the model suggests that the specific reasons behind data exchange relationships influence the specific structural layout of the interaction mechanisms implemented by the sharing entities. All five structural dimensions of interaction mechanisms identified above (extent of interaction, nature of interaction, standardization activities, participation status of entities involved, and level of contribution to shared activities) are incorporated in the model. Motivations as well as the resulting structural layout of the data-sharing agreements are expected to differ for data-sharing projects depending on whether the exchange occurs internally (within organizations) or externally (between organizations).

Methodology

A national survey of city and/or county governments, regional entities, and other related public and private organizations that engage in data-sharing activities was conducted to validate the relationships proposed by the conceptual model. A self-administered survey instrument was designed based on items derived from the model concepts. The questionnaire was pre-tested through interviews with GIS professionals and academics for readability and clarity. The survey instrument is accessible at the following address: http://www.urban.uiuc.edu/faculty/budic/W-NSF-2.html. Only the responses to Section 1 titled "Interorganizational Mechanisms and Motivations" are relevant for the discussions included in this paper. Factors related to context, relationship, implementation, and outcomes of interorganizational GIS were analyzed and presented in other works.

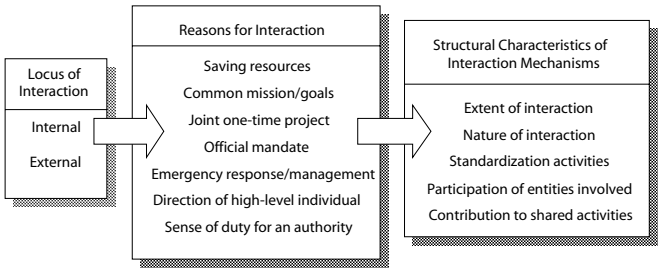

Figure 1. Conceptual model of relationships between motivations and interaction mechanisms

Questionnaires were distributed to a non-random, purposive sample of representatives from local governments involved in interorganizational data-sharing relationships. The employees in GIS managerial roles were targeted to fill out the questionnaire. Because the unit of analysis for this research was the individual organizational unit/entity from a sharing consortium or "cluster," the survey sampled 107 selected clusters of organizations across the United States using and sharing GIS. These clusters had been identified primarily based on the NSGIC/FGDC Framework Survey conducted in 1998 (FGDC 2002). Only sharing clusters that involved some kind of coordinating entity were included. Additional clusters known from the anecdotal GIS case study literature (e.g., conference proceedings and trade magazines) were also considered. Next, telephone interviews were conducted for screening purposes as only clusters that reported interorganizational data-sharing activities were to be included in the final sample. This initial screening was also used to obtain contact details for the other sharing entities within the cluster. At least five units/entities per cluster were contacted to account for differences in the views of the members of the sharing relationship. In most states, two clusters were identified and sampled, although in more populous states three to six sites were sampled. In less populous states only one cluster was sampled. All states were represented in the sample.

Information about the relationships of the respondent organization with the other entities in the data-sharing cluster was collected by asking the respondents to consider a maximum of eight entities *internal* and eight entities *external* to their organization. Departments, divisions, or other units within an organization (e.g., within city or county government) were considered as internal to that organization; functionally, financially, and administratively independent organizations were considered as external entities (e.g., utility companies, municipal governments, regional planning commission, and school district would be regarded external to a county government). For each of the listed entities, the respondents were asked to characterize their shared geographic information systems/geographic data (GIS/GD) activities in terms of extent, reasons, and the nature of the interaction, as well as standardization activities, participant status, and contribution to shared GIS/GD activities by selecting all applicable responses. A respondent's interactions were identified as having certain char-

acteristics if at least one of the internal interactions or at least one of the external interactions was described in that specific way.

A total of 529 questionnaires were mailed out following the Dilman (1978) Total Design Method for mail survey administration. The final sample yielded 245 responses, for a response rate of 46 percent. The sample was analyzed with respect to the locations of the organizations to see whether all U.S. regions were represented in the data. For this purpose, the sample pool was defined geographically to include four regions as defined by the U.S. Census Bureau. The sample used for the analysis had the following geographical distribution: south (79 responses, or 32.2 percent), west (58 responses, or 23.7 percent), northeast (42 responses, or 17.1 percent), and Midwest (66 responses, or 26.9 percent). In terms of types of organization represented in the respondent pool, city and county government responses outnumbered all other types by a large margin. A demographic breakdown of the sample in terms of organizational type is shown in Table 1. The majority of responses came from representatives from city, county, or regional governments.

To get a sense of the character of the area in which the clusters of GIS users surveyed were situated, responses also were broken down by population size. Medium size counties in categories 50,001–250,000 and 250,000–1 million inhabitants represent the majority of the sample, or about 80 percent. More specifically, cluster locations with a population of less than 50,000 account for 12.7 percent of the sample; those with 50,001–250,000 inhabitants account for 34.7 percent; 44.5 percent of the clusters have a population size of 250,001–1 million; and only 8.2 percent of the locations have a population of more than 1 million inhabitants.

Finally, the respondents contained in the sample also can be described by organizational function (Table 2). While a substantial portion of respondents identified themselves as "Planning," (24.6 percent), when the categories of official and unofficial GIS/IT (information technology) organizational representatives were compiled, they represented over 30 percent of the overall sample.

The characteristics of the respondent organizations in terms of geographic distribution, population size, and type were compared to those organizations that had not responded to the survey. No significant differences were found. For the purpose of this paper, the specific characteristics of the organizations were only used to describe the sample and were not taken into account for further analyses. Rather, the focus was to point to differences between internal and external sharing activities, and it was assumed that these differences would be found for all organizations, regardless of their type, function, location, or size of jurisdiction. The variability across those factors was found sufficient not to bias the results. Even the respondents from the same cluster represented very different organizational units with different contributions to and perceptions of the shared GIS. Also, many different clusters were included to offer enough variance in values and no significant number of respondents belonged to the same cluster. In the majority of cases, there were only two respondents per cluster.

Descriptive analyses were conducted to investigate the occurrence of certain data-related activities and types of interactions within the sample as well as to obtain insights with respect to the motivations that underlie such joint GIS-development and data-exchange activities. While the general descriptive statistics were generated for the whole pool of the respondents, for a cluster to be included in further analysis a minimum of two members of the interorganizational-sharing cluster had to respond to ensure that each cluster was represented by at least two entities. However, only a few clusters had more than two respondents. Therefore, a

Table 1. Distribution of responses by organizational type

Organizational Type	Respondents (n=245)
City	94 (38.4%)
Joint city/county	13 (5.3%)
County	72 (29.4%)
Utility	9 (3.7%)
Regional	38 (15.5%)
Special purpose organization	5 (2.0%)
Other, for profit	6 (2.4%)
Other, non-profit	8 (3.3%)

Table 2. Distribution of responses by organizational function

Organizational Function	Respondents (n=245)	Organizational Function	Respondents (n=245)
Elected official	3 (1.2%)	Planning	60 (24.6%)
Chief administrative office	7 (2.9%)	Building inspection	1 (0.4%)
Information systems office	21 (8.6%)	Public works	25 (10.2%)
Official GIS within IT	33 (13.5%)	Utilities	12 (4.9%)
Official GIS outside IT	32 (13.1%)	Environment/natural resources	11 (4.5%)
Unofficial GIS within IT	4 (1.6%)	Property mgmt./real estate	2 (0.8%)
Unofficial GIS outside IT	10 (4.1%)	Health and human services	2 (0.8%)
Finance	2 (0.8%)	Public safety	4 (1.6%)
Taxation	11 (4.5%)	Other	4 (1.6%)

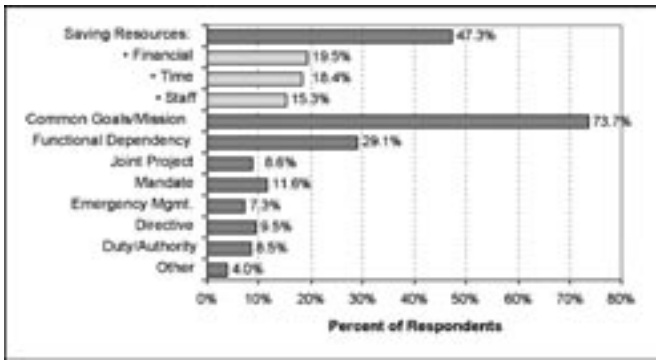

Figure 2. Reasons for interaction (n=245)

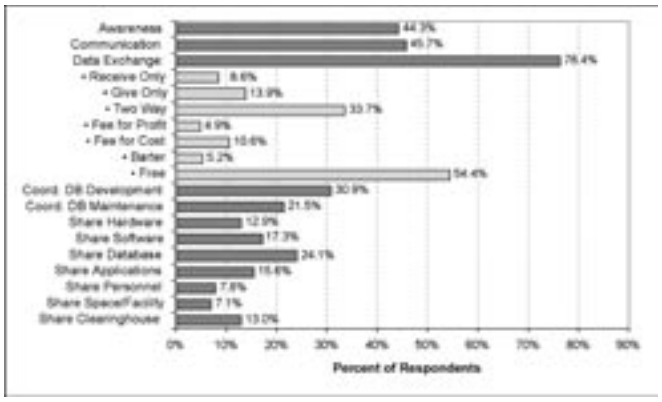

Figure 3. Extent of interaction (n=245)

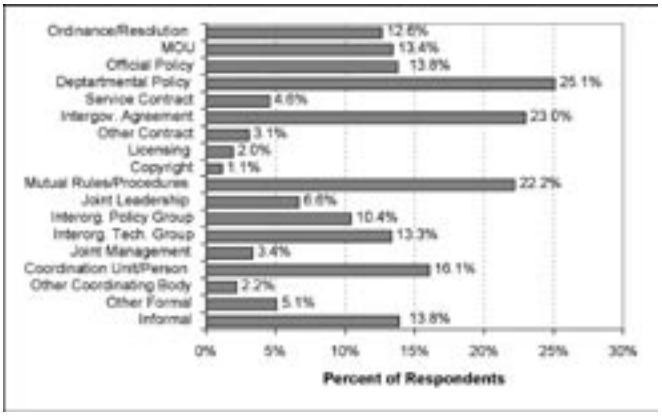

Figure 4. Nature of interaction (n=245)

data set comprised of 228 responses was used for a preliminary analysis of differences between internal and external interactions to gain a better understanding of the specific nature of interorganizational versus intraorganizational interaction mechanisms. A series of t-tests was conducted to analyze whether significant differences between internal and external relationships existed. Finally, the relationship between the most common motivations and the structural aspects of interactions was analyzed using cross-tabulations and chi-square statistics.

Characterizing the Interactions

The reasons for establishing shared GIS development or data-exchange activities, as depicted in Figure 2, vary widely, though the most frequently cited reasons include common goals or mission (73.7 percent), desire to save resources (47.3 percent), and functional dependency (29.1 percent). These findings reinforce early cross-functional cooperation by demonstrating that superordinate, or jointly held and compelling goals are the strongest antecedent motivating collaboration among organizational sub-units (Pinto, Pinto, and Prescott 1993). When there exists a fundamental data-exchange "motivator" for all concerned parties in the form of shared goals, economies of scales through saving resources (Croswell 1991), or functional dependency in the form of pooled, sequential, or reciprocal interdependency as noted by Thompson (1967), there is a strong incentive to engage in cooperative data-sharing ventures.

Many of the interactions captured in this study do not reach beyond basic levels (Figure 3). However, a large majority of sharing activities (76.4 percent) have at least reached a stage where actual data exchange occurs. Interestingly, about half (54.4 percent) of these data exchange relationships are described as being free of charge and only about a third (33.7 percent) of the exchanges are mutual. More complex forms of interaction, such as joint database development and the sharing of resources beyond data (such as personnel, facilities, or equipment) are less common. However, the findings indicate that efforts in this direction are being undertaken and that a significant number of sharing activities include at least some coordination in terms of database development. Nevertheless, more active sharing efforts that aim at facilitating a direct access to data, such as the development of spatial data clearinghouses, appear to be still largely neglected, with only 13 percent of the interactions being focused on such initiatives. A recent national study of metropolitan planning organizations by Knaap and Nedović-Budić (2003) affirms the relatively low reliance on Internet and clearinghouses for data exchange or access, with less than one-fifth of organizations reporting such practices. This particular finding confirms the trend toward individual GIS developments found in the FGDC survey (Tulloch and Fuld 2001) and a reliance on less efficient data-access methods, which could potentially endanger investments in broader efforts to build spatial data infrastructures.

As we have previously noted, one area of possible misinterpretation has to do with divergent views as to what information sharing among interorganizational units actually connotes. That is, "data sharing" as a concept may be viewed benignly by various exchange partners; however, the practical mechanics of what data sharing actually requires tends to result in a potentially contentious process of proposal and counter-argument (Nedović-Budić and Pinto 2000). In the absence of clear guidelines on the nature of data-sharing interactions, there is a strong opportunity for political and power differentials to tilt the balance away from an equal exchange to one that may be beneficial only to one of two partners (Azad and Wiggins 1995; Pinto and Azad 1994). Hence, another important finding from this research is to isolate the nature of the various forms of data-sharing interactions that are most often practiced in these initiatives. The key mechanisms for coordination are shown in Figure 4.

Only a small portion of the sharing relationships included in the analysis are informal (13.8 percent), that is, ad hoc or based on personal contacts, needs, or availability. The most common formal types of agreement governing the involved interactions are "Departmental policy" with 25.1 percent, followed by "Intergovernmental agreement" (23 percent) and "Mutual rules/procedures" (22.2 percent). Joint leadership, coordinating units, and policy or technical groups are also present but do not govern many relationships. "Copyright" is the least frequently used governing mechanism with only about 1 percent of the relations being based on this type of arrangement. It appears that the sharing entities regulate the relationships rather than the content of their activities. The content, however, is often guarded by the use of disclaimers and distribution restrictions. Further, although a large majority of the interactions is governed by formal agreements rather than being driven by ad hoc needs, the border between informal and formal seems to be fuzzy, and less formal ways of regulating the data-sharing relationships, such as mutual rules and procedures, appear to be as important as very explicit mechanisms. This finding confirms the difficulty in distinguishing between formal and informal agreements as well as the relevance of rather informal sharing networks, particularly in smaller local governments, suggested by Harvey (2001a; 2001b).

The issue of standards selected is intriguing. Figure 5 gives the breakdowns of the types of standardization activities that underlie the sharing ventures studied. The most commonly used standards tend to be those developed locally (66.5 percent), rather than some "higher order" standard developed at the state, federal, or international level. In fact, outside of those agreed to by the sharing partners, most clusters are as likely to adopt no standard at all as they are to employ a state or federal standard. These findings offer further credence and support for the recent analyses of the FGDC survey findings by Harvey (2001a) and Tulloch and Fuld (2001) who note the tendency for coordination efforts to conflict with the complex reality of locally-developed data and sharing practices. The study results suggest additional challenges that face proponents of NSDI and related initiatives, such as the National Map, given a tendency to resist such higher, national standards.

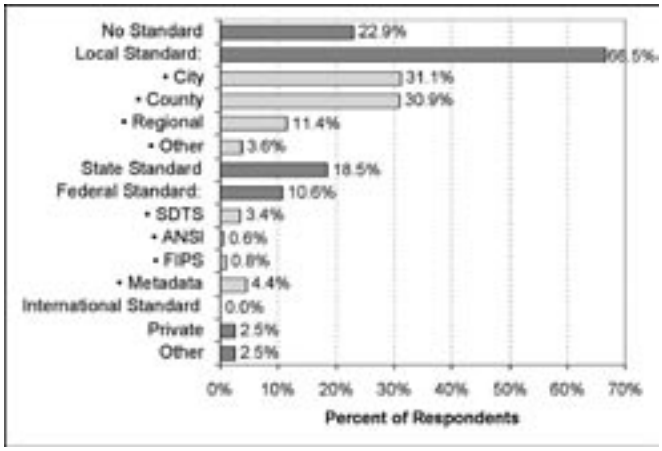

Figure 5. Type of standard employed (n=245)

Figure 6. Participation status (n=245)

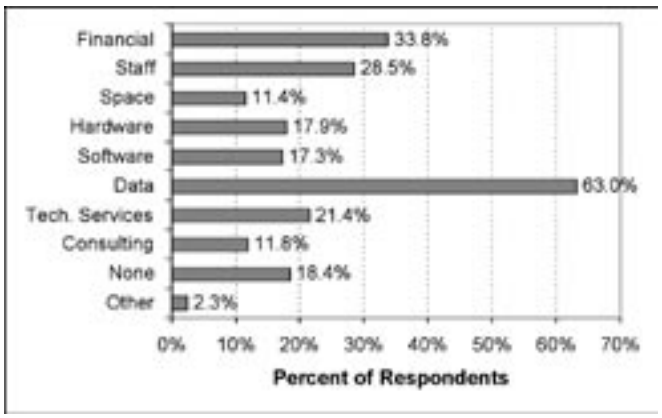

Figure 7. Contribution to shared GIS/GD activities (n=245)

Another issue identified in the study is the nature/status of various participants in a data-sharing arrangement. Do these clusters tend to be dominated by the main members whose agenda could prevail over a number of less powerful members, or who could be operating within a more egalitarian participation process? Figure 6 shows findings with respect to participation status. From a demographic perspective, it is clear that the majority of the respondents to the survey (though not an absolute majority) see their participation as being represented best by the classification "lead member." Smaller proportions of respondents are non-members, subscribers, or having membership either with or without voting rights. The way in which respondents participate in the surveyed clusters is certainly expected to influence their position on various interorganizational issues and relationships.

An issue of significant interest has to do with the various contribution levels offered by members of these interorganizational networks; that is, to what degree and in what manner do most members contribute to the initiative? As Figure 7 demonstrates, the clear majority of participants identify their primary contribution as consisting of supplying geographic data for use by other organizations. This result confirms the relative importance of

data-driven sharing relationships and a view of data as a public good (Masser and Campbell 1995). A significant percentage of the sharing partners also provide financial and/or staff support to the arrangement.

Intraorganizational versus Interorganizational Motivations and Interaction Mechanisms

When looking at issues of sharing from an intraorganizational versus interorganizational perspective, for example, by comparing relationships that are internal to the organization to those that cross organizational boundaries, some additional findings become evident. First, interesting differences in the reasons for sharing interactions are found. Saving financial resources is a much more frequent motivator for external interactions than for internal sharing agreements (Table 3). In contrast, saving time and staff are slightly more frequent motivators for internal relationships; however, the difference is not significant. Common goals, functional dependency, emergency management, and especially directives from higher-level organizations are more frequent reasons underlying internal than external relationships. Further, sense of duty for an authority is a more common motivator in external relationships, although this difference is not significant. Only slight differences are found for official mandate and joint one-time projects, with official mandate being more common in the intraorganizational context and joint projects being more frequently mentioned with external relationships.

Regarding the extent of interactions, coordinated database development and more complex forms of interaction beyond just the data (including software, hardware, applications, space, and staffing) are more evident with internal relationships (Table 4). Also, the use of a joint clearinghouse is more common within organizational boundaries, although the difference is not significant. Not surprisingly, both "fee for profit" and "fee for cost" arrangements are more often mentioned with external interactions. Free exchange relationships are slightly more common in the context of internal sharing. Further, one-way interactions that involve giving data are more prevalent with internal relationships whereas receiving data is more common if the exchange occurs with an external agency. Interestingly, city standards appear to

Table 3. Reasons for interaction

Reasons for Interaction	Percent of Respondents (n=228)	
	Internal	External
Saving resources:	64.3%	62.0%
• Financial*	17.3	27.1
• Time	25.5	23.4
• Staff	22.6	21.9
Common goals/mission*	84.7	78.6
Functional dependency*	49.5	36.5
Joint project	12.2	16.1
Mandate	15.3	14.6
Emergency management*	17.9	10.9
Directive*	11.2	2.6
Duty/authority	12.8	16.7
Other	6.1	5.7

*Significant at the 0.05 level; †Significant at the 0.1 level

Table 4. Extent of interaction and standardization activities for internal vs external interactions

Extent of Interaction	Percent of Responses (n=228)		Standardization Activities	Percent of Responses (n=228)	
	Internal	External		Internal	External
Awareness	56.9%	58.6%	No standard*	24.0%	34.4%
Communication	57.9	63.4	Local standard†	70.4	64.1
Data Exchange:	86.2	90.6	• City	32.7	29.2
• Receive only*	3.1	7.9	• County	29.1	33.9
• Give only*	25.6	12.6	• Regional*	10.2	21.4
• Two way	46.2	51.8	• Other	5.6	3.6
• Fee for profit*	0	2.6	State standard*	16.8	25.0
• Fee for cost*	5.1	25.7	Federal standard†	9.7	14.6
• Barter	0	0	• SDTS	3.6	3.6
• Free	67.2	63.4	• ANSI	0.5	0.5
Coord. DB development*	58.5	32.5	• FIPS	1.0	1.0
Coord. DB maintenance*	43.1	22.5	• Metadata	3.6	4.2
Share hardware*	30.3	7.9	International standard	0	0
Share software*	37.9	9.9	Private	3.1	2.1
Share database*	46.7	20.4	Other	4.1	3.1
Share applications*	31.8	11			
Share personnel*	21.0	6.3			
Share space/facility*	15.9	2.1			
Share clearinghouse	18.5	15.7			

*Significant at the 0.05 level; †Significant at the 0.1 level

Table 5. Nature of interaction, participation status, and contributions by internal vs external interactions

Nature of Interaction	Percent of Responses (n=228)		Participation Status	Percent of Responses (n=228)	
	Internal	External		Internal	External
Ordinance/resolution	17.3%	16.6%	Leading member*	55.1%	38.0%
MOU*	7.1	29.5	Voting member	19.9	22.4
Official policy*	16.3	8.8	Non-voting member	13.8	13.5
Dept. policy*	31.6	22.3	Subscriber	15.8	21.9
Service contract*	2.0	8.3	Non-member*	11.2	30.7
Intergov. agreement*	18.4	40.9	Other	12.8	14.1
Other contract*	0.5	5.2	Contributions	Internal	External
Licensing	1.5	2.1			
Copyright	1.0	1.0	Financial	52.0	46.1
Mutual rules/procedures	31.6	30.6	Staff*	52.6	34.2
Joint leadership†	11.7	6.7	Space*	27.0	13.0
Interorg. policy group†	12.2	7.8	Hardware*	37.8	22.3
Interorg. tech. group	13.8	13.5	Software*	35.7	20.2
Joint management†	7.1	4.1	Data	72.4	73.6
Coordination unit/person*	21.9	13.0	Tech. services†	37.8	33.7
Other coord. body	1.5	3.6	Consulting*	14.8	22.8
Other formal governance*	4.6	9.3	None	26.5	32.1
Informal	13.8	17.6	Other	3.1	3.1

*Significant at the 0.05 level; †Significant at the 0.1 level

play a more significant role in internal relationships while county and regional standards are more frequently employed when the interaction occurs with external organizations or agencies. One has to, of course, keep in mind that a large portion of the organizations surveyed are city governments. Importantly, state and federal standards are more often used in conjunction with external sharing activities. Thus, it appears that the sharing entities recognize a greater need for such standards when engaging in interorganizational sharing.

The nature of interactions often varies widely depending upon whether the sharing arrangement is predominantly based on internal or on external partners (Table 5). Interestingly, for internal sharing relationships, the mechanisms tend to be departmental policies or official policies. On the other hand, for external relationships, we find a higher frequency of intergovernmental agreements and memoranda of understanding (MOU), as well as service and other contracts. Further, it appears that coordination units and joint leadership and management are more common ways of coordinating intraorganizational sharing activities. Policy groups are also more frequently mentioned in connection with internal sharing activities. The same is true for technical groups; however, the difference is not significant. Surprisingly, informal exchanges can be more frequently found in the interorganizational context; however, the difference is not significant.

In terms of participation status, "leading member" occurs more frequently in conjunction with internal interactions, while the status "non-member" is more common for entities that are external (Table 5). The findings for contributions to the shared GIS activities confirm the results presented for the extent to which different entities engage in sharing relationships. Sharing beyond simple data exchange, for example, staff, space, hardware, and software contributions, is more common when the interaction is internal. Contributions in the form of financial resources and technical services also can be more frequently found in the internal context; yet, the difference is not significant. Consulting is more prevalent in external activities. Again, the results illustrate that exchanges that only involve receiving data and do not involve active contributions from an entity occur somewhat more often in the interorganizational context.

Relating Motivations and Structures

Because many significant differences were found between internal and external interactions, the relationships between motivations and structural aspects of sharing were tested separately for intraorganizational and interorganizational relationships. The implications of the presence versus non-presence of the most common motivations were explored using cross-tabulations and chi-square statistics. A relationship was identified as being positive when the interactions that were characterized by that specific motivation were more frequently associated with the presence of a certain structural characteristic than those for which the given motivation was not present.

Only the three most common motivations—saving resources; common goals/mission; and functional dependency—were considered for this analysis because the number of responses for some of the less frequent reasons were too low to conduct cross-tabulations. Also, only significant relationships (based on chi-square tests) were indicated. The interrelationships between the existence of certain forms of contributions, standardization, and participation and the nature as well as the extent of interac-

tion were investigated using the same methodology. The following text highlights some of the most important relationships; tables that display all significant relationships can be found in Appendix A.

Respondents motivated to participate in interorganizational relationships in order to save resources are more likely to establish closer interactions with other entities than respondents not motivated by saving resources. These interactions include communication; data sharing; joint database development; sharing of hardware/software, space, and personnel; and, in case of external entities, joint applications and clearinghouses. Saving of resources is also the strongest driver for use of standards, internally in particular. This motivator coincides with the use of mutual rules/procedures and joint leadership as the most prominent internal interaction mechanisms, with generally less emphasis on formalization. More formal mechanisms, such as intergovernmental agreements, are more common for external interactions, which still rely considerably on informal relationships. Respondents who express that saving resources is their motivation for GIS interactions contribute in various ways, but more extensively in internal settings.

Common goals/mission tends to stimulate two-way exchanges and establishment of clearinghouses, while functional dependency internally appears to allow for sharing of space and personnel, and externally for sharing and joint database developments. Common goals/mission as the motivator is associated with state standards in both internal and external contexts. In terms of mechanisms, functional dependency tends to stimulate the use of policy and technical groups for interaction mechanisms. Among the varying contributions by internal and external entities, the contributions that stand out are financial in case of interactions based on goals/mission as motivation and staff in case of interactions based on functional dependency. Data remains to be the main contribution item in all relationships that were included in the analysis.

In exploring the relationship among various structural factors, we find that respondents in the lead member role report extensive relationships including establishment of clearinghouses, particularly in relationship with external entities. In those external settings, the emphasis is more on two-way exchanges. Standardization efforts also relate to closer relationships, which for external entities tend to include sharing of hardware and software. The two main types of contributions—financial and data—tend to associate with more intense relationships, the former in external settings, and the latter in internal settings. The financial contribution also drives a varied approach to the cost attached to data exchanges—free for internal exchanges and fee-based for external exchanges. Data contributions internally are associated with joint applications and coordinated database maintenance; externally they coincide with coordinated database development and establishment of clearinghouses.

Finally, the nature of interactions indicated by the respondents in the role of lead members is more policy-based in internal settings and more contract-based in external settings. A very similar pattern is found with respect to both financial and data contributions. Presence of local standards is associated with formalized mechanisms both internally and externally, including memoranda of understanding and intergovernmental agreements. However, the persisting characteristic of the relationships applied in interactions with external entities is the mix of formal and informal mechanisms.

Summary

Respondents to the survey come from organizations with varying participation status in GIS-sharing interactions. About a third of the respondents indicate their organization is a lead member, while the remainder includes other voting or non-voting members and subscribers. The respondents cite common goals/mission, saving resources, and functional interdependences as the key motivation factors for their engagement in GIS- and database-sharing activities. Among various organizational resources, financial resources seem to be more relevant than staff and time resources for external relationships, while directives and emergency management are more stimulating internally.

Overall, data is the main currency in GIS-sharing activities. It is mostly exchanged for free and two way, particularly in internal settings. Externally, the fee-based exchange is more present. Coordinated database development or maintenance is pursued, but somewhat sporadically, especially when external partners are involved. Similarly, the efforts to establish clearinghouses are irregular, although they are more likely to happen internally. Externally, the clearinghouses are more likely to be set up when the motivation for the relationship is to save resources than in the case of other motivations. However, in a recent study, Knaap and Nedović-Budić (2003) suggest that although the reliance on the Internet for data access or exchange is becoming more frequent, it is still not a dominant practice among external partnering organizations.

To conduct GIS-sharing activities, organizations use various but mostly formal interaction mechanisms, including: policies, intergovernmental agreements, mutual rules and procedures, memoranda of understanding, ordinances and resolutions, policy and/or technical groups, and joint coordination unit/person. Internal relationships are more based on policy, groups, and joint management, leadership, or coordination point; external relationships are more based on agreements, memoranda of understanding, and contracts. Interestingly, external relationships are more formalized, but also rely on informal interactions. In general, the entities involved in GIS- and database-sharing activities tend to regulate their relationships more than the content of data that is exchanged.

Standardization activities are characterized primarily by the use of locally developed standards. The higher use of county, regional, state, and federal standards in the external context is a promising indication that standards are recognized as necessary in facilitating cross-organizational exchange. Analysis of the motivations and structures point to saving resources as driving the use of standards internally (i.e., within an organization), and common goals/mission as stimulating the use of standards

in coordinating or exchanging data with external organizational partners. Reliance on standards is also more present in formalized contract-based interactions and among organizations that contribute financially.

Overall, saving resources as the motivator and data as the form of contribution have strong presence across interorganizational and intraorganizational settings, but they are a more typical factor in internal organizational bonding. Common goals/mission is a stronger motivator of external relationships, most often realized through data exchanges and establishment of joint clearinghouses. In those interorganizational settings, financial contributions tend to create tighter ties between external organizations, but also prompt the fee-based data exchanges.

Conclusion

While there is general agreement that data sharing does represent a positive step forward in advancing the goals of the NSDI as well as in promoting greater joint cooperation among distinct organizational units, one of the frustrations to date has been the general lack of empirical evidence to support the more widely-held assumptions regarding the characteristics of data-sharing activities. Previous research that has employed case studies or anecdotal evidence, though offering some valuable preliminary evidence of the nature of cooperative data-sharing ventures, could not provide a comprehensive understanding of these interorganizational relationships. This research, employing a large-scale mail survey methodology based on previous qualitative findings, represents an important contribution toward improving our understanding of GIS data sharing.

One of the prevailing questions in studying interorganizational data sharing as it applies to geographic information has to do with gaining a better understanding of the nature of such sharing arrangements. While the concept of data sharing is becoming more and more accepted, our research and experience had led us to conclude that the manner in which such concepts as "sharing" are interpreted tend to vary widely, depending upon the individual and organizational unit. For some, cooperation seems to be defined simply as "non-aggressive" coexistence while others hold a more positive, resource linkage–based view. This research sought to directly address a number of the principal questions underlying GIS data-sharing interactions among organizations in terms of why they shared data, the extent of sharing activities, the nature of the sharing relationship, the standards employed, the participation status of the units/entities involved, and the contributions made. As a result, this research offers a unique glimpse inside the characteristics of and motivations surrounding organizational units willing to enter into data-sharing activities across organizational boundaries.

The results presented in this paper indicate that

- common goals/mission, saving resources, and existing functional dependencies are the most common motivations that drive data-sharing activities;
- exchange relationships are most often restricted to simple data sharing and are frequently provided or received free of charge;
- building of data clearinghouses continues to be somewhat sporadic, regardless of the increased use and role of the Internet in accessing and exchanging information;
- if standards are employed, they are mostly locally agreed upon rather than based on national or international standards;
- organizations tend to regulate their relationship more than the contents of their exchanges; ordinances/resolutions, departmental policies, MOUs, and intergovernmental agreements constitute the most commonly used formal mechanisms; other formal sharing agreements such as service contracts, licensing, and copyright agreements are not very frequently used; and
- informal interactions still play a significant role in enabling data sharing.

All these characteristics of present sharing interactions indicate that a broader data-sharing vision and related practices have not yet been adopted or have at least not been successfully implemented by the majority of public agencies in the United States. Further, significant differences were identified between interactions that occur in an intraorganizational context as opposed to sharing relationships with external entities. The findings indicate that

- more active and extensive sharing is more likely to take place within organizational boundaries;
- this emphasis on internal sharing has led to a considerable lack of recognition for federal and international standard although standardization activities are more pronounced as part of external interactions and relationships;
- saving financial resources is the most stimulating factor for enticing relationships with external organizations;
- exchange with external entities tends to be more fee-based than exchange with internal entities; and
- internal interaction mechanisms are more policy-based, while external mechanisms are more likely to include a legal component; external interactions are more formalized, but still substantially taking advantage of informal relationships.

Yet, the study results also illustrate that motivations have a significant influence on the structural characteristics of the sharing activities. They also point to the relationships between particular structural elements. For instance,

- the presence of functional dependency as a motivating factor for internal relationships is found to be associated with limited one-way provision of data rather than comprehensive sharing activities;
- two-way exchanges are more present when common goals/mission is a motivating factor;
- organizations contribute financially more often if common goals/mission motivate their interorganizational relationships; and

- extensive interactions are associated with more two-way exchanges, increased reliance on standards, and more substantial contributions to the joint geographic information activities.

The findings with respect to relationships between motivations and sharing mechanisms confirm that differences exist between the internal and external sharing context. Although additional research is needed to investigate interdependencies among the various motivations and the strengths of the particular relationships, the current findings provide an encouraging initial evidence for the assumption that instilling certain motivations into the data-sharing communities could lead to more extensive sharing with a broader focus.

Given the nature of the data-sharing agreements discovered as a result of our study, future research needs to continue to refine and sharpen definitions of such cooperative ventures. Due to the pressures to cut costs as well as to increase organizational efficiency while enhancing customer response and external effectiveness, the need to share geographic data across organizational boundaries is likely to increase rapidly. This research offers some valuable insights in terms of how such agreements currently work and, by implication, can suggest ways in which these agreements can be enhanced to derive the maximum advantage out of data sharing, both in terms of its impact on customer satisfaction as well as the promotion of greater cross-organizational cooperation and positive working relationships. Specifically, the importance of common goals/mission as a motivator for sharing activities and the more extensive interactions with internal partners suggest that successful sharing implies more than just the resolution of data-related issues. Also, the dominance of local standards in internal sharing arrangements suggests that much groundwork beyond the introduction of standards has yet to be done to establish broader sharing and commitment among the users of geographic data. Similarly, the continued low use of clearinghouses, especially with external partners, implies that data exchange currently occurs largely within local "islands of sharing" rather than on a regional or even national level. With no dramatic change occurring since the administration of this survey, Knaap and Nedović-Budić (2003) suggest a small positive trend in the reliance on the Internet for data access or exchange with external partners.

It is argued here that an extensive communication of a more comprehensive vision of data sharing is necessary and should make common goals/mission more explicit as it seems to serve as a very strong motivating factor. What is also necessary in addition to the vision is an implementation strategy and plan that incorporates these goals. It appears that understanding the nature and characteristics of the institutions involved in data-sharing activities is crucial to understanding and fostering sharing relationships, especially in an interorganizational context. Further, the differences in internal- versus external-sharing relationships have to be considered and addressed in the design, implementation, and communication of national data-sharing initiatives. Finally, future research has to concentrate on linking these situational and structural aspects to variables that measure the success of and/or satisfaction with such shared activities to be able to promote specific sharing arrangements that are most beneficial for certain organizational contexts.

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Appendix A: Relating Motivations and Structures

Table A1. Relationship between motivations and extent of interaction/standardization activities

	Internal			External		
	Saving Resources	Common Goals/ Mission	Functional Dependency	Saving Resources	Common Goals/ Mission	Functional Dependency
Extent of Interaction						
Awareness						
Communication	P*	P*		P*	P*	P*
Data exchange:	P*			P*	P*	P*
• Receive only						
• Give only			P*			
• Two way		P†		P*		
• Fee for profit						
• Fee for cost						
• Barter						
• Free						
Coord. DB development	P*	P*		P*	P*	P*
Coord. DB maintenance	P*	P*		P*		
Share hardware	P†	P*				P*
Share software	P*	P*				
Share database	P*			P†		P*
Share applications				P*		
Share personnel			P*			
Share space/facility	P†		P*			
Share clearinghouse				P*	P*	
Standardization Activities						
No standard	N*					
Local standard:	P*	P†	P*	P*	P*	P*
• City	P*					
• County	P†			P†		
• Regional	P†	P*		P*		P†
• Other						
State standard		P*			P†	
Federal standard:	P*					
• SDTS						
• ANSI						
• FIPS						
• Metadata						
International standard						
Private						

P = Positive association; N = Negative association; *Significant at the 0.05 level; †Significant at the 0.1 level

Table A2. Relationship between motivations and nature of interaction, participation, and contributions

	Internal			External		
	Saving Resources	**Common Goals/ Mission**	**Functional Dependency**	**Saving Resources**	**Common Goals/ Mission**	**Functional Dependency**
Nature of Interaction						
Ordinance/resolution		P*				P*
MOU						
Official policy						
Dept. policy		P†				
Service contract						
Intergov. agreement					P*	P*
Other contract						
Licensing					N*	
Copyright						
Mutual rules/procedures	P*	P†			P†	P*
Joint leadership	P*	P†	P*			
Interorg. policy group		P*	P†			P*
Interorg. tech. group		P*	P*			P†
Joint management						
Coordination unit/person						
Other coord. body						
Other formal governance			N†			
Informal					P*	P†
Participation Status						
Leading member		P†	P*	P*		P*
Voting member						
Non-voting member						
Subscriber	P†					
Non-member						
Contributions						
Financial	P*	P*	P*	P*	P*	
Staff	P*	P*	P*	P*		P*
Space	P*		P*	P*		
Hardware	P*	P*	P*			
Software	P*	P*	P*	P*	P*	
Data	P*	P*	P*	P*	P*	P†
Tech. services	P*	P*	P*	P*	P†	P*
Consulting				P*		
None						
Other	N*					

P = Positive association; N = Negative association; *Significant at the 0.05 level; †Significant at the 0.1 level

Table A3. Relationship between participation (leading member), standardization (local), and financial and data contributions and extent of interaction

	Internal				External			
	Leading Member	**Local Standard**	**Financial Contrib.**	**Data Contrib.**	**Leading Member**	**Local Standard**	**Financial Contrib.**	**Data Contrib.**
Extent of Interaction								
Awareness	N*							
Communication			P*		P*		P*	P†
Data exchange:			P†		P†	P*		P†
• Give only					N†			
• Two way				P*	P†	P*		
• Fee for cost							P†	
• Free			P*	P*				
Coord. DB development		P*	P*		P*	P*	P*	P*
Coord. DB maintenance	P*	P*	P*	P*	P*	P*	P*	
Share hardware						P†		
Share software	P*	P*	P*			P*		
Share database	P*	P*	P*		P*	P*	P*	P*
Share applications	P†	P*	P*	P†	P*	P*	P*	
Share personnel			P*		P†		P*	
Share space/facility			P†		P*			
Share clearinghouse	P†				P*	P*	P*	P*

P = Positive association; N = Negative association; *Significant at the 0.05 level; †Significant at the 0.1 level

Table A4. Relationship between participation (leading member), standardization (local), and financial and data contributions and nature of interaction

	Internal				External			
	Leading Member	**Local Standard**	**Financial Contrib.**	**Data Contrib.**	**Leading Member**	**Local Standard**	**Financial Contrib.**	**Data Contrib.**
Nature of Interaction								
Ordinance/resolution					P*	P*	P*	
MOU		P†				P*	P†	
Dept. policy	P*		P*	P†				
Service contract		N†						
Intergov. agreement		P*				P*		P†
Other contract					N†			
Mutual rules/procedures				P†	P*			P*
Joint leadership		P*	P†				P†	
Interorg. policy group	P*			P*	P*		P*	
Interorg. tech. group					P†			
Coordination unit/person								P†
Informal	N†							P*

P = Positive association; N = Negative association; *Significant at the 0.05 level; †Significant at the 0.1 level