[KE-03-033] Organizational Models for GIS Management

Abstract

Organizational structures and management practices for GIS programs are numerous and complex. This topic begins with an explanation of organizational and management concepts and context that are particularly relevant to GIS program and project management, including strategic planning and stakeholders. Specific types of organizations that typically use GIS technology are described and organizational structure types are explained. For GIS Program management, organizational placement, organizational components, and management control and policies are covered in depth. Multi-organizational GIS Programs are also discussed. Additional topics include management roles and technology trends that affect organizational structure. It concludes with a general description of GIS Project management.

Keywords: enterprise GIS, GIS Program, governance, management, organizational structure, policy

Author & citation

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Explanation

1. Organizational Context for GIS Management

1.1 Types of Organizations with GIS Programs

GIS was considered a niche technology when originally implemented in selected organizations in the middle 1970s to mid-1980s. Today, GIS has become an accepted information technology tool used by a wide range of public-sector organizations, public and private utility organizations, private companies, academic institutions, not-for-profit groups, and a range of non-governmental organizations (Table 1).

Table 1. Organization Types that Use GIS Technology

Type of Organization	Examples of Organizations	Mandates and Authority*
National/Federal Government Agencies	• Federal government civilian agencies in the United States and Canada • National civilian agencies/ministries in other countries • National military and security organizations	• Existence based on national constitutions and statutes • Formal regulations and policies drive organizational structure and processes • Elected or delegated political leadership and appointed senior management
State/Provincial/ Territorial Governments	• State government agencies in the USA and other (includes LA parishes and AK boroughs in the United States) • State governments in other countries (e.g., Australia) • Provincial government agencies and equivalents (e.g., Canada, China) • Territories and regional governmental bodies	• Created by national government and enabled by state and provincial constitutions and statutes • Formal regulations and policies drive the organizational structure and processes • Leadership by governor or an equivalent official and appointed senior managers for departments and offices
Local Governments	• Counties (mainly in USA, Canada, and British Isles) and equivalent local jurisdictions in other countries (e.g., District, Department, Prefecture, etc.) • Municipalities (incorporated cities, villages, towns, townships, boroughs, etc.)	• Established through formal charters or terms of incorporation • Formal regulations and policies drive organizational structure and processes • Leadership by elected or appointed county executive, mayor, or equivalent and appointed senior manager (e.g., city or county manager)
Regional Governments	• Regional urban governments established by legislative action (e.g., regional governments in several Canadian provinces) • Consolidated city/county governments in the United States • Other forms or regional government smaller than a provincial/state level	• Established through formal legislation or charters • Formal regulations and policies drive organizational structure and processes • Leadership by elected or appointed chief executive
Regional Public Agencies	• Regional planning agencies • Economic development districts or authorities • School districts • Natural resource planning and management districts • Multistate, multinational commissions, or compacts (e.g., river basin commissions)	• Enabled through legislation and/or formal compact agreements • Mission and operations defined by charter, by-laws, and formal policies • Oversight by appointed or elected board • Appointed senior officer (e.g., executive director)
Tribal/Native Governments and Organizations (mainly USA and Canada)	• Tribal governments • Native corporations	• Enabled through treaties and charters with Federal and/or state and Provincial governments • Leadership by appointed or elected chief and council
Public Utilities	• Water, sewer, wastewater, flood control, gas, or electric authorities or districts • Utility departments (part of local government jurisdictions) • Public utility cooperatives • Large government owned national and regional utility companies (mainly outside USA and Canada)	• Enabled through legislation and/or formal agreements with local, state, or provincial organizations. May include formal incorporation as a publicly-owned company • Mission and operations defined by charter, by-laws, regulations, and formal policies • Direct oversight by an appointed board • Appointed senior executive officer (e.g., general manager)

Type of Organization	Examples of Organizations	Mandates and Authority*
Private Utilities	• Investor-owned water, electric, and gas companies • Telephone and communication services companies • Oil and gas transmission companies	• Enabled through corporate charters • Mission and operations defined by charter, business plans, and formal policies • Oversight by appointed (or shareholder elected) board • Appointed senior officer (e.g., CEO, president, general manager)
Contained Site- based Facilities	• Airports • Military bases and facilities • University and campus-styled facilities, e.g., hospitals, industrial parks • Site-based GIS projects (e.g., environmental remediation projects)	• Depends upon legal and administrative structure of parent organization or private owner • These sites normally have a range of needs for spatial information management for their limited geographic areas that mirror those of a governmental body (real property transportation, utilities, environmental, emergency management, etc.)
Private Companies - Resource Management	• Mineral or petroleum exploration and extraction companies • Forestry and large-scale agricultural production organizations	• Enabled through corporate charters • Mission and operations defined by charter and business plan, • Driven by resource and market location • Oversight by appointed or shareholder-elected board • Appointed senior officer (e.g., CEO, president)
Private Companies - Retail and Commercial Services	• Real estate management and development companies • Business planning/siting organizations • Retail companies with distributed locations	• Enabled through corporate charters • Mission and operations defined by charter and business plan, driven by real estate and location • Oversight by appointed board • Appointed senior officer (e.g., CEO, president)
Private Companies - Service Delivery	• Material logistic and transport companies • Private transportation – rail, air, water, motor carrier • Product shipping and delivery – from pizza to pianos	• Enabled through corporate charters • Mission and operations defined by charter and business plan, driven by origin and destination • Oversight by appointed board • Appointed senior officer (e.g., CEO, president)
Private Companies - Market-Oriented	• Social services, medical care • Product advertising and sales • Consumer surveys • Content distribution, news, weather, fact and fiction	• Enabled through corporate charters • Mission and operations defined by charter and business plan, • driven by demographics and their location • Oversight by appointed board • Appointed senior officer (e.g., CEO, president)
Private Companies - GIS/IT Product and Service Providers	• GIS and IT software companies • GIS data collection and database development companies • GIS data product providers • GIS consultants and development services companies • Surveying and mapping companies	• Enabled through corporate charters and articles of incorporation • Mission and operations defined by charter and business plan • Oversight by appointed or shareholder-elected board • Appointed senior officer (e.g., CEO, president)
Not-for-Profit Organizations	• Citizen action groups • Environmental advocacy organizations • Land trust organizations (e.g., Nature Conservancy)	• Enabled through organization charters • Mission and operations defined by charter and business plan • Oversight by appointed or elected governing board • Appointed senior officer (e.g., CEO, president, executive director)

Type of Organization	Examples of Organizations	Mandates and Authority*
Academic/ Research Institutions	• Colleges & universities • Private or public research foundations	• Governmental charters for public universities • Mission statements • Appointed or elected governing boards • Director, president and/or chancellor as senior managers
International Treaty and Non- Governmental Organizations (NGOs)	• United Nations programs involving geographic information and use (e.g., UN Environmental Program) World Bank • International non-governmental humanitarian organizations (NGOs) • International research programs	• Depends upon legal and administrative structure of organization or parent body. Usually includes a governing board of directors and appointed senior officer (e.g., CEO, general secretary, president, executive director).

* Identifies the legal, regulatory, or other formal basis and executive leadership for the establishment and operation of the organization.

More recently, the scope and complexity of GIS programs have greatly expanded and become “Enterprise GIS.” Enterprise GIS programs are a fundamental part of an organization’s information technology architecture, evident when GIS serves multiple departments and user communities (Somers, 2004; Tomaselli, 2007; Babinski, 2009; Holdstock, 2017). Enterprise GIS programs are characterized by

- a focus on organization-wide business needs and strategic goals,
- a long-term focus,
- GIS data and infrastructure as being an investment with value and benefits,
- an Integration of GIS with overall information technology architecture,
- policies and management structure that encourages and supports coordination and collaboration, and
- shared data, applications, and support.

At the same time, many GIS programs have a scope that now includes users from outside of the organizational boundaries, in order to support a variety of collaborative efforts such as joint funding and data sharing with external organizations and user groups. This expanding domain of GIS operations tends to blur strict organizational lines and has required GIS managers to put in place creative legal, financial, and administrative mechanisms to support collaboration within and external to the organization.

For additional information on the history of GIS and its management issues impacting GIS implementation and operation, see Foresman, 1997; Wellar, 2012; and Kuhn & Onsrud, 2018.

1.2 Organizational Structure Types

Decisions about organizational placement and management of GIS programs and projects must first consider the organization’s overall structure. Organizational structures establish a consistent and efficient way to direct resources, convey information, comply with formal requirements, and ultimately accomplish the organization’s mission. Common structure models include hierarchical (also referred to as “bureaucratic” or “functional”), matrix, and project-oriented (Figure 1). In practice, one of these organizational structure types may

dominate but they often incorporate elements of the other organizational types.

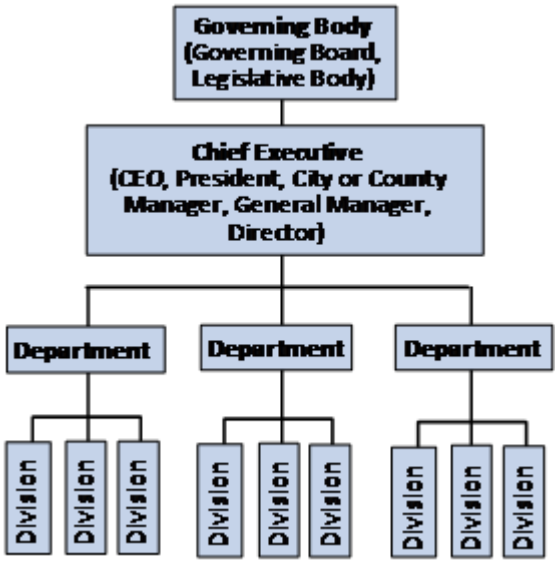
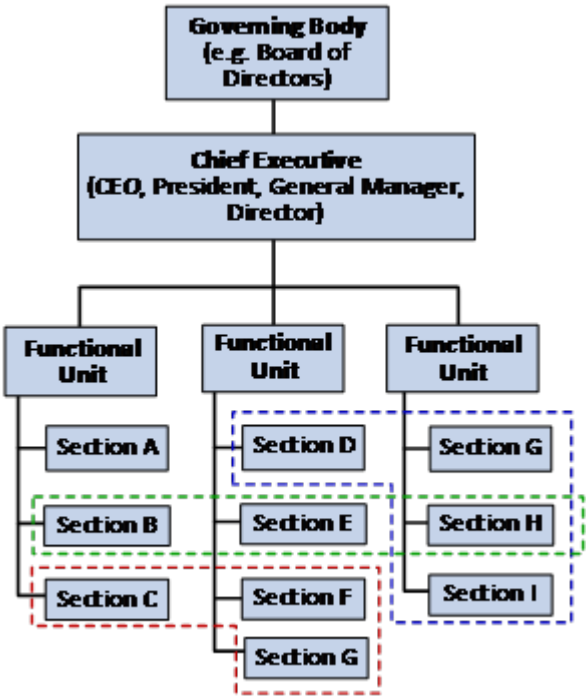
Diagram	Characteristics
	**Hierarchical ("Bureaucratic" or "Functional") Structure** • Strict vertical (top-down) lines of authority. • Clear "unity of command "(each organizational unit has one defined manager). • Organizational unit groupings typically defined by business or workflow responsibility. • Lack of formal horizontal lines of communication between units at the same level. • Predominant structure for government, military, utility companies, and many private firms. • Many hierarchical structures incorporate "staff" and "line" organizational units. Staff units connect directly to the chief executive office to play organization-wide support roles (e.g., legal, financial). Line departments address operational activities. • Most organizations with a predominant hierarchical structure incorporate some features of matrix structures (see below).
	**Matrix Structure:** • Underlying hierarchical structure with formal means for horizontal collaboration (lateral linkages) to create work teams that cross vertical authority lines. • Characterized by horizontal groupings (project teams, committees, task forces) created to take advantage of competencies across organizations. • Organizational units organized under "functional unit" groups that may be defined by type of product, service, customer or geographic characteristics. • May violate strict "unity of command" principles and vertical lines of authority. A single employee may answer to more than one superior. • Little formal lines of horizontal communication between units. • Typical structure for private services firms or non-profit organizations. • Private technical services companies often use this structure to define vertical lines of business but to allow for cross-departmental project or research activities (to make use of staff and resources most suited to the job). • Many organizations predominantly structured as hierarchical (e.g., governments) have some elements of matrix structure (e.g., some local governments assign assistant city or county managers to top-level functional units defined by service area).

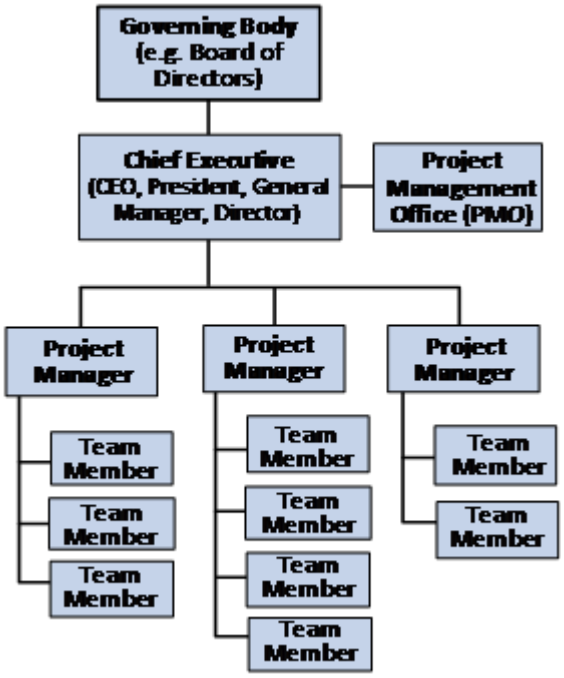
Diagram	Characteristics
	**Project Structure:** • Established in cases where the organization's work is carried out through individual projects—where projects have a specific set of objectives to accomplish • Project managers or project steering groups oversee the work of one or more teams. • Teams are composed of people who may be placed anywhere in the organization, and one person may be a member of more than one team. • Project managers responsible for overseeing and reporting performance to senior management. • Organization may have a "project management office" that establishes standards and procedures for project planning and execution and that may have a role in performance monitoring. • Structure used by services firms, research institutions, R&D arms of private companies, and some non-profit groups that are oriented around project-based work.

Figure 1. Management scientists including Mintzberg (1979) and Melin (2010) categorize administrative organizational structures into types such as hierarchical, matrix, and project-based ones.

Examples of GIS integration and enterprise GIS can be found within each of these organizational structures. In the 21st century, organizations are finding it necessary to evolve to become more flexible and collaborative and remain competitive. Organizations are taking greater advantage of technologies for communication and coordination and worker lifestyle. This trend is resulting in less rigid management controls, the location of workers (remote location and worker mobility), increased collaboration in the workplace, and more routine formation of collaborative teams with participants from through an organization.

2. GIS Management

Organizational management has now become its own distinct discipline (Fayol, 1949; Drucker, 1973; Moore, 1995). For the purposes of this chapter, organizational management is defined as the planning, organization, coordination, and oversight of activities, people, and resources for the achievement of defined objectives. Sound GIS management requires the efficient use of resources and effective planning and execution of tasks to deliver value to users and "customers" of GIS products and services inside and outside of the organization.

GIS management is relevant at multiple levels, from the organizational to the program to the project. URISA's Geospatial Management Competency Model (GMCM), which addresses

the management competencies of the U.S. Department of Labor's Geospatial Technology Competency Model (GTCM), is directly relevant for management within this domain. The numerous competencies of the GMCM, listed below in an edited list, presents a comprehensive scope of GIS management responsibilities and activities, whether the focus is at the program or project level.

- Geospatial Technology Management
- Human Resource/Personnel Management
- Legal Affairs and Policy Management
- Work Team and Assignment, Delegation and Monitoring
- Marketing, Promotion, and Business Development
- Training and Professional Development Management
- Work Monitoring and Management
- Organizational and Political Affairs Management
- Financial Accounting and Management
- Self-Management
- Performance and Quality Management
- Communications Management
- Stakeholder, Relationship, and Interorganizational Management
- Leadership
- Strategic Planning and Action
- Geospatial Project Management
- Contract Negotiation and Management
- Fixed Asset Management

2.1 Strategic Planning as Basis for GIS Management

A well-crafted strategic plan is a good foundation for all management activity. Strategic plans define direction and act as a compass to help programs and projects stay on track, maintain alignment with overall organizational goals and needs, and serve as a basis for assessing and reporting on status and progress. GIS management strategic plans should be brief while still adequately describing 1) the GIS-related organizational mission and goals, 2) information about services to users, 3) major initiatives for GIS development and enhancement work, and 4) how GIS supports the organization's mission and business needs. Strategic plans often span 3-5 years, and while there may be minor revisions from year-to-year, the strategic plan should not be changed substantially during this planning period, unless necessary. Table 2 contains suggested content and format for a GIS strategic plan. For further information, see Somers, 2000; Haack, 2002; Bryson, 2004; and Croswell, 2009.

Table 2. Suggested Content and Format for a GIS Strategic Plan

Section	Possible Components
Current Situation and Organizational Context: A summary of the current business and organizational environment, system resources and standards, and status of GIS activities.	• Organization mission and goals • Summary of current GIS management, activities, and program status • Overview of technical resources and staff • Organizational context, GIS users, and stakeholders.

Section	Possible Components
Strategic Foundation: Key pieces that provide a basis for action and create a picture of the end result to be achieved through this plan. This major part of the plan includes concise high-level goals and establishes a business justification for accomplishing those goals.	• Reference to previous strategic plans • Business drivers for GIS • GIS vision statement • GIS mission statement • Strengths, weaknesses, opportunities, and threats • Guiding principles and values • Key business processes impacted by GIS • High-level goals and strategies • Critical success factors • Business case justification
Strategic Initiatives: Elaborates on high-level goals and provides more specific information on particular actions to accomplish the goals. While still high-level, this part of the plan provides sufficient detail to define the nature of the work, the overall timing, and the resources necessary.	• Objectives or initiatives (related to high-level goals) • General timing • High-level budget and anticipated funding sources • Major management and stakeholder roles and responsibility • Performance measurement and monitoring.

2.2 GIS Stakeholders and Stakeholder Relationships

GIS “stakeholders” are individuals or groups that have some interest in the development and operation of the GIS program or products generated from the GIS. Effective GIS project and program management is attuned to these different GIS stakeholder roles, and the roles are specified and differentiated in the strategic plan.

- GIS managers: Individuals or bodies with a formal or informal role in planning, managing, overseeing, or coordinating GIS programs and projects. This may include formal bodies created to support GIS project and program management and coordination (e.g., GIS Steering Committee).
- GIS/IT technical staff: Individuals with technical skills and roles in GIS program development and operations. Includes responsibilities in such areas as GIS database development and administration, software/application development, system and network administration, and other technical areas.
- Direct GIS users: Individuals or groups that directly access GIS software and applications to support their organization’s needs. These users may be involved in such activities in GIS data collection, GIS database update and quality control, direct use of GIS software and applications to generate to generate products or results, or use of a software or Web service integrated with GIS (e.g., infrastructure asset management system). This stakeholder group also includes a wide array of “external users” not part of the organization hosting the GIS but which access GIS data and tools by public facing Web-based applications, mobile apps, and a range of location-based services.
- Indirect GIS users: Individuals and groups that have access to products generated from a GIS (e.g., map) but do not access GIS software or data directly.
- Organization management: Mid-level or senior managers in organizations that have a role in overseeing GIS operations, approving resources for GIS, or which have other decision-making responsibilities that impact GIS programs and products. This stakeholder category may also include high-level bodies (e.g. GIS or IT policy board) that have oversight responsibilities over GIS programs or projects.

- External partners: Outside organizations, with which the organization running the GIS program collaborates, normally through a formal agreement. These external relationships may involve sharing of data, funding support for GIS development or operations, or other relationship. For example, in the USA and Canada, there are well-established multi-organizational consortia (multiple local government jurisdictions and utility organizations) which provide benefits for all parties.
- Product/service providers: Includes any parties, most frequently private companies, which provide GIS programs with an array of products (e.g., GIS software and hardware) and services. Services provided including consulting, GIS database development and integration, application development, Cloud-based or hosted GIS services, etc.

3. GIS Program Management

3.1 GIS Program Management Organizational Placement

A decision to establish a GIS management office in an organization revolves around two key questions:

1. Where in the organizational structure should the GIS management office be placed?
2. What is the appropriate level of centralization of GIS services?

Many GIS programs operate as an organizational unit (“office”, “division”, “department,” “center”, etc.) inside a parent organization, and they adhere and respond to the established lines of authority and management controls that exist in that organization. Today, most GIS programs are established to serve a broad user community both inside and outside the host organization, and this has implications for placement of the unit.

No single optimal approach to GIS organizational structures has emerged in practice. The dominant trend recently has been to put in place more centralized mechanisms for coordination, collaboration, and management in multi-departmental and multi-organizational settings. It is also common to place GIS management inside the main information technology department.

Specific factors that contribute to the placement decisions might include

- appropriate administrative placement of a GIS program management office,
- the particular purpose and applications for GIS technology at the organizational or individual department level,
- clear definition of administrative authority over the GIS program or project,
- adherence to overall information technology standards and policies,
- coordination and communication with managers of user departments or business units,
- support to multiple user groups and involvement of user groups from different departments or business units in GIS program and project work,
- funding and cost allocation for GIS development and operations,
- maintenance of support from senior management,
- assignment and oversight of responsibilities for a range of operational and technical support function, and

- communication and coordination with external GIS stakeholder organizations.

However, the most appropriate placement depends on many factors such as the type and size of organization, the nature and size of the GIS user community, the geographic distribution of users, the organizational culture and history, and existing organizational policies (Table 3).

Table 3. Summary of Organizational Placement Options for GIS Management

Location of GIS Management Unit	Advantages and Disadvantages
Senior Executive Office: Special management position or office inside the senior executive management office of an organization (e.g., Mayor or City Manager's Office)	**Advantages**: a) Can use existing lines of authority for communication and management control of entire organization; b) Effective way to maintain awareness and support from chief executive. **Disadvantages**: a) Technology management not always a normal role of the executive office, resulting in less effective oversight; b) In some cases, lines of communication can result in disconnect with user departments.
User Department: Placement inside a line department or office in the organization that is a principal user of GIS and which has been assigned a role for organization-wide GIS coordination and management.	**Advantages**: a) Line department may have a strong history of GIS use and support; b) GIS can take advantage of reliable revenue. **Disadvantages**: a) Objective to fulfill department's mission may conflict with organization-wide GIS needs and support to other departments; b) Line of authority and political perception may inhibit organization-wide participation.
Organization's Information Technology Department: Placement inside the unit and given responsibility for the information technology management and support for the organization.	**Advantages**: a) Lines of authority and policies in place to provide organization-wide services and support, b) IT standards and practices for information management apply directly to GIS, c) IT department already has responsibility for HW/SW/network infrastructure that GIS will use. **Disadvantages**: a) IT department management, staff, and resources may not address specific needs of the GIS program, b) IT functions in organization may be decentralized without strong central oversight or standards
Independent Public Entity: Approach for GIS in public-sector agencies in which GIS management is assigned to an existing or newly created autonomous organization, not directly managed by or in the line of authority of the organization(s) that it serves. The autonomous organization would be formally created by the user organization(s) and has the oversight of a governing board.	**Advantages**: a) Level of independence allows focus on GIS program needs, b) Greater management and operational flexibility (staffing, decision-making, budgeting, resource allocation).**Disadvantages**: a) Legal/Administrative complexity to create, b) Start-up costs can be high, c) Lack of direct lines of authority with user departments can impact acceptance of management decisions, d) Separation from user organization can make it more difficult to secure funding sources, e) independence makes it more difficult to share administrative resources and costs (e.g., clerical, financial management) with a parent organization.
Outsourced to External Contractor: All or some GIS management and coordination functions are assigned to an external group (e.g., private company, public agency, or non-profit organization) with terms established through a formal contract.	**Advantages**: a) Contract terms clearly define management and operational support role and duties, b) Greater management and operational flexibility (staffing, decision-making, budgeting, and resource allocation), c) Can open up new channels for revenue not readily available to public agencies. **Disadvantages**: a) Legal/Administrative/Policy complexity and obstacles, b) Lack of direct lines of authority with user departments can impact acceptance of management decisions, c) Separation from user organization can make it more difficult to secure funding sources.

For further discussion of issues regarding organizational structures and placement, consult Brown & Friedley, 1988; Edwards, 1990; French & Skiles, 1996; De Man, 2000; Pornon, 2002; Somers, 2004; Nedovic-Budic, 2005; Obermeyer & Pinto, 2007; Croswell, 2009; and Tomlinson, 2013.

3.2 Multi-Organizational GIS Programs

Multi-organizational GIS has the potential to benefit all involved parties because of shared costs and resources. Multi-organizational programs typically include formal or informal collaboration among organizations with shared geography, such as local governments (counties and municipalities), public and private utility organizations, and sometimes other agencies with specific responsibilities (e.g., planning agencies, flood control districts). There is no single management model for successful multi-organizational GIS programs. A recent survey and assessment of such programs in the USA and Canada showed a range of models from very loosely structured with little formal governance structure to very highly structured programs with a GIS management office and governing board (Croswell, 2015). Selected observations from this survey include:

- In most cases, multi-organizational GIS programs have formal agreements (e.g., inter-local agreement, memorandum of agreement) that define terms for participation, data sharing, and other types of collaboration.
- Some multi-organizational GIS programs have no designated lead organization or management body but do include advisory bodies (without direct management authority) which develop collaboration policies and support communication among parties.
- Most multi-organizational GIS programs assign management and administrative responsibilities to one of the participating organizations. These lead organizations often include staff that support users in the participating organizations and have a range of operational responsibilities that might include: maintenance of a central GIS data repository, software license management, oversight on GIS policies and standards. These multi-organizational GIS programs normally have a high-level oversight body, with representatives from the participating organizations—which may or may not have management authority on GIS operations.
- There are a small number of multi-organizational GIS programs which have formed a GIS management office—with a manager and staff, which operates independently of any of the participating organizations but which supports the program and provides support for users in all the organizations.

For additional information on multi-organizational GIS management factors such as structure and coordination, governance, and financing, see Geodata Aliance, 2001; Johnson & Nedovic-Budic, 2002; Pornon, 2002; Nedovic-Budic, 2005; GITA, 2006; Obermeyer & Pinto, 2006; and NASCIO, 2012; as well as the full Croswell survey report (Croswell, 2015).

3.3 GIS Program Organizational Components

GIS programs are more or less likely to contain certain organizational components depending on the settings within which the programs are based (Table 4). These settings can vary in complexity from focused “project-based” GIS with limited scope and “multi-organizational” settings with high complexity and a large, diverse user community.

Table 4. GIS Program Organizational Components

GIS Organizational Component	Description	Organizational Setting*			
		Project-based	Department-based	Multi-Departmental	Multi-Organizational
Governing Authority	Legislative body or governing board (e.g., national, state, or provincial legislature; county or city council; elected or appointed governing body or board of directors).	S	U	U	U
Executive Management	Executive leadership of organization that empowers/approves GIS management (e.g., governor, mayor, city manager, county executive, president, general manager, CIO, etc.).	S	U	U	U
GIS Governing or Policy Body	Senior representatives of multiple departments with explicit responsibility for overseeing the GIS program. Level of authority varies depending on the organization.	R	R	S	S
GIS Advisory Body	May be created in many cases as a vehicle to obtain participation, ideas, and support from stakeholders inside, and often outside, the organization running the GIS program.	S	R	U	U
Central GIS Management	Formal office with GIS manager and staff responsible for managing/coordinating the GIS program. May also provide centralized system administration, GIS services, and user support.	R	R	U	U
External Organizations	Any outside organizations or vendors with which the GIS program has contractual relationships or agreements for sharing information or joint project work. May be any public, private, nonprofit, or other outside groups that use services or products from the GIS organization.	S	S	U	U
Standing Committees	Formal groups, with a designated chair and membership drawn from the entire organization, whose role is to investigate and oversee critical program initiatives and needs (e.g., data standards, policies, and database maintenance). As "standing committees" they have a long life (although "time-limited committees" may also be created).	R	S	U	U
Task Forces or Work Groups	Formal groups, with a designated leader and membership drawn from the entire organization (and perhaps external organizations), with a focused, time-limited mission to produce specific end-results (e.g., specific research task, specifications, vendor product review, etc.).	S	S	U	U
Project Teams	Similar to task forces, but may be defined separately to imply more formality in structure, resourcing, management, and oversight. They are given responsibility for a specific project with defined deliverables (e.g., development of an application). Project teams may be composed solely of employees of the organization, but they may also include contracted personnel.	U	U	U	U
User Groups	Formal or informal collections of users from the organization and sometimes outside organizations who meet periodically or communicate through other means to share information about GIS technology, applications, data issues, etc. These groups typically do not have a direct management support role but exist for sharing information and collaboration among users.	R	S	U	U
Information Technology Department	The unit that, in most organizations, is responsible for maintaining its computing infrastructure and IT users. These organizational units are normally responsible for IT standards, policies, system design and development, user support, and training.	R	U	U	U
Program/Project Management Office	An organizational unit sometimes created in large organizations to support sound management. Its main functions are to develop or provide: a) management standards and practices, b) tools/ templates to support program/project management, c) training and support to managers, and d) oversight and review of program or project performance.	R	R	S	S
Governing Authority	Legislative body or governing board (e.g., national, state, or provincial legislature; county or city council; elected or appointed governing body or board of directors).	S	U	U	U
Executive Management	Executive leadership of organization that empowers/approves GIS management (e.g., governor, mayor, city manager, county executive, president, general manager, CIO, etc.).	S	U	U	U

*Indicates how frequently the organizational component is found in the different

organizational settings: **U** = Usually; **S** = Sometimes; **R**= Rarely or Never

Below we detail with an organizational chart one hypothetic but realistic scenario in which an Enterprise GIS office is placed inside a City's Information Technology Department (Figure 2). This office would have responsibility for managing the GIS program and supporting users in all City departments and coordinating with external organizations for sharing of data and access to the GIS. To fully appreciate all of the relationships among stakeholders, all GIS program management efforts should be able to produce organizational charts such as this one in order to appreciate the relationships and dependencies.

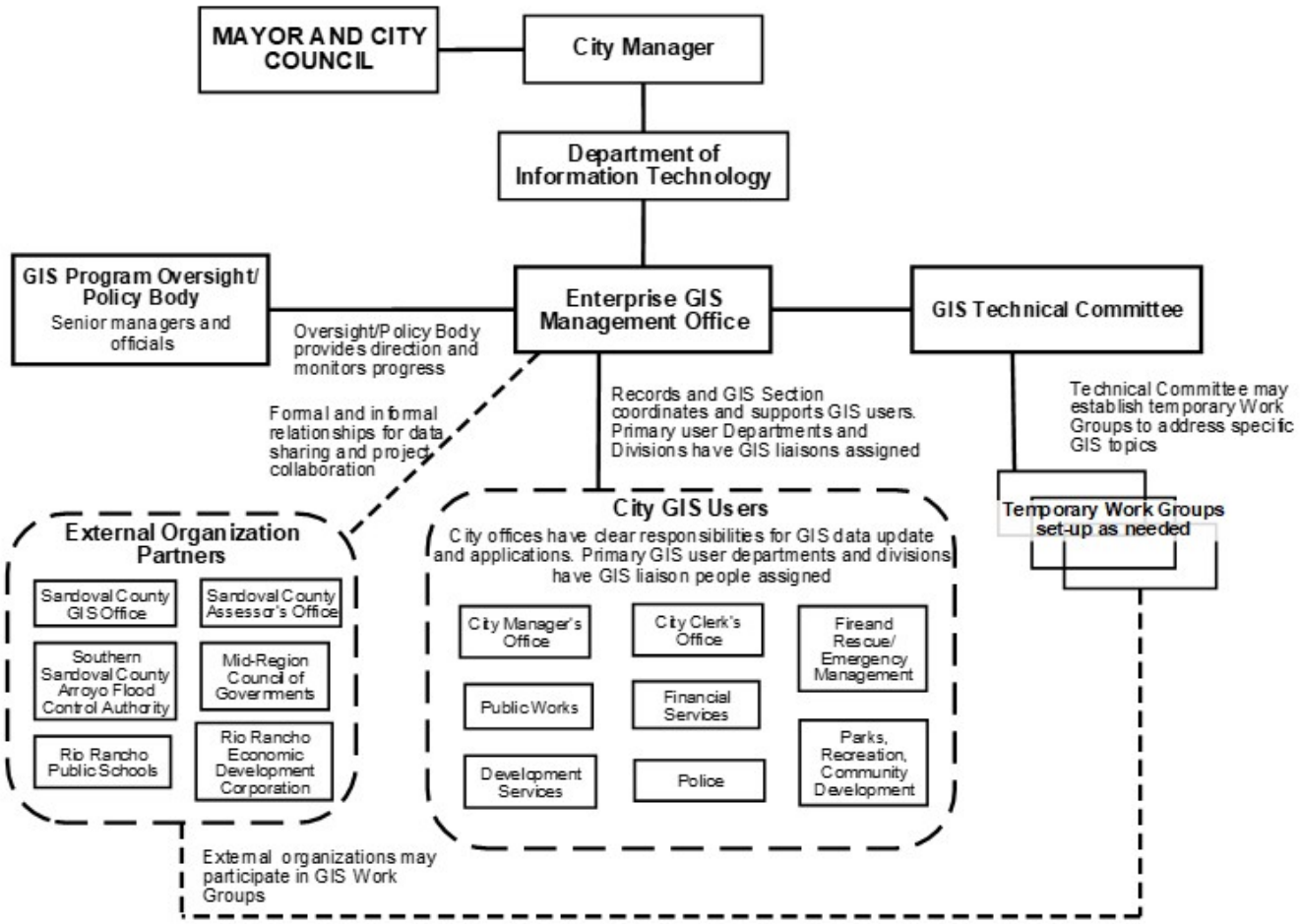


Figure 2. Enterprise GIS Organizational Structure for a Municipality.

3.4 Management Control and Coordination of GIS Programs

3.4.1 GIS Management Roles - Level of Centralization

Any successful GIS program that serves multiple user groups must provide and respond to a range of coordination and management needs and operational roles and functions. How these roles and functions might be allocated to various parties, e.g., assigned to a central GIS management office, decentralized to one or more user departments, or outsourced through a contract with a private company or other outside service provider, are key

decisions. Table 5 below details the responsibilities for an enterprise GIS program with a high level of centralization, a combination that is especially common in government and utility organizations.

Table 5. Responsibilities for Enterprise GIS Program Management and Operation

GIS Coordination and Management Role/Activity	Centralized GIS Office	User/Line Department	Outsource
Contract and Financial Management and Tracking	**L**	**P**	
Defining and Overseeing Policies for System Access and Information Sharing	**L**	**P**	
Establishing/Overseeing Technical Standards	**L**	**P**	**O**
Forming and Leading GIS Coordination Bodies	**L**	**L**	
Management of GIS Data Development Projects/Contracts		**L or P**	**P**
Developing/Providing Applications for GIS Access	**L**	**L or P**	**L or P**
Ongoing Updating of Common GIS Data	**L or P**	**L or P**	**P**
Ongoing Updating of Departmental GIS Data		**L or P**	**P**
Database QA and Posting to Central Database	**L**	**L or P**	**P**
GIS Software License and Cloud Service Management	**L**		
User Training and Orientation Services	**L**	**L or P**	**P**
Departmental GIS Application Development	**L or P**	**L or P**	**L**
System and Network Monitoring Administration	**L or P**	**L or P**	**P**
Ongoing Technical Support/Help Desk Services	**L**	**P**	**P**

L=Lead Role, **P**=Participate or Support Role

Cost effectiveness and maximized benefits are the principal arguments for higher levels of centralization of GIS management and operations. They result from the following:

- sharing technical staff resources and management reduces duplication of staff while minimizing cost,
- sharing common data resources and data update work improves data quality and reduces costs,
- aggregating purchases and maintenance of hardware and software lowers costs,
- more efficient system and network administration and security controls lower costs and improve quality,
- reusing or sharing applications and application templates reduces redundancy and lowers costs, and
- departmental collaborating fosters innovation and better customer service.

The goal is to establish a mix of centralization and decentralization that is optimal for that organization to maximize coordination and sharing of resources, as well as quality of service to users.

3.4.2 GIS Management Personnel and Staff Size

The degree of centralization influences the size of the central GIS management office and the make-up of its staff, as well as the type and number of GIS staff retained by user departments. Some organizations with enterprise GIS programs have relatively modest staffs, including a GIS manager or coordinator, a small number of technical staff, and administrative support personnel. In other cases, central GIS management offices have sizable staffs and have assumed a comprehensive range of roles in program administration, coordination, technical support, and operations. More discussion of staffing levels and roles for GIS programs are covered in Tomaselli, 2007; Croswell 2009; Butler, 2013; and Tomlinson, 2013.

3.4.3 Organizational and Technology Trends Impacting Organizational Structure

Current trends in GIS technology and services that have had a major impact on GIS program organizational structure. These include

- cloud-based IT infrastructure and externally hosted GIS services,
- web-based mapping platforms and location-based services,
- participatory GIS and crowd-sourcing of GIS data and mobile apps,
- advances in Open Source GIS software, and
- the importance of 24/7 operations and services to users.

These advances in technology have created expanded demands on GIS program management by increasing a) the size of the user community inside and outside the host organization, b) the need for high-quality, updated data, and c) the complexity and operational integrity of system configurations (hardware, software, and networks). Recent literature that describes these and additional GIS technology trends include Kouyoumijian, 2011; Huang et al, 2013; Scassa, 2013, Cho, 2014; UNGGIM, 2015; CDG, 2015; Datta, 2017; Bauman, 2010; and Agrios & Mann, 2010. Other relevant sources and resources for understanding organizational and technological influences include the The Open Source Geospatial Foundation and the Federal government's Citizen Science Toolkit.

3.5 GIS Program Management Policies

Along with applicable laws and regulations from governmental authorities, GIS programs and their organizations traditionally rely on written policies as a basis for their operation. A well-managed GIS program should have clearly articulated, easily accessible, and regularly revisited written policies that cover such topics those listed below.

- Personnel and professional development: Policies that reference existing personnel policies, as well as any additional ones related to ethics and professional development that specifically affect IT and GIS management and use.
- Standards compliance: Policies that identify approved technical standards and clarify how they apply.
- Contract and financial management: Policies that define authority and procedures for budgeting, entering into contracts with private firms, and procedures for managing contracts.
- Project coordination and management: Policies that define requirements for projects

and all elements of managing and monitoring progress, directing team activities, and project reporting.

- GIS participation and project partnerships: Policies that define procedures and administrative instruments for identifying and "registering" GIS users and participants, both internal and external, and for entering into partnerships for joint project work with outside organizations.
- Data/product access and sharing: Policies that govern access rights to the GIS, specific agreements for data sharing and data distribution limitations, and legal issues for data and product distribution.
- System administration and network security: Policies that direct the use of technical tools and practices for system operation, system monitoring, network security, and all aspects of system and database administration.
- User support and help desk services: Policies that define the nature and extent of support provided by the GIS management and technical support staff or other designated parties and procedures through which users can access support or services.
- Data maintenance procedures and responsibilities: Defines accepted policies for update of GIS data elements and specific procedures and responsibilities for carrying out the update and posting data for general access. Includes procedures for users to report data errors and problems found during routine GIS use.
- External communications: Procedures and protocols that govern any external communications about the GIS program, including contacts; collaboration with other agencies; media relations and formal press releases; participation in public communication forums; publications; and other external communications activities.

4. GIS Project Management

A common unit of activity within GIS programs is a GIS project. The Project Management Institute (PMI) defines a "project" as a "temporary endeavor undertaken to create a unique product or service." In addition to providing routine, ongoing services to the user community as projects, GIS programs also manage their own internal and ongoing projects, such as database improvements, custom application development, GIS integration with external systems.

The PMI has its own Project Management Body of Knowledge which is an excellent resource for all types of projects, including GIS ones. The PMI defines "project management" as "the application of knowledge, skills, tools, and techniques to project activities to meet requirements" and they also detail project management "knowledge areas" (Figure 3). Each of the PMI's project management knowledge areas are often implemented within GIS projects.

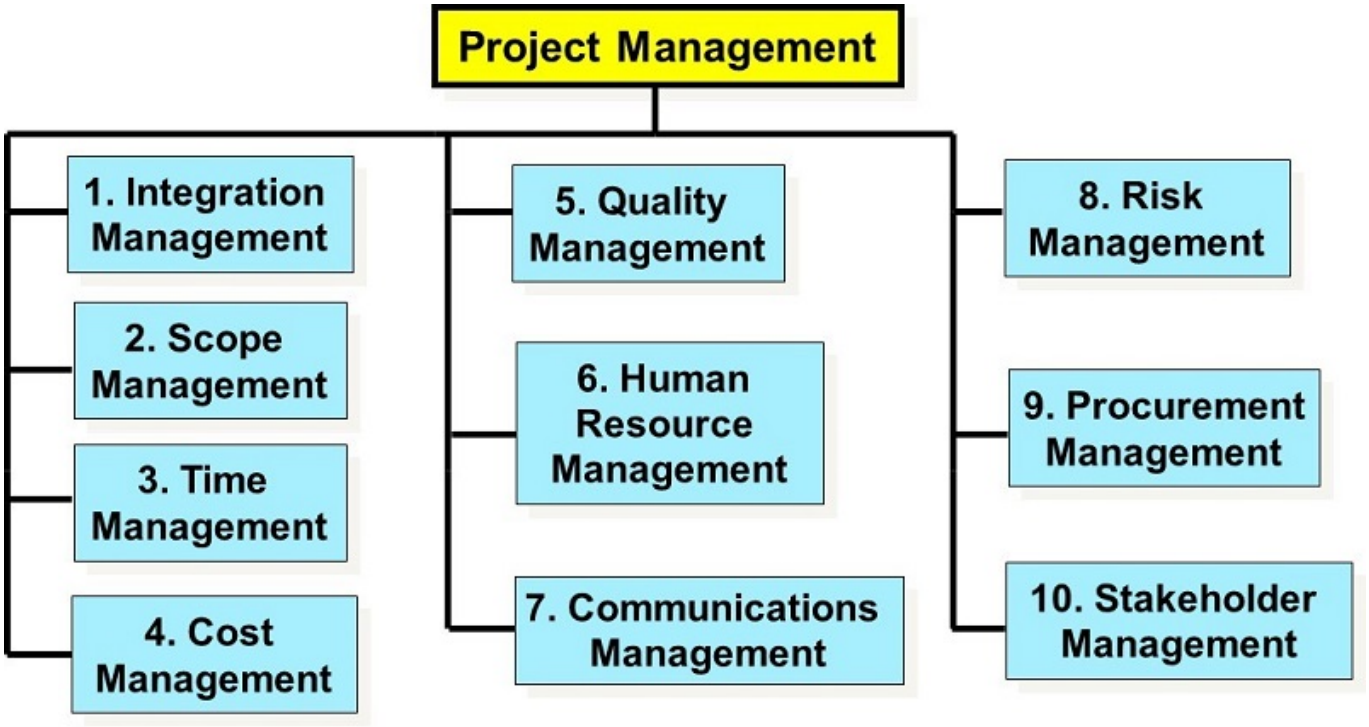


Figure 3. The Knowledge Areas of the Project Management Institute.

The PMI defines and endorses effective standards and practices including a set of "process elements" which provide a framework for the full lifecycle in project initiation, planning, execution, and closure (Figure 4). These process elements, along with the PMI's knowledge areas, provide an effective structure for GIS project planning and management.

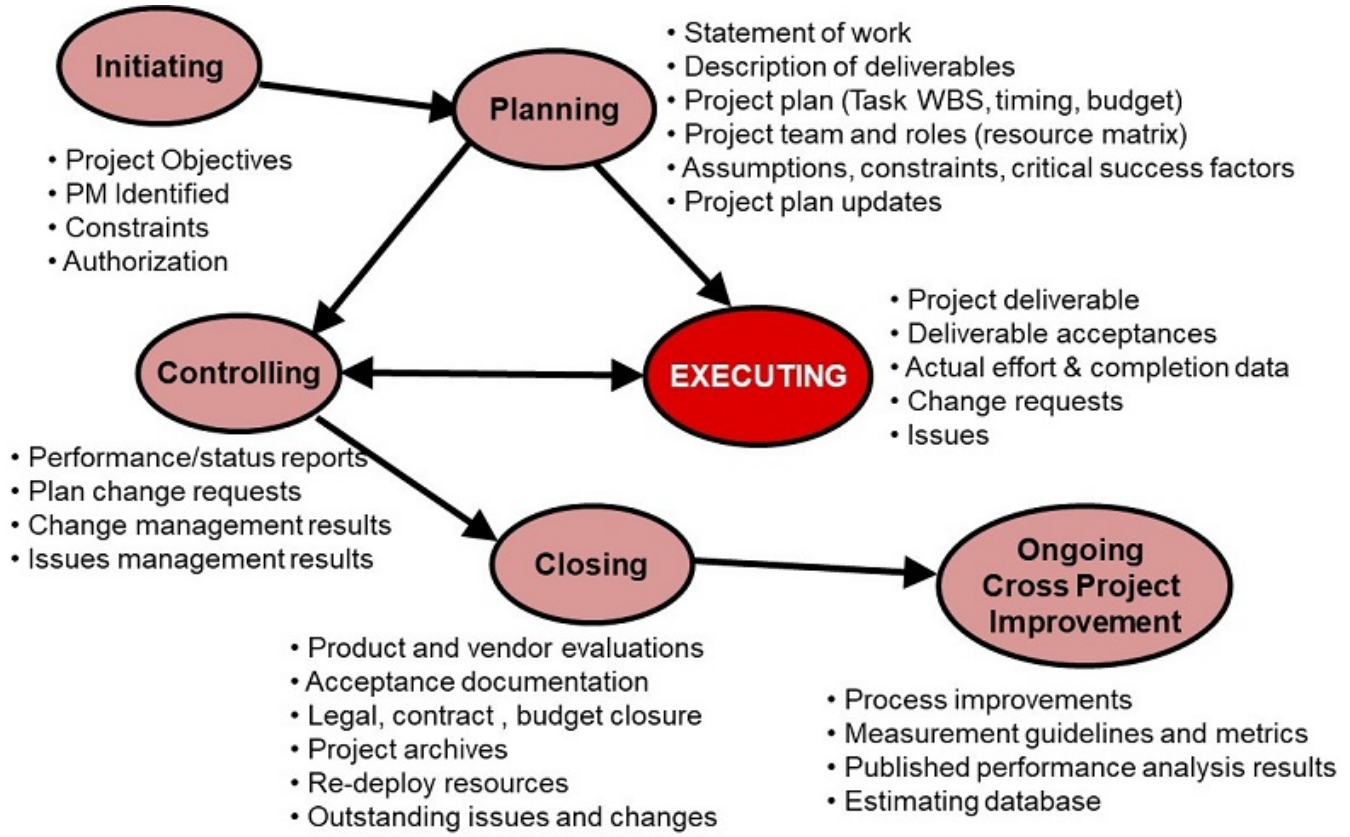


Figure 4. Project Management Process Elements, as defined by the Project Management Institute. Source: adapted from Figure 2.1, Project Management Process Groups, GEOG 771: Geospatial Technology Project Management course, Penn State University.

Project planning and management is a routine aspect of GIS programs. In addition to ongoing, routine management and support for users, GIS staff carry out special projects on a regular basis. Typical projects for GIS programs include GIS database development or enhancement, major software migration and configuration, development and delivery of training, custom GIS application design and development, and integration of GIS with external systems and databases.

For additional information on GIS project management including approaches and best practices for planning and executing GIS in a way that delivers results and supports the overall GIS program mission and goals, see Wilder & Brinkerhoff, 2003; Fournier, 2007, 2008; and Croswell, 2009.

References

Agrios, B., & Mann, K. (2010). Getting in Touch with Volunteered Geographic Information. ArcUser, Vol. 13(3), 20-21.

Babinski, G. (2009). GIS as an enterprise municipal system. Government Finance Review, February, 2009, 22-30.

Bauman, J. (2010). The role of volunteered geographic information in a postmodern GIS world: A Conversation with Michael Goodchild. ArcUser, 14(2), 20-21.

Bradbard, D., Fuller, B., & Townsend, B. (2017). Geographic information systems in selected cities and counties in the southeast United States. URISA Journal, 27(2), 5-20.

Brown, P., & Friedley, D. (1988). Assessing organizational preparedness for a comprehensive, distributed LIS/GIS. Proceedings of the 1988 Annual URISA Conference, 3, 22-36.

Bryson, J. M. (2004). Strategic Planning for Public and Non-profit Organizations. Jossey-Bass.

Butler, A. (2013). Model GIS Job Descriptions, 2nd Edition. Special publication of the Urban and Regional Information Systems Association (URISA).

Center for Digital Government (CDG). (2015). 24/7 government: Enabling access to critical services anytime, anywhere. Folsom, California: Center for Digital Government, Q1.

Cho, G. (2014). Some legal concerns with the use of crowd-sourced geospatial information. 7th IGRSM International Remote Sensing & GIS Conference and Exhibition, IOP Conf. Series: Earth and Environmental Science 20.

Croswell, P. (2015). Report on National Survey of Multi-Organizational GIS Programs. GIS

Management Institute Discussion Paper No. 2. Special report prepared by Croswell-Schulte IT Consultants and Major Oak Consulting.

Croswell, P. L. (2009). The GIS Management Handbook, 1st Edition. Frankfort, Kentucky: Kessy Dewitt Publications.

Datta, A. (2017). Nine geospatial technology trends that could define 2017. Geospatial World, April 25, 2017.

De Man, E. W. H. (2000). Institutionalization of geographic information technologies: Unifying concepts? Cartography and Geographic Information Science, 27(2), 139-151.

Dearing, A. (2017). IoT and the move to open source GIS. Directions Magazine, May 17, 2017.

Drucker, P. F. (1973). Management: Tasks, Responsibilities, Practices. 1st Edition. Harper and Row Publishers.

Fayol, H. (1949). General and Industrial Management, Pitman Publishing Company.

Foresman, T. W. (Ed.). (1998). The History of Geographic Information Systems: Perspectives from the Pioneers. Upper Saddle River, NJ: Prentice Hall.

French, S., & Skiles, A. (1996). Organizational structures for GIS implementation. Proceedings of the 1996 Annual URISA Conference, 6, 280-293.

Geospatial World. (2014). Cloud for GIS Systems. December, 2014.

Haack, C. (2002). What's your plan?: An argument for strategic planning. Proceedings of the 2002 Annual URISA Conference.

Holdstock, D. A. (2017). Strategic GIS Planning and Management in Local Government, CRC Press-Taylor & Francis.

Huang, Q., C. Yang, K. Liu, J. Xia, C. Xu, J. Li, Z. Gui, M. Sun & Z. Li (2013b). Evaluating open-source cloud computing solutions for geosciences. Computers & Geosciences, 59, 41-52.

Kouyoumjian, V. (2011). GIS in the Cloud. Redlands, CA: Esri Press e-book.

Mintzberg, H. (1979). The Structuring of Organizations. Prentice Hall.

Nedovic-Budic, Z. (chair), URISA National Geographic Information Cooperation, Coordination, Collaboration Task Force (3CTF). (2005). 2002-2004 Report and Recommendations.

Obermeyer, N. J., & Pinto, J. (2007). Managing Geographic Information Systems, 2nd Edition. New York, NY: Guilford Press.

Onsrud, H. and Kuhn, W. (Eds.) (2015). Advancing Geographic Information Science: The

Past and the Next 20 Years. GSDI Association Press. 339 pages.

Pearlson, K., & Saunders, C. (2006). Managing and Using Information Systems: A Strategic Approach, John Wiley and Sons.

Scassa, T. (2013). Legal issues with volunteered geographic information. Canadian Geographer, 57(1), 1-10.

Scott, J. (2005). The Concise Handbook of Management: A Practitioners Approach. The Haworth Reference Press.

Somers, R. (1994). GIS Organization and Staffing. In Proceedings of the 1994 Annual URISA Conference, 6.

Somers, R. (2000). GIS Strategic Planning. In Proceedings of the 2000 Annual URISA Conference.

Somers, R. (2004). Moving up to an enterprise GIS: Making a successful transition. Proceedings of the 2004 Annual URISA Conference.

Tomaselli, L. (2007). The enterprise model of GIS, and the implications for people and organizations. In Joshi, R. and Seshagiri, S. (Eds.) Geographic Information Systems: Management and Technology Perspectives. SBS Publishers.

Tomlinson, R. F. (2013). Thinking about GIS: Geographic Information System Planning for Managers, 5th edition. Redlands, CA: Esri Press.

United Nations Global Geospatial Information Management (UN-GGIM). (2015). Future Trends in Geospatial Information Management, 2nd Edition. Special report by the United Nations Committee of Experts on Global Geospatial Information Management.

Wellar, B. (2012). Foundations of Urban and Regional Information Systems and Geographic Information Systems and Science. URISA Publications.