PLANNING SUPPORT TECHNOLOGY IMPLEMENTATION BY LOCAL GOVERNMENTS IN THE U.S. MOUNTAIN WEST

By

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The final copy of this dissertation has been examined by the signatories, and we find that both the content and the form meet acceptable presentation standards of scholarly work in the above mentioned discipline.

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Planning Support Technology Implementation by Local Governments in the U.S. Mountain West

Dissertation directed by Professor Barbara P. Buttenfield

Information and communication technologies (ICT) have come to impact nearly all aspects of modern life, including the development, function and operation of urban and rural landscapes. An emerging theme in planning research is the role of technology to enable and support formal planning tasks and activities. To realize the full potential of these planning support instruments (PSI) and geographic information systems (GIS)-based planning support systems (PSS), it is necessary to gain a better understanding of both their current level of use, and the technical and institutional factors influencing their adoption.

This study utilizes a mixed-method research design to assess current levels of PSI use in local government, and explore the opportunities and barriers to PSS implementation in rural settings. A World Wide Web-based survey is employed to characterize and assess the extent and nature of PSI implementation for planning departments in the U.S Mountain West. The survey inventories planning office web site content and functionality, community process tools, GIS infrastructure and PSS use. Case research, grounded in diffusion of innovation and technology acceptance theory, is conducted on PSS implementations in four rural local governments in Colorado. All cases involve CommunityViz® PSS software in comprehensive planning, and are assessed using a combination of semi-structured interviews and content analysis of administrative and policy-related documents.

Study results indicate that Mountain West planners are capable in ICT adoption and use, but lack experience as early adopters of innovative applications. While GIS implementation is ubiquitous, PSS adoption has been minimal and limited to project-specific applications with significant support from external expertise. Benefits of PSS implementation are perceived as improved communication and credibility, while identified adoption barriers include hardware/software costs, lack of staff and time, difficulties with usability, and complexities of planning problems. The study sheds light on differences in ICT needs and use between urban and rural planning settings, and is unique in its focus on demand-side evaluation of PSS adoption. A pragmatic contribution includes recommendations for planning education, future PSS development and PSS adoption best practices.

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"There are two kinds of people, those who finish what they start and so on."

Robert Byrne, author and chess grandmaster
The 2,548 Best Things Anybody Ever Said (2002)

"Oh, I get by with a little help from my friends…"

John Lennon and Paul McCartney, musicians and singer-songwriter duo
Sgt. Pepper's Lonely Hearts Club Band (1967)

While usually completed at the end of a study, it's only fitting that saying thanks comes before everything else in this document. Undertaking and completing this dissertation would not have been possible without the assistance, cooperation and support of many individuals; I finished but not without the help of many others.

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CHAPTER I

INTRODUCTION

Information Society, Information Age, and Information Era, have become widely recognized conceptual labels for characterizing the increasingly significant influence and centrality of information in all domains of human activity (Beniger 1986; Williams 1988; Salvaggio 1989). An information society may be defined according to a wide range of thematic criteria – cultural, economic, occupational, spatial, or technological, all of which typically share the premise that quantitative increases in information have brought about qualitative changes in our social systems (Webster 2006). Of these perspectives, the technological information society viewpoint may be the most commonly recognized (Forester 1985; Kranzberg 1985; Negroponte 1995).

While specific definitions may vary, Information (and Communication) Technology (IT/ ICT) relates to a "broad area of activities and technologies associated with the use of computers and communication, but generally implying the application of computers to storage, retrieval, processing, and dissemination of data" (Keary 2000, p. 868). Sociologist Manuel Castells (1996) characterizes the ongoing Information Technology Revolution by the pervasiveness of ICT in society (e.g., ubiquitous computing; Weiser 1991) and by its application in generating both new "knowledge… and new information processing/communication devices in a cumulative feedback loop between innovation and the uses of innovation," (Castells 1996, p. 32). In this sense, ICT converge into socio-technical information systems and information infrastructures grounded in the theoretical position that technology is largely designed and constructed via social processes (MacKenzie and Wajcman 1985; Bijker et al. 1987).

Over the last several decades, the growth of ICT applications has come to impact nearly all aspects of life in the modern world, including the development, function, and operation of our urban and rural landscapes. At the disciplinary nexus of geography and planning, a number of major issues have emerged relative to research on ICT systems (Velibeyoglu 2004). Prominent themes include: the impact of ICT on urban form (e.g., Audirac 2002; Maeng and Nedovic-Budic 2008); the influence of ICT on the nature and outcomes of urban and regional planning and the ways in which planners approach planning problems (e.g., Wegener 1987 cited in Campbell 1996; Cecchini 1999; Graham and Marvin 2000; Firmino 2005; Yigitcanlar et al. 2008); and the role of ICT in carrying out planning activities (e.g., Yeh 1988; Harris 1989; Harris and Batty 1993; Stillwell et al. 1999; Klosterman 2000). It is primarily with the third area – the role of ICT in planning support, that this dissertation is concerned.

The Challenges of Planning Support Technology Implementation

This study addresses the broad need to better understand the challenges to implementing planning support technologies in urban, rural and regional planning. Geertman (2006) defines planning support as "dedicated information, knowledge, and instruments that people actively involved within formal [planning] practices can receive to enlighten… their planning tasks and activities" (p. 864). Geertman suggests the way to bring about planning support is through planning support instruments (PSI), defined as computer- based tools dedicated to the support of spatial planning tasks (2006). Examples of these instruments can be very specific single-purpose tools, including permit tracking spreadsheet templates and population trend forecasting algorithms. Others have more broadly defined these instruments to refer to a wide range of more generic planning tools fostering civic engagement and public decision making, including, for example, key pad polling devices and web "blogs". Some but not all of these instruments support cooperative or collaborative work. Some are also not digital technologies, and not all of the digital tools incorporate geospatial data and information (Lieske et al. 2009).

Within the literature, the term planning support system (PSS) refers to a special type of PSI representing, "geo-information-technology-based [planning support] instruments that incorporate a suite of components (theories, data, information, knowledge, methods, tools) which collectively support all or some part of a unique professional planning task" (Geertman 2006, p. 864). Such integrated systems have been developed to address a wide range of planning activities. Example applications include site design and comprehensive planning, growth allocation and build-out analysis, green space planning, land use-transportation modeling, urban design visualization, and environmental assessment (Brail and Klosterman 2001; Geertman and Stillwell 2003a; 2009).

PSS have been hailed as a logical extension of geographic information systems (GIS) in local planning environments (Batty 1995; 2003), where geospatial technologies and geographic data are combined to support complex spatial problem solving and workflow processes. Further, the utility of PSS is also broadly supported in the literature (Nedovic-Budic 2000a; Snyder 2003; Couclelis 2005; Geertman and Stillwell 2009). Nevertheless, implementation of these technologies has been slow and often unsuccessful (Klosterman and Pettit 2005).

To realize the full potential of PSS and other PSI technologies in local planning environments, it is necessary to gain a better understanding of the technical and institutional factors influencing their adoption and use. This need for further research has recently been identified by a number of scholars, including Vonk et al. (2005), and Geertman (2008).

While the utilization of planning support technology in planning has been addressed by a significant number of studies over the last 10 to 15 years, two shortcomings should be noted. First, most past research on PSI and PSS has focused on applications in urban settings, with little or no specific research on PSI / PSS use in rural local government planning environments. Second, the published literature to date heavily emphasizes PSI / PSS development and a corresponding supply-side and academic perspective of implementation, with few examples exploring demand-side planning department needs, sustainability of use by individuals and organizations, or effectiveness in planning practice.

Research Goals and Questions

This dissertation has two over-arching and related goals: (1) to assess the current level of planning support instrument use in local government planning departments; and (2) to gain a better understanding of the specific opportunities and barriers to planning support system implementation in rural local planning processes. Research questions and corresponding propositions are outlined in Table 1.1.

The first question (Q1) aims to characterize the current extent of ICT in supporting planning activities in city and county planning departments, including the types of PSI technologies employed, the breadth and level of sophistication in their application, and an identification of factors influencing adoption and use. While not solely a survey of GIS and geospatial data use in planning, an assessment of these resources in such departments is included.

Table 1.1. Research questions and corresponding propositions

Research Questions	**Propositions**
Q1. How are planning support instruments (PSI) currently being incorporated into local government planning? – What different types of technology are being implemented and for what purposes? – What factors influence the adoption and use of this technology?	**P1.** Most existing PSI implementations focus on well-established technologies.
	P2. Innovative PSI use is typically limited to one-time project-specific implementations, and more prevalent in urban planning environments.
Q2. For what reasons are geospatially-enabled planning support systems (PSS) being utilized in rural local government planning, and how are they being applied? – In what ways does PSS implementation differ at various stages in the planning process? – What factors influence the adoption and use of these technologies?	**P3.** Use of PSS technology will be greatest in the "information gathering" and "issue / scenario characterization" phases of the planning process.
	P4. The relative influence of technical and institutional factors on PSS adoption will vary at different stages in the planning process.
Q3. How is planning support system implementation in rural local planning affected by spatial data infrastructure (SDI) development? – What relationships exist between institutional geographic information systems (GIS) development and PSS use? – What roles do outside experts (i.e., consultants) play in PSS implementation?	**P5.** More advanced PSS implementation will coincide with more advanced SDI. - A well-developed SDI is a prerequisite for enterprise-level PSS implementation.
	P6. Despite adoption of GIS and geospatial data development, use of PSS in day-to-day planning process workflows has not been widespread.
	P7. Planning consultants play a critical role in PSS adoption and use in rural local planning environments.

Building on Q1, subsequent questions focus more specifically on implementation of geo-enabled PSS in rural planning environments, their relationships with the overall planning process and the technical and institutional drivers influencing PSS use or the lack thereof. Particular attention is given to understanding relationships between PSS, GIS, and local, regional, and state spatial data infrastructures (SDI).

Finally, the research questions provide insight on two related topics of inquiry: (1) differences in planning support technology adoption and use between urban and rural environments; and (2) determination and application of best practices to ensure successful planning support technology implementations in local government planning.

Project Methods and Scope

Research questions were addressed using a two-phase methodological approach. In Phase One, an exploratory World Wide Web-based survey was employed to characterize and assess the extent and nature of PSI implementation for a population sample of both urban and rural county and county-seat planning departments in the eight-state Mountain West region of the United States. Using the department rather than an individual as the unit of analysis, the survey inventoried planning office web site content and functionality, GIS infrastructure, and PSS use. While designed to emulate (and replicate) aspects of certain previously conducted surveys in the literature, concerns for both adequate response and completion rates resulted in a relatively concise questionnaire with few complex, casual-type questions.

Phase Two involved conducting an integrated, in-depth analysis of four rural local government PSS implementations in the State of Colorado. These cases were identified in part through survey results, and informed by input from interviews conducted with experienced PSS developers and consultants (i.e., experts) working in the Mountain West region. Case selection considered a number of feasibility criteria, including the perceived richness of the PSS applications, appropriateness of a case study analysis approach, and the ability to generalize results to other rural locations. The cases included two cities and two counties, all of which involved the same PSS software (CommunityViz®; Placeways LLC, Boulder, CO) in a comprehensive planning application.

Relevance for Geography and Planning

ICT plays a significant theoretical and practical role in both geography and planning (Bracken and Webster 1990; Brunn et al. 2004; Sipes and Lindhult 2007). The focus of this dissertation is situated at a particular intersection of these two cognate disciplines, that is, the adoption and use of PSI and PSS in place-based planning and decision making. As a geography thesis, the interpretations are grounded in geographic information science, but equally relevant to planning theory and application.

Major substantive knowledge contributions of this research are twofold. Most central is an improved understanding of the current opportunities and barriers for PSI implementation in local planning. This is based, in large part, on the survey of current ICT use among planning agencies, including an exploration of contributing institutional factors. Second, the in-depth case studies provide an improved understanding of the relationships between GIS, SDI and PSS adoption and use. In particular, the research complements recent work on the role of SDI in decision-making (Feeney 2001; Feeney et al. 2002) and provides an empirical evaluation of recently proposed PSS implementation frameworks implementation (Vonk et al. 2005).

The research is innovative and unique in its focus on the specific challenges to ICT implementation posed by rural local planning environments. Pragmatically, it proposes a set of first principles for PSS implementation in rural local panning practice. Methodologically speaking, the research provides improved methods for case study analysis in geographic information science research, an area which has not been recently or adequately addressed in either the geography and planning fields (Onsrud et al. 1992; Nedovic-Budic 2000b; Geertman 2006).

Finally, and more broadly, this work contributes to research on institutional aspects of geographic information science (Tulloch 2008) and questions of the role of technology in urban/rural planning processes (Nedovic-Budic 2000a) by extending previous work done on data sharing and access, addressing issues of supply-side drivers versus demand-side drivers in PSS implementation, and contributing to a better understanding of the unique challenges of collaborative place-based decision activities. Ultimately, this work will also assist in advancing the field of geographic information studies, a crosscutting interdisciplinary field focused on, “the systematic study of society’s use of geographic information,” (Longley et al. 2005, p. 30).

How this Dissertation is Organized

The remainder of this manuscript is organized into five chapters and a series of appendices. Chapter II is a literature review focused on evolving roles of ICT in planning, including GIS and the development of PSS technologies and the scholarship addressing their development, utility, and under-utilization. Chapter III is a broad overview of the dissertation's methodology, providing a theoretical context for information systems research, followed by an outline of the study's two-phase, mixed-method research design and considerations in working with human subjects and human subject data.

Chapter IV describes the specific methods and results of the online survey questionnaire, including a standalone interpretation of this exploratory inquiry. The PSS implementation case studies are the focus of Chapter V. Included are a discussion of case study methods in information systems research and a detailing of the case study design. Individual descriptive summaries for each of the four cases are then presented, followed by a more explanatory cross-case analysis and integrated synthesis of results.

The dissertation concludes with Chapter VI, including a summary of findings, a discussion of the theoretical and practical implications of the study, and opportunities for further research. Following a listing of cited references, a series of appendices provide additional details on questionnaire design and case study data collection protocols.

CHAPTER II

LITERATURE REVIEW

Chapter II introduces the theoretical foundations for the research. First, a substantive context is provided, defined in this study as the role of information and communication technology (ICT) in planning and focusing specifically on geographic information systems (GIS), planning support systems (PSS), and spatial data infrastructures (SDI) for computer-aided planning. The second context informing the study focuses on relevant literature in diffusion research and technology acceptance associated with ICT implementation.

Computer-Aided Planning

Since the 1950s, planners have looked to information technology (IT) to support analysis, problem solving, and decision-making activities (Brail 1987; Klosterman 1990; Mandelbaum 1996). This interest in IT corresponded closely with the Quantitative Revolution in social science, during which time the planning discipline shifted from an emphasis on "planning as design" to "planning as an applied science". With this paradigm shift, the role of IT came to be viewed as providing support for a value and politically-neutral (i.e., rational) planning process. Klosterman (1997) notes that this view changed in the 1970s and 1980s when new paradigm shifts led to the ideas of "planning as politics" within which IT was seen as inherently political, and "planning as communication" where IT and technical analyses were seen as less important than how information was transmitted to others. In the 1990s, the role of IT in planning once again came to be viewed differently. The discipline was now being considered by many as “planning as reasoning together” with IT now seen as providing the information infrastructure that facilitates, “social interaction, interpersonal communication, and debate… to achieve collective goals and [address] common concerns,”. Today, geospatial information technologies, which include both geographic information systems (GIS) and planning support systems (PSS), have become increasingly incorporated into this “collective design” approach to planning (Klosterman 1997).

Geographic Information Systems. The use of geographic information systems (GIS) in local planning environments is well established (Brail 1987; Harris 1989; Scholten and Stillwell 1990; Harris and Elmes 1993; Holmberg 1994; Masser 1998; Stillwell et al. 1999). Nedovic-Budic (2002, p. 81) notes that “… planning departments have been in the forefront of GIS use among local government agencies,”. Over the last 20 years, issues of hardware and software, data development, data access, and data sharing have been widely examined (Budic 1994; Budic and Godshalk 1994; Campbell and Masser 1995; Onsrud and Rushton 1995; Brown 1997), yet challenges still persist, particularly in terms of institutional hurdles related to long-term data stewardship and maintenance (Nedovic-Budic and Pinto 2000; O’Looney 2000; Drummand and French 2008).

Though applied to a wide range of planning activities from general mapping and zoning enforcement to comprehensive planning, more sophisticated GIS analyses applications have been less developed (Nedovic-Budic 2002; Gocmen and Ventura 2010). This underutilization was initially noted by Harris (1989) and substantiated by Holmberg (1994) and Klosterman (1997).

Reasons identified for this situation include "… inadequate capacity and structure…, complexity of technology, …lack of trained staff, …scarce organizational resources, and the incompatibility of most generic geographic information products with the tasks and functions performed by urban and regional planners," (Nedovic-Budic 2002, p. 82).

Planning Support Instruments and Systems. Geertman (2006) defines planning support as "dedicated information, knowledge, and instruments that people actively involved within formal [planning] practices can receive to enlighten… their planning tasks and activities" (p. 864). Geertman suggests the way to bring about planning support is through planning support instruments (PSI), defined as computer based tools dedicated to the support of spatial planning tasks. Others have more broadly defined these instruments to refer to a wide range of planning tools fostering civic engagement and public decision making. Some but not all of these instruments support cooperative or collaborative work. Some are also not digital technologies, and not all of the digital tools incorporate geospatial data and information. Recognized categories include: (i) information resources; (ii) community process tools; (iii) visualization tools; (iv) impact analysis tools; (v) predictive modeling techniques; and (vi) regional resource centers (Henton 2001; Boyd and Chan 2002; Snyder 2003).

Developed as a subset of GIS-based spatial decision support systems (SDSS) (Densham 1991; Batty and Densham 1996), planning support systems (PSS) are a special type of PSI consisting of geospatial technology tools and information frameworks designed to support planning processes or sub-processes for any specifically defined spatial scale and planning context (Klosterman 1997; Geertman and Stillwell 2003b). By formal definition, PSS are "geoinformation-technology-based [planning support] instruments that incorporate a suite of components (theories, data, information, knowledge, methods, tools) which collectively support all or some part of a unique professional planning task" (Geertman 2006, p. 864). More specifically, PSS, in an application oriented definition, "…bring together the functionalities of geographic information systems (GIS), models, and visualization, to gather, structure, analyze, and communicate information in planning" (Vonk et al. 2005, p. 910).

Among geospatial information technologies, PSS are unique in their focus on planning needs and planning process-driven tools (Batty 1995). PSS extend GIS capabilities in analysis and problem solving and add design, decision making and communication capabilities (Nedovic-Budic 2000a). Unlike complex land use or resource modeling software, PSSs often take the form of a toolbox from which decision-makers can draw for assistance in decision management, providing tools for modeling, analysis and design, as well as communication, visualization, and information dissemination functionality (Klosterman 1997; Batty 2003).

Two dominant trends in the literature surround PSS: the utility of planning support tools (Couclelis 2005; Nedovic-Budic 2000a; Snyder 2003) and the underutilization of these tools (Geertman 2002; 2006; Geertman and Stillwell 2003a; 2003b; Nedovic-Budic 1998; 2000a; Vonk et al. 2005). The utility of PSS are broadly supported in the literature. Couclelis (2005) lists the development of scientifically based insights, communication, the testing of alternative planning strategies ('what may be'), assistance with visioning ('what should be') and assistance with storytelling ('what could be') as some of the potential benefits of PSS. Snyder (2003) indicates PSS could transform planning decision making in two ways: first, by shifting planning from the currently typical regulatory approach to a more forward looking pro-active performance based approach; and second, by enabling public involvement in planning and decision making processes. Nedovic-Budic (2000a) lists what PSS are expected to do: help with data management, analysis, problem solving, design, decision making and communication as well as facilitate group understanding in collaborative planning processes. Specific to integrating preferences and values from public involvement, PSS can incorporate decision analysis techniques such as multi-criteria analysis (MCA) which help in assimilating values and moving past values disagreements in the planning process (Malczewski, 1999).

In spite of the potential benefits of PSS, the literature makes clear that usage of PSS is not on par with utility. As a general summary, Geertman (2006) puts forth that planners have not embraced tools available to them, and goes on to address the mismatch between supply, demand and applications of PSS. Vonk et al. (2005) summarize existing research and conclude PSS usage is not widespread, listing many general (e.g. institutional) and specific (e.g. too complex) reasons for underutilization. Little has been published on the effectiveness of PSS or other spatial decisions support systems in specific planning applications (Aggett and McColl, 2006). However, more effective ways to implement and expand use of these tools are actively being explored (see Couclelis 2005; Klosterman and Pettit 2005; Vonk et al. 2005).

The PSS literature has evolved to the point where well-informed recommendations for enhanced utilization and broader implementation have emerged. Some of the most important include a shared commitment to well-defined methods and the ability of PSS to provide needed outputs for a substantial user community (Klosterman and Pettit 2005). In order to reach this desirable state, Vonk et al. (2005) recommend disseminating information and knowledge about PSS through real world example projects.

Spatial Data Infrastructures. Closely related to both geographic information systems and planning support systems is the concept of spatial data infrastructures (SDI). Masser (2005) provides the following description of spatial data infrastructures:

> …spatial data infrastructure supports ready access to geographic information. This is achieved through the co-ordinated actions of…organizations that promote awareness and implementation of complimentary (sic) policies, common standards and effective mechanisms for the development and availability of interoperable digital geographic data and technologies to support decision making at all scales for multiple purpose… (Masser 2005, p. 16).

The idea of considering geospatial data as a supporting infrastructure for geospatial technologies and their applications was widely introduced with the United States National Research Council's (NRC) Mapping Sciences Committee publication entitled "Toward a Coordinated Spatial Data Infrastructure for the Nation" (NRC 1993). The SDI concept was formalized in the U.S. in 1994 with establishment of a country-wide National Spatial Data Infrastructure (NSDI), an action followed in similar fashion by many other countries in the ensuing decade (Masser 2005).

In the last 10-plus years, SDIs have come to be viewed not only as geographically-referenced data, but also incorporating the technology, human expertise, and institutional support that accompany geospatial technologies, location-based services, and place-based decision making. This linkage to decision-making activities has increasingly been reinforced throughout the evolution of the SDI concept, including planning applications (Arbeit 1993; Williamson et al. 2001; Nedovic-Budic 2002; Feeney et al. 2002). Feeney (2001) identifies both human and technological drivers behind the development of SDIs in a decision-support role, including the need for increased efficiency and higher level analysis capabilities (human) and increasingly more powerful and more accessible ICT.

As described above, both PSS and SDI strongly relate to both decision support needs and decision support functions. This commonality will be addressed in the dissertation by exploring the relationship between SDI development and PSS implementation from both a causal and reciprocal viewpoint.

Diffusion and Technology Acceptance Research

The second theoretical context for this research is associated with the view that the adoption and use (that is, acceptance) of planning support systems is a specialized implementation of ICT systems. ICT systems and their implementation have been studied within a number of domains, particularly diffusion research and management science.

Nearly all diffusion research over the last forty-five years, including ICT-focused studies, has grown from Roger's Diffusion of Innovations framework (Rogers 1962; 2003). Rogers (2003, p.11) defines diffusion as "..the process by which (1) an innovation (2) is communicated through certain channels (3) over time (4) among the members of a social system,". An innovation "..is an idea, practice, or object that is perceived as new by an individual or other unit of adoption," (Rogers 2003, p.12). Individuals are seen as having different degrees of willingness to adopt innovations, with the rate of adoption impacted by five factors: relative advantage; compatibility; trialability (the degree to which an innovation may be experimented with); observability; and complexity. Accompanying the diffusion process is the innovation-decision process. In this process, an individual or organization passes from initial knowledge of an innovation, to forming an attitude toward the innovation, to a decision to adopt or reject the innovation, to implementation, and finally, confirmation of the decision (Rogers 2003).

Within management science, ICT adoption and use studies have primarily been grounded in the social psychology theory of “reasoned action” (Fishbein and Ajzen 1975). Most significant has been the development of the Technology Acceptance Model (TAM), first published by Davis (1989). The premise behind TAM is that perceived usefulness and perceived ease of use influences an individual’s intention to use a system, which in turn, dictates level of actual system use. TAM assumes that when someone forms an intention to act, they will be free to act without limitation, an assumption often constrained in practice by limited ability, lack of time, organization restrictions, etc. (Furneaux 2010).

Vonk et al.’s (2005) PSS Adoption Framework integrates aspects of diffusion of innovations and technology acceptance theory and provides the primary theoretical context for this study’s research design. Building on similar integrative work by Frambach and Schillewaert (2002), the framework combines both organizational and individual factors determining PSS adoption in a mutual top-down and bottom-up process (Vonk et al. 2005).

As depicted in Figure 2.1, three major sets of factors-“perceived innovation” characteristics, “adopter” characteristics, and “external conditions” directly influence the innovation-decision process. Both “persuasion” and “social” influences shape perceived innovation characteristics, which are also influenced by adopter characteristics. The upper dotted boxes in each component of the figure relate to organizational-level adoption drivers, while the lower boxes relate to individual-level drivers.

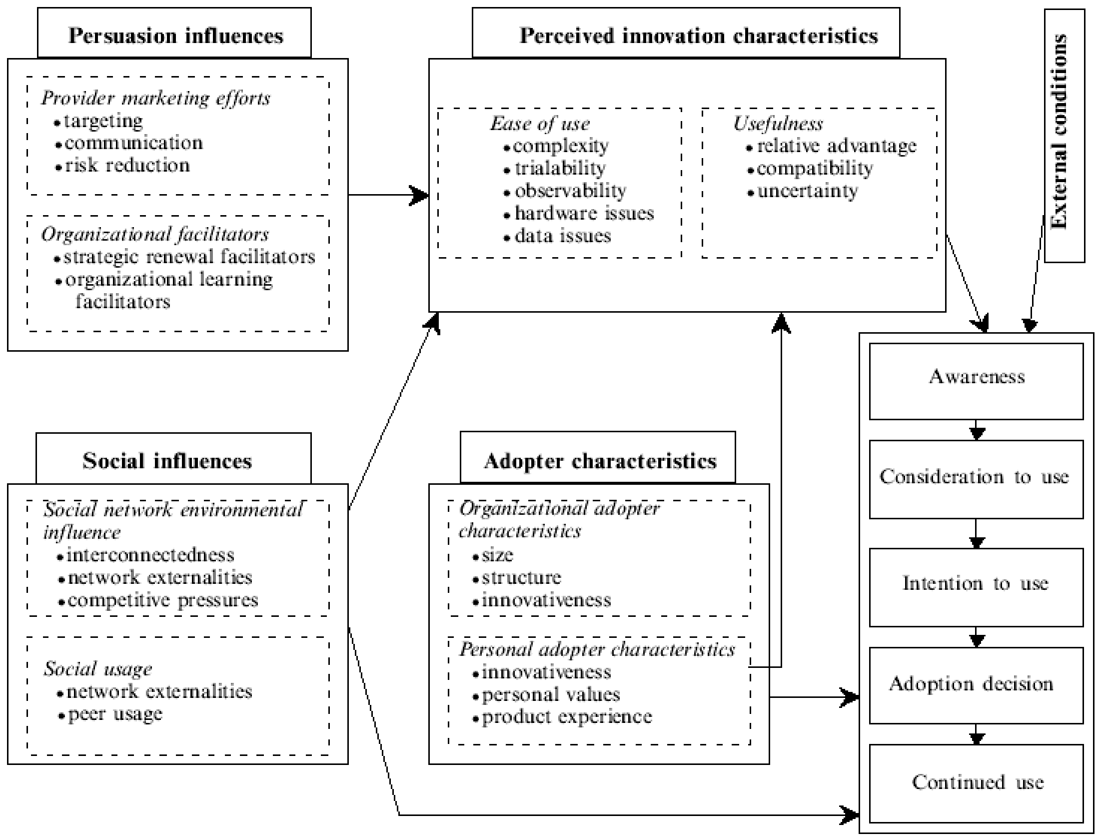

Figure 2.1. Planning support system adoption framework.

Source: Bottlenecks blocking widespread usage of planning support systems, by G. Vonk, S. Geertman and P. Schot, 2005, Environment and Planning A, Volume 37 (5), pp. 909-924. Copyright 2005 by Pion Limited, London. Reprinted with permission.

Summary

The role of ICT in planning continues to evolve, both in terms of breadth of technology and sophistication. Much of this development is grounded in two decades of GIS implementation, as well as more recent innovations in community process planning support tools. Nevertheless, while potential benefits of use are great, a need exists to better understand the gap between utility and lagging usage. This study will explore this disconnect in the context of local planning in the U.S. Mountain West, employing a research design built upon the diffusion of innovation and technology acceptance concepts presented here. Specific research methods, also drawn from the field of information systems research are detailed in Chapter III.

CHAPTER III

METHODOLOGY

In this chapter, the term methodology refers to the aggregate components of the study's overall research design. This includes defining researchable problems and identifying both the theories and data by which the problems can be addressed, as well as the methods – concepts, models and techniques – by which data are analyzed and interpreted in a particular context (Outhwaite and Turner 2007; Alasuutari et al. 2008).

Presented first is a brief summary of theoretical influences and methods in information systems research, which serves to provide context for the study's research design. Next, the major components of the dissertation's research design are introduced, including the specific methods employed. The chapter concludes with a discussion of issues relating to work with human subjects and how they were addressed in the study.

Theory and Methods in Information Systems Research

IS Research Theory. Theory in information systems (IS) research provides the context for this dissertation's research design. Information systems research is a relatively new academic field, dating to the late 1960s (Steinbach and Knight 2006). Combining the study of information technology (IT) with the study of human behavior (Gregor 2009), IS research is characteristically interdisciplinary and relies to a significant degree on theories originating from a wide range of complementary disciplines, including computer science, management, mathematics, psychology, and sociology. IS theory has been applied to a wide range of application issues, including "development, adoption, implementation, [and] training... as well as strategic, social and political factors," (Dwivedi et al. 2009, p. xxxvi).

In considering the range of theory types in IS research, Gregor (2006) identifies three distinct viewpoints of theory in the discipline:

- "*Theory as statements that say how something should be done in practice* ...provid[ing] prescriptions to be followed in practice;
- *"Theory as statements providing a lens for viewing or explaining the world* ...seen as a desirable end product – formal testing of such a theory is not envisaged;
- "*Theory as statements of relationships among constructs* that... leads to testable propositions that can be investigated empirically (Gregor 2006, p. 614, italics added).

The third view point reflects the perspective that theoretical constructs and their relationships are fundamental to the testing of theories in IS research (Bacharach 1989). In this sense, a construct refers to an "abstract concept that describes an idea or phenomenon that is not directly observable," while relationships describe "an association or connection between... concepts," (Furneaux and Wade 2009, p. 17). Among others, Benbasat and Zmud (2003) posit that all IS research constructs in some way relate to the study of information technology (IT) artifacts and their use. An IT artifact may be defined as a collection of hardware and software combined and applied to enable or fulfill certain information tasks or needs and embedded within a specific context (Benbasat and Zmud 2003). The Technology Acceptance Model (TAM) is the most widely recognized IS theoretical framework based on IT constructs, in this case, use intention, usefulness and use (Furneaux and Wade 2009).

IS Research Methods. An increasingly wide range of methods – both quantitative and qualitative - have been applied in IS research since its disciplinary inception (Myers and Avison 2002; Dwivedi et al. 2009). Galliers and Land's taxonomy of IS research methods (1987) distinguishes among empirical/observation-oriented approaches (e.g., theorem proof, laboratory experiment, field experiment, survey, case study), interpretation-oriented approaches (e.g., forecasting, role playing, action research), and also according to the different objects on which the methods are applied (i.e., society, group, individual, technology, methodology).

Survey Methods. Today, Galliers and Land's emphasis on matching method to subject matter is well established in the field (Myers and Avison 2002). However, despite a great diversity of methods in practice, quantitative analysis using survey data remains the most commonly employed method in IS research (Whitman and Woszczynski 2004; Palvia et al. 2006).

Online surveys represent one of the most significant advances in survey methodology since the introduction of random sampling in the 1940s and telephone-based interviews in the 1970s (Dillman 2000), with great potential for additional cost savings and increased efficiencies relative to self-administered questionnaire design and administration.

Fink (2006) summarizes advantages and disadvantages of online self-administered surveys. Advantages include design flexibility and user support, reduction of measurement error, and efficiencies in data coding and analysis. Disadvantages include need for reliable Internet access, respondent technical literacy requirements, and browser and network constraints. Fink also notes the need for specific technical expertise in survey fielding and the need to provide a convincing method for ensuring privacy and confidentiality.

Schonlau et al. (2002) address the issues of response rate and coverage/sampling error when considering online survey delivery mechanisms. They conducted a thorough literature review of published mail, email, Web, and dual-mode Web-mail surveys between 1986 and 2001. This review identified Web survey response rates ranging from 7 to 44 percent, compared to ~ 25 to 78 percent for mail surveys and ~ 37 to 76% for dual-mode Web-mail surveys. Similar rates were reported by Sue and Ritter (2007). While Dillman (2000) notes that one of the greatest challenges to higher response rates relates to coverage issues associated with lack of Internet access, it is acknowledged that both Internet access and literacy is improving so quickly that it is difficult to accurately assess response rates for such a moving target (Dillman 2000; Schonlau et al. 2002). Dillman et al. (1998) also cite design complexity as another factor influencing Web survey response rate (e.g., simple is better).

Finally, conclusions based on published response rates for Web surveys must be tempered by the fact that, to date, most Web surveys have been conducted with a convenience sample (i.e., open to anyone to participate), and relatively few probability sample surveys have been published from which reliable response rates can be obtained (Schonlau et al. 2002). Furthermore, response rates for any type of survey mechanism - mail, Web or otherwise, are likely most influenced by case specific conditions and can best be mitigated with sound design and implementation.

Case Research. Qualitative approaches in IS research continue to gain in popularity (Trauth 2001; 2005; Myers and Avison 2002), with the case study being cited as the most widely used qualitative method in the IS field (Darke et al. 1998; Myers and Avison 2002)[1]. Case studies first gained prominence as a methodological approach in the fields of sociology and psychology in the 1930s, 1940s and 1950s with considerable recent contributions by non-academic practitioners in business, health sciences, social work and planning (Platt 2007; Mabry 2008). Though definitions vary, case studies (or case research) may generally be considered as empirical inquiries that investigate "… contemporary phenomenon within its real-life context, especially when the phenomenon and context are not clearly evident," (Yin 2003, p. 13). During the 1980s and 1990s, case research became a well-established and popular approach in information systems (IS) research (Fidel 1984; Benbasat et al. 1987; Lee 1989; Cavaye 1996; Doolin 1996). During this same period, case studies were also increasingly utilized in studies of GIS diffusion, adoption and use (Onsrud et al. 1993; Masser and Onsrud 1993; Budic 1994; Robey and Sahay 1996; Sahay and Robey 1996; Assimakopoulos 1997; Chan and Williamson 1999; Stillwell et al. 1999). This line of inquiry continued in geography and planning during the 2000s, especially in participatory GIS and planning support settings (e.g., Laituri 2003; Vonk et al. 2007, Ensard 2007).

Recognizing that IS research will always be characterized by constant technological change and innovation, lagging theory, and a critical need for action, Benbasat et al. (1987) provide the following reasons that case studies provide a viable approach in IS research:

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[1] Some have argued that case study research need not rely solely on qualitative data and thus should not be exclusively categorized as such (Cavaye 1996, Doolin, 1996, Yin 2003).

> First, the researcher can study information systems in a natural setting, learn about the state of art, and generate theories from practice. Second, the case method allows researchers to answer “how” and “why” questions, that is, to understand the nature and complexity of the processes taking place... Third, a case approach is an appropriate way to research an area in which few previous studies have been carried out (Benbasat et al (1987, p. 370).

As described in Chapter II, the current state of knowledge and character of past research on PSS development and use (i.e., context-rich applications, limited understanding on adoption and use barriers, few existing empirical studies) closely match these application strengths, making the case research approach an attractive one for further in-depth exploration of implementation issues in this dissertation.

Mixing Methods in IS Research. Over the last two decades, mixed-methods approaches have been increasingly utilized in IS research (Kaplan and Duchon 1988; Lee 1991; Gable 1994; Falconer and Mackay 1999; Mingers 2001; Chen and Hirschheim 2004; Petter and Gallivan 2004). Mixed methods research may be defined as “research in which the investigator collects and analyzes data, integrates the findings, and draws inferences using both qualitative and quantitative approaches and methods in a single study or program of inquiry” (Tashakkori and Creswell 2007, p. 4). Twentieth-century social and behavioral scientists frequently utilized mixed methods in their work (Fielding and Fielding 2008). However, it has only been in the last 20 to 25 years that the mixed methods research orientation has emerged as a separate and distinct alternative to the dichotomy of the quantitative and qualitative traditions (Teddlie and Tashakkori 2009).

Researchers choose to employ a mixed method research design for a number of reasons. Investigators may seek to triangulate data sources (i.e., seek convergence in validity) across multiple methods. Results from one method can also help develop or inform another method, or one form of data may be nested within a broader data collection activity to enable analyzing different levels or units of analysis. Finally, mixed methods may serve a transformative purpose to advocate for marginalized groups or populations (Cresswell 2003).

Mixed method research has a number of advantages over single method design approaches. First, mixed method research can use both quantitative and qualitative approaches to simultaneously address confirmatory and exploratory questions. Second, mixed method research provides stronger inferences by mixing methods with "complementary strengths and nonoverlapping weaknesses" (Johnson and Turner 2003, p. 299). Third, mixed method research provides greater opportunity for consideration of divergent views, and consequently, reexamination of underlying concepts and assumptions (Teddlie and Tashakkori 2009).

Mixed method research is also not without its challenges. For example, data collection is typically more extensive in mixed method approaches versus single method approaches. Also, the need to analyze both text and numeric data can be very time-intensive in nature. Finally, a mixed method approach requires that investigators be well versed in both quantitative and qualitative techniques (Cresswell 2003).

Introduction to the Dissertation's Mixed-Method Research Design

This dissertation employs a mixed-method approach in its research design, conducted from a pragmatic paradigmatic viewpoint and grounded in a combination of diffusion of innovation (Cooper and Zmud 1990; Fichman 1992; Rogers 2003) and user-acceptance (Davis 1989; Venkatesh et al. 2003; Bradley 2009) IS theory. Two defining characteristics of the mixed method approach are the centrality of a study's research questions to the research design, and the ability to address questions that are both exploratory and confirmatory in nature (Teddlie and Tashakkori 2009). These were the primary reasons for selecting a mixed method approach in this dissertation, with certain aspects of each question being addressed with a quantitative survey and others with a more qualitative, multi-case study analysis.

Figure 3.1 graphically portrays the two major phases of the dissertation's scope of work, which followed a QUANTITATIVE→QUALITATIVE[2] sequential mixed method design where different method types are applied with equal importance, but done so in a chronological fashion (Creswell and Clark 2007). The Phase One survey questionnaire and Phase Two case study analysis were both also supported by a series of planning support system expert interviews. All three components are introduced below.

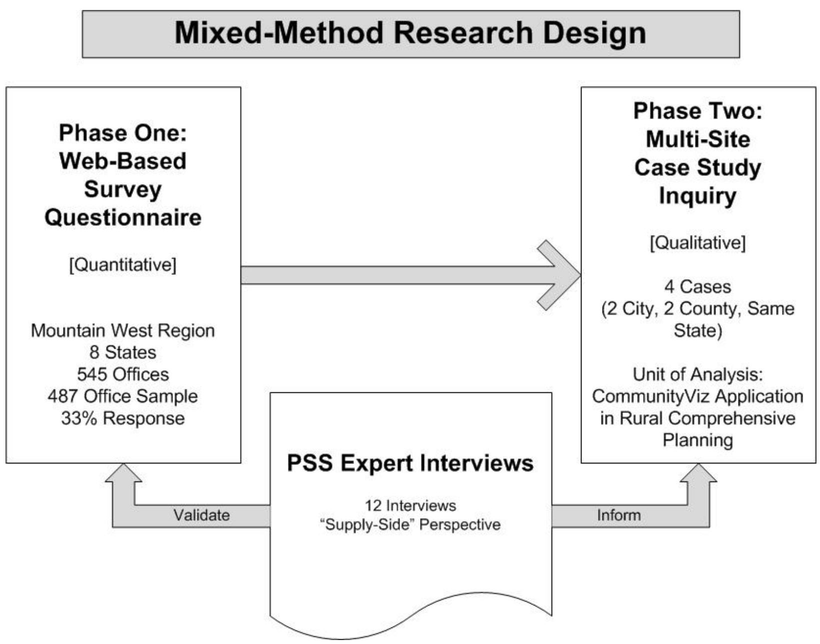

Figure 3.1. Two-phase mixed method research design.

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[2] Morse's (2003) mixed method design notation.

Phase One: Surveying Planning Support Instrument Use. Phase One involved a self-administered World Wide Web-based survey questionnaire utilizing close-ended quantitative measures. The objective of the questionnaire was exploratory in nature, focused on assessing the current level of adoption and use of planning support instrument adoption and use. Five hundred and forty-five (545) county and county-seat planning agencies in the eight-state U.S. Mountain West census region served as the population for the inquiry. Ultimately, a sample of 487 planning offices was surveyed in July and August 2008, resulting in a ~33% response rate. The entire survey process, including detailed methodology, results, and discussion are the subject of Chapter IV.

Phase Two: Case Studies of Planning Support System Implementation. Informed in part by the Phase One questionnaire results, Phase Two of the scope of work involved conducting a multi-site case study inquiry in four local government planning jurisdictions. In this circumstance, the focus was both explanatory and confirmatory, with the objective to gain a more in-depth understanding of the technical and institutional factors fostering geographic information system-based planning support system (PSS) adoption and use. Cases included two city and two county rural planning jurisdictions in Colorado. All focused on the application of the CommunityViz® PSS application (Placeways LLC; Boulder, CO) in a comprehensive planning activity. Data collection included open-ended observations collected through semi-structured interviews, in combination with document analysis. Details of the case study methodology along with individual and synthesized results of the four cases are the subject of Chapter V.

Planning Support System Expert Interviews. In response to the low number of questionnaire respondents identifying PSS application experience, an additional data collection component (semi-structured interviews with identified PSS experts) was incorporated into the research design between completion of the Phase One survey and initiation of the Phase Two case studies. The reasons for doing so were to better understand why the apparent low level of PSS implementation reflected in the survey results might be occurring, and to provide a means of triangulating major data sources and methods. While the questionnaire and case studies focused on “demand-side” characteristics of Planning Support System (PSS) adoption and use, the PSS experts interviews provided input from the “supply-side” perspective of the issues.

In total, twelve PSS experts were interviewed either in person or by telephone between May 2009 and September 2009. Two different types of PSS experts were interviewed: developers and consultants. For the purposes of this study, PSS developers were defined as individuals with competencies and significant experiences associated with the PSS software development process. PSS consultants were defined as individuals with competencies and significant experience in the use and application of PSS technology and who had demonstrated experience in assisting other individuals or organizations with the adoption and use of PSS software. Interviewees were selected based on level of experience with North American PSS applications, with additional interest in individuals who had worked in the Mountain West Region. A balance between developers and consultants was sought, recognizing that many PSS experts may qualify to a certain extent under both categories. All interviews were conducted by the author, recorded (with permission) and transcribed for accuracy.

Results of the “supply side” interviews assisted interpretation of survey results (Chapter IV) and selection and interpretation of case studies and their findings (Chapter V). Insight from the interviews was also incorporated into the meta-inference process combining findings from both Phase One and Phase Two of the overall research design (Chapter VI).

Appendix A includes names and affiliations of the PSS experts interviewed (provided with permission through informed consent). Appendix B contains the interview background information provided to interviewees prior to being interviewed. Appendix C contains the interview question guide used in the PSS expert interviews.

Other Methodological Issues

Institutional Collaboration. It should be noted that all of the data collection conducted for the dissertation was carried out by the author under the auspices of the Plan-IT Wyoming Initiative lead by the Wyoming Geographic Information Science Center (WyGISC) at the University of Wyoming in Laramie, WY. In my capacity as WyGISC’s director, I was a co-founder of the initiative in the early 2000s and continue to serve as one of its principal investigators. The Plan-IT Wyoming initiative’s mission is to build capacity in the use of information technology (IT) in local government planning practice in Wyoming and the Mountain West.

My ongoing work with Plan-IT Wyoming both informed my early thinking about opportunities and barriers to PSS implementation and provided a network of established connections with the practicing planning community through which to implement the dissertation’s research design. This affiliation with the University of Wyoming and Plan-IT

Wyoming is especially reflected in the background documents and questionnaire design associated with the dissertation's Phase One survey of planning departments in the Mountain West region (Appendices D and E). In addition, for sake of compliance requirements with two universities, Institutional Review Board (IRB) approval for research involving human subjects was authorized via two IRB Authorization Agreements (March 2007 and October 2008) between the University of Colorado-Boulder and the University of Wyoming, with the University of Wyoming Office of Research and Economic Development as the IRB of Record in both cases.

Confidentiality in Case Studies and Human Subject Interviews. An overview of the dissertation's research design would be incomplete without clarification regarding variation in how case study locations and interview subject confidentiality have been maintained. IRB protocols for the case study interviews specified anonymity for case study interviewees. In this case, anonymity means that individual responses cannot be linked with participants' identities. Due to the relatively small population of both the local government planning and geographic information systems communities in Mountain West states, it became necessary to establish aliases for the case study cities and counties, in order to be able to refer to individuals by functional titles e.g., planning director, GIS manager, etc.). The exceptions to this include the state GIS coordinator and the president of the state chapter of the American Planning Association. Anonymity was not possible in these cases, given that it was impossible to mask entirely the fact that all of the cases were in Colorado and there might only be a single person in a given functional role. In these cases, permission was sought and granted by these individuals to identify their affiliations, if not their names. Other interviewees waiving anonymity included individuals associated with CommunityViz® itself (i.e., developers and software managers), since the software's functionality and usability could not be readily masked in the case study evaluations. Finally, the reader should note also that the 12 PSS experts who were interviewed have been identified by name and affiliation in Appendix A for the purposes of establishing credibility. All of these experts agreed to these conditions, and any reporting of individual responses in the dissertation has maintained confidentiality unless permission for use of a direct quote was granted by the interviewee.

CHAPTER IV

A SURVEY OF INFORMATION AND COMMUNICATION TECHNOLOGY USE BY LOCAL GOVERNMENT PLANNING AGENCIES IN THE U. S. MOUNTAIN WEST REGION

This chapter centers on Phase One of the dissertation's mixed-method research design. It presents the development, administration and results of a multi-state survey assessing current use of information and communication technologies (ICT) for planning support purposes by local government planning agencies in the Mountain West region of the United States. The survey's original contribution to the field of research on ICT in planning centers on its "demand side" focus on planners' specific needs and on its consideration of rural as well as urban planning environments.

First, the objectives of the survey are introduced, both as they relate to the overall research focus of the dissertation and in the context of similar previous surveys in the U.S. and Europe. Next, the target survey population and sampling strategy are reviewed, followed by an overview of the online survey questionnaire which was developed and implemented. Response rate, reliability and validity issues are then discussed, along with a presentation of salient survey results. The chapter concludes with an interpretation of the survey outcomes and a discussion of their implications.

Introduction

Survey Objectives. This dissertation has two over-arching and related goals: first, to assess the current level of ICT planning support instrument use in local government planning departments; and second, to gain a better understanding of the opportunities and barriers to ICT-based planning support system implementation in rural local planning processes. The primary objective in conducting the Phase I survey was to specifically address the first of these goals - that is, to determine how planners in general are currently using ICT to support local government land planning functions and activities. Survey results will also contribute to work on the second goal and informing inquiries into components of all of the dissertation's principal research questions. More specifically, the survey was conducted to address the dissertation's first research question (Q1), which aims to characterize the current extent of ICT in supporting planning activities in city and county planning departments, including the types of planning support instrument (PSI) technologies employed, the breadth and level of sophistication in their application, and an identification of factors influencing adoption and use. The survey also sought to inform work related to Q2 and Q3, which focused more specifically on geo-enabled and ICT-based planning support system (PSS) implementation.

Tailored Design Survey Method. A survey is a systematic type of method for collecting information from entities in order to describe, compare, or explain knowledge, attitudes and behaviors of individuals or groups (Groves et al. 2009). Several types of survey instruments exist, including self-administered questionnaires, interview, structured record reviews, and structured observations (Fink 2003b).

For this study, the survey data collection and analysis was conducted via implementation of a self-administered, World Wide Web (WWW) - based survey questionnaire. The decision to use a self-administered questionnaire was based on its unique utility in describing characteristics of large populations (in this case professional planners), and the fact that data could be collected in a relatively inexpensive manner from a remote location (through email and web browser interaction via the Internet) (Bourque and Fielder 2003; Alreck and Settle 2004).[3]

The process was conducted following Dillman's Tailored Design Method (2000). A revision of the classic and widely-recognized Total Design Method (Dillman 1978; de Leeuw 2008), the approach is based on established principles of social exchange theory regarding why and how people respond to survey instruments. Both the original and revised approaches have been widely used in survey research by geographers, planners and others over the last 25+ years (Sheskin 1985; Dandekar 2003). In contrast to the original approach, the Tailored Design Method (TDM) moved away from a one-size-fits-all approach to promote solutions customized "to most effectively and efficiently deal with the contingencies of different populations and survey situations," (Dillman et al. 2009, p. 12). As such, TDM centers on:

> the development of survey procedures that create respondent trust and perceptions of increased rewards and reduced costs for being a respondent, which take into account features of the survey situation and have as their goal the overall reduction of survey error (Dillman 2000, p. 27).

The method addresses four principal concerns: (1) identifying all aspects of the survey process that might affect either response quality or quantity; (2) organization of the survey process

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[3] See Survey Instrument Overview section below for details regarding the decision to utilize an Internet-based survey mode.

through an administration plan that ensures that all details of the survey's design are achieved; (3) survey error sources; and (4) determinants of respondent behavior (Dillman 2000).

Relationship to Other Recent Survey Research. The survey was undertaken in part to extend other recently conducted academic research on planners' use of ICT. In particular, past work included a 2004 survey on U.S. planning agency use of World Wide Web technology conducted by the International City/County Management Association (ICMA; Washington, DC) and the American Planning Association (APA; Chicago, IL) (Simpson 2005), and a significant body of inventory and survey research on planning support system (PSS) development and use in Europe and the U.S., conducted between 2000 and 2004 by researchers at the Netherlands Expertise Center of Geographical Information (NexPRI) at Utrecht University, Utrecht, The Netherlands (Geertman and Stillwell 2004; Vonk et al. 2005).

The 2004 ICMA/APA survey (Simpson 2005) was specifically conducted to evaluate the degree to which Web technology was being utilized in the urban planning field. All U.S. municipalities with populations of 25,000 or greater were surveyed. Five hundred five (505) agencies responded across 48 states for a response rate of ~ 35%. Of those planning departments that responded, 95% reported having some type of Web presence for their agency, though most used their Web site primarily for information dissemination and not for citizen interaction or more sophisticated functions (i.e., visualization, analysis, modeling). Results also indicated that departments with larger staffs were bigger users of Web technologies than those with smaller staffs.

Many of the questions asked by the ICMA/APA survey about ICT use were also of interest for the dissertation survey, partially to address reliability concerns in questionnaire design and also to enable comparison of results with past research. A copy of the ICMA/APA survey was obtained from the authors, and consequently several questions were either replicated or incorporated with slight modification in the Mountain West survey in either exact or slightly modified fashion. Specifically, these included select questions dealing with type of Web presence, maintenance, content and modes of interaction, as well as impressions of the level of departmental technology sophistication. The evaluation of the ICMA/APA survey also confirmed the fact that ICT development and use is a rapidly changing domain, necessitating considerable thought in questionnaire design to ensure both completeness and relevance.

Equally influential on the Mountain West survey's development was the significant research on PSS implementation undertaken over the last decade by Stan Geertman and John Stillwell with colleagues at Utrecht University in The Netherlands (previously discussed in Chapter II). Their work included establishing a Web-based inventory of PSS between June 2000 and June 2001, which resulted in approximately 50 entries from 20 different countries, providing details of PSS applications developed and implemented over the previous five years (Geertman and Stillwell 2004). Also, significant in helping shape the Mountain West survey's content was a follow-up Web-based questionnaire in 2003-2004 (Vonk et al. 2005) which solicited input from 800 individuals worldwide who had been identified as having some involvement with PSS development and use. Both PSS experts and non-experts alike were asked to respond to 67 statements describing potential "bottlenecks" to PSS implementation. As a result, 96 responses were received for a 12% response rate, 87% of which originated from Europe or North America. Given the potential overlapping focus with this dissertation on PSS adoption and use, the Vonk-led survey was obtained for application toward the Mountain West sample. Several portions of the Vonk questionnaire were incorporated into the dissertation survey in one form or another, but due to concerns with questionnaire length, completion time and potential drop-offs prior to survey completion, many of the questions were ultimately eliminated or shortened.

Though not designed to be a comprehensive assessment of geographic information system (GIS) use in local government, GIS did play an important role in the survey due to an interest in exploring relationships between overall GIS infrastructure maturity and PSS adoption and use. Over the last 15 years, numerous surveys have been conducted in the U.S. on GIS development in local government practice, addressing issues ranging from data development to hardware and software to implementation and maintenance barriers. Prominent among these efforts were the 2003 Survey on the Use of GIS Technology in Local Governments (PTI 2003), sponsored by the U.S. Department of Interior Geospatial One Stop Project (~1,000 agencies surveyed nationwide), and a 2002 Western Rural Development Center (Utah State University; Logan, UT) survey of GIS use in rural counties of 12 western states (Selfa and Bailey 2003). Sample questionnaires from both surveys were acquired and consulted during question development for the current effort.

Specific to GIS use in planning, the questionnaire design and administration components of the survey also drew on some of the many GIS implementation survey research efforts conducted in the U.S. and Europe during the 1990s and early 2000s. Of particular value was Budic's 1993 survey of 125 county and municipal governments in four southeastern U.S. states (Budic 1994), and Knapp and Nedovic-Budic's 2003 survey of 116 Metropolitan Planning Organizations regarding regional GIS capacity for land use and transportation planning (Knapp and Nedovic-Budic 2003). Other influential survey research on GIS use by planners included work conducted in Great Britain during this same period by Heather Campbell and Ian Masser (1992; 1995).

Unique Characteristics. The survey builds on the past work described above in a number of unique ways. First, most work on implementation of ICT (including GIS related technologies) in local government to date had focused on large, urban, planning environments (PTI 2003; Simpson 2005). By comparison, conducting a new study incorporating a distinct examination of rural environments provided an opportunity to explore the unique challenges of such settings for technology adoption and use. Second, while the "developer" or 'supply-side" view of planning support ICT implementation had been previously documented (Geertman and Stillwell 2004; Vonk, et al. 2005), a need existed to gain a better understanding of the issue from an end-user, or 'demand-side," perspective. Finally, the survey was able to include questions on new, state-of-the-art applications, not in wide use at the time of previous surveys.

Survey Population and Sampling Strategy

Table 4.1 outlines major characteristics of the survey population and sample. A more detailed description of each characteristic follows.

Table 4.1. Survey population characteristics

Population of Inference	Urban and rural local government land planning organizations in the United States
Target Population	City and county planning departments in the U.S. Bureau-defined Mountain West Region (AZ, CO, ID, MT, NM, NV, UT, WY)
Sample Frame	The designated 'lead" city (e.g., county seat) and county planning offices in each county in the eight Mountain West states, as identified from membership databases from the respective state planning professional organizations
Unit of Analysis	Agency

Population of Inference. Population of inference refers to all individuals or entities about which the researcher wishes to generalize survey results (Dillman 2000; Schonlau et al. 2002). In this study, this was defined generally as both urban and rural local government land planning organizations in the United States. This includes, but is not limited to, city and county land planning departments.

Target Population. The target population for the survey – that is, that portion of the population of inference included in the study (Schonlau et al. 2002), included city and county planning departments in the eight states of the Mountain West census region, as defined by the U.S. Census Bureau. Due to constraints on available fiscal resources, the size and extent of the target population was necessarily constrained to an identifiable sub-region of the United States. A discussion follows of the geographic definition of that study area, and how designations of "urban" versus "rural" jurisdictions were addressed in the sampling protocol.

Study Area Definition. The study area for the survey was identified as the Mountain West region of the United States. In conventional usage, the term region refers to a sizeable area possessing some type of common characteristic(s) or organizing principle(s) that distinguish it from other geographic space. Regions may be established by nature (e.g., physiographic regions) or delineated by humans for descriptive, analytical, managerial, or other purposes (e.g., historical, cultural, economic, etc.) (Branch 1988; Gregory 2000).

In name and geographic extent, the Mountain West study area is coincident with the Mountain West sub-boundaries for the U.S. Census Bureau's two-level system for statistically grouping contiguous states into four Regions and nine nested Divisions (Figure 4-1). The

Mountain West study area boundary loosely matches those of Garreau's Empty Quarter Region (US portion) (Garreau 1981) and the Atlas of the New West (Riebsame 1997).

Figure 4.1. Census regions and divisions of the United States, portraying the Mountain West region study area. Source: U.S. Bureau of the Census 1994, p. 6-2.

The Mountain West study area was selected as the source of the target population for several reasons. First, the area represents a place of rapid change in demographics and shifting economies during the 1990s and early 2000s. Between 1990 and 2000, the five fastest growing states in the U.S. were located in the Mountain West: Nevada (66%); Arizona (40%); Colorado (31%); Utah (30%); and Idaho (29%) (Perry and Mackun 2001). Common drivers behind this growth include a shift from traditional agriculture- and extraction-based industries to high-technology, service-based economies, as well as an attraction to both real and perceived amenities associated with a "high quality" Western lifestyle (Power 1996; Case and Alward 1997; Beyers 1999; Vias 1999; Power and Barrett 2001). The associated impacts of these changes on the region's physical and human environments pose significant challenges for effective natural resource management and community planning (Howe et al. 1997; Ringholz

1996; Hobbs and Theobald 2001; Baron 2002; Duerksen and van Hemert 2003; Travis 2003; Travis 2007). The magnitude of these impacts is often greatest in rural areas. McKinney and Harmon (2002) describe the impacts of these trends on planners in the region's states:

> Within these trends, western state planners recognize a variety of common challenges—pockets of explosive population growth, sprawl, drought, out-of-date legislation, a lack of funding, and a lack of public and political support for planning and changing the way development occurs in the West. They also point out many differences in their states' approaches to planning. Oregon and Hawaii have long-standing statewide land use planning efforts, but planning in Nevada is a recent phenomenon, limited mainly to the Las Vegas and Reno areas. Vast federal holdings in Nevada, Idaho and Utah dictate land use management more than in other states, and Arizona and New Mexico share planning responsibilities with many sovereign tribal governments. Alaska and Wyoming—with small populations and little or no growth—do very little planning. (McKinney and Harmon 2002, p. 4).

A second justification for the study area includes the fact that its boundaries match the region-division census geography for the area (U.S. Census Bureau 1994), which allows for both contemporary and historical comparisons of land use and related planning issues and drivers. Finally, the region was chosen due to its "local" accessibility from research and institutional resources at the University of Colorado and University of Wyoming.

Urban versus Rural Jurisdictions. As noted above, the survey incorporated both urban and rural jurisdictions in its scope in response to an urban bias in past research. Numerous definitions have been proposed and debated on the differentiation between urban and rural places in the U.S. (Rios 1988; Zhang et al. 1998; John 2005; Cromartie 2007a; 2007b). Most are based in some way on design characteristics utilized in the U.S. Census Bureau's methodology for conducting its nationwide decennial census of population program (U.S. Census Bureau 1994). Due to an interest in surveying both city and county-level planning departments, and to allow for comparison with similar past studies of planning in the region, the decision was made to designate jurisdictions as urban or rural based on the U.S. Department of Agriculture (USDA) Economic Research Service (ERS) Urban-Rural Continuum categories (Beale 2004). This coding scheme was originated in 1975 by David L. Brown, Fred K. Hines, and John M. Zimmer, then of the Economic Research Service, for a report Social and Economic Characteristics of the Population in Metro and Nonmetro Counties: 1970. It has been updated in association with each decennial census since that time (most recently published in 2003), and has been recognized as the most used urban-rural classification of counties currently in existence (Cromartie and Swanson 2001).

As outlined in Table 4.2, the continuum contains nine categories for counties (and by extension, the municipalities they contain). The urban (also known as “metropolitan”) categories are categories 1, 2, and 3, and are distinguished by population size. The rural (or “nonmetropolitan”) categories are distinguished by their degree of urbanization or proximity to metropolitan areas.[4] By defining rural as those counties designated as categories 4 through 9, the classification allows for inclusion of cities up to 50,000 in population, as opposed to the standard US Census Bureau urban / rural classifications, in which urban areas are now defined to include communities as small as 2,500 populations, based solely on population density (Beale 2004). Such a classification was deemed too restrictive for identifying rural planning environments, which may occur in rural counties containing city populations much larger than 2,500.

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[4] For the remainder of this document, the terms urban and metropolitan (or “metro") will be used interchangeably. Similarly, the terms rural and non-metropolitan (or “non-metro”) will also be assumed to carry the same meaning.

Table 4-2. USDA Economic Research Service Urban-Rural Continuum Codes

Code	Description
Metro counties:	
1	Counties in metro areas of 1 million population or more
2	Counties in metro areas of 250,000 to 1 million population
3	Counties in metro areas of fewer than 250,000 population
Nonmetro counties:	
4	Urban population of 20,000 or more, adjacent to a metro area
5	Urban population of 20,000 or more, not adjacent to a metro area
6	Urban population of 2,500 to 19,999, adjacent to a metro area
7	Urban population of 2,500 to 19,999, not adjacent to a metro area
8	Completely rural or less than 2,500 urban population, adjacent to a metro area
9	Completely rural or less than 2,500 urban population, not adjacent to a metro area

Source: Beale, C., 2004, Measuring Rurality: Rural-Urban Continuum Codes. Available online at: http://www.ers.usda.gov/Briefing/Rurality/RuralUrbCon/ (accessed 3 July 2007).

Figure 4-2 (see next page) is a map of the eight-state study area. The eight-state region contains 281 counties, 62 of which are categorized as urban, while 219 counties are categorized as rural. Total population of the seven-state study area in 2000 was 18,172,295, with 14,374,981 found in counties categorized as urban.

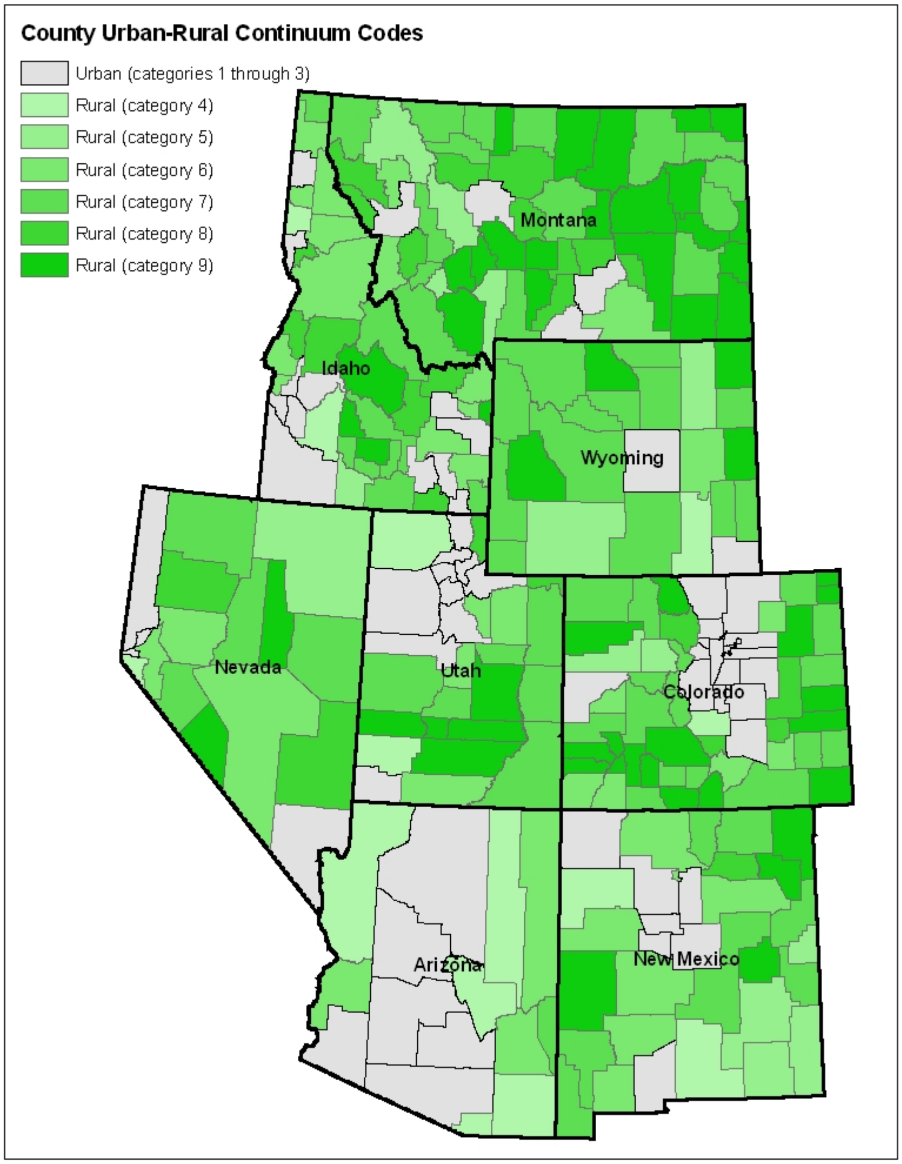


Figure 4.2. Mountain West region urban and rural counties, 2003.
Data source: USDA Economic Research Service. Available online at:
http://www.ers.usda.gov/Data/RuralUrbanContinuumCodes/ (accessed 2 February 2006).

Sample Frame. The sample frame – that portion of target population that can be identified and potentially counted (Dillman 2000; Schonlau et al 2002) - was defined as the county planning office in each of the 281 counties and the city county planning office in each county seat municipality, resulting in an estimated sample frame population of 562. Multiple sources were used to identify the planning offices and an appropriate point of contact, including state professional planning organization databases, mailing lists and web sites, individual city and county web sites, and other miscellaneous professional planning organization directories and publications. Sources were stored and managed in a Microsoft Access® contact database which included information on potential agency contact names, mailing locations, and personal email addresses.

If a city or county lacked a designated “planning” department, an attempt was made to determine whether planning functions were being conducted by another department associated with land development, such as an engineering department, economic development office, or building inspector. In cases where actual planning staff could not be identified, contact information was secured for elected or appointed officials identified with planning activities. If none of the above could be determined, the contact was identified as the city manager, city clerk, or county clerk or assessor. If a viable email address could not be determined for the jurisdiction, an attempt was made to secure one by telephone or letter mail.

This process succeeded in delineating an initial sample frame database of 545 agencies. The difference between this number and that of the anticipated 562 agencies reflected instances where city and county planning agencies had been combined, where a jurisdiction was too small for formal planning function to be performed, or where a viable planning entity could not be identified.

Unit of Analysis. The unit of analysis refers to the entity examined in analysis (Fink, 2003a). The strategy was to use the planning agency as a whole as the unit of analysis to better represent and analyze the organizational-level influences on planning support technology implementation. In all cases, a planner actually working in the planning office being surveyed was sought as the respondent. Offers to redirect the survey response to a GIS specialist or IT staff person were discouraged whenever possible.

Human Subject Considerations. In accordance with established policies for protecting human subject confidentiality, Institutional Review Board (IRB) approval was attained prior to administration of the survey. In this instance, the survey was authorized via an IRB Authorization Agreement (March 2007) between the University of Colorado-Boulder and the University of Wyoming, with the University of Wyoming Office of Research and Economic Development as the IRB of Record (see Chapter III for further explanation). During and following the fielding of the survey, all questionnaire responses were kept confidential unless the respondent's contact information was voluntarily provided for consideration in receiving notification of the final survey results and analysis, and/or if the respondent choose to be considered for the incentive lottery (see details on survey administration below). Throughout the survey, potential respondents were assured that responses were voluntary and that the survey could be exited at any time. Once agreement to begin the survey had been granted by the respondent, only two questions required mandatory response for branching purposes (Couper 2008), though respondents could also terminate the survey entirely or submit an incomplete survey at either of these junctures, should they have chosen to done so.

Survey Instrument Overview

The decision to utilize an online Web-based questionnaire delivery mechanism in this study was based on a combination of factors, including cost, time efficiency, and substantive context (Sue and Ritter 2007). Much of the cost associated with Web surveys is in technical development. In this case, those costs were largely covered through salary support from the Wyoming Geographic Information Science Center (WyGISC) at the University of Wyoming. Similarly, a large proportion of the time investment associated with Web survey is in up-front design, which was also supported by WyGISC. In regard to possible concerns with coverage error, it should be noted that in a survey of United States city planning offices in communities of greater than 25,000 people, Simpson (2005) found (via mail questionnaire) that 95% of the agency offices responding had Internet access. Though not rural, this rate of access may be considered a positive indicator of relatively high Internet access for local planning offices in general.

Questionnaire Design and Automation. As noted by Schonlau et al. (2002), "current research on the design… of Internet surveys has yet to produce an authoritative set of rules on constructing and fielding these surveys most effectively," (p. 41). Dillman (2000) notes that the biggest design challenge with Web questionnaires is that "the intentions of the designer for creation, sending, and receipt of the questionnaire are mediated through the [variable] hardware, software, and user preferences," (p. 361). Consequently, Dillman (2000) provides extensive guidelines for Web-specific design and automation regarding questionnaire navigational paths and visual navigational aids.

Question design was conducted over a nine-month period between July 2007 and March 2008. Questions were developed in part from previous surveys on ICT, PSS and GIS presented in the published literature. In fall 2007, a subset of the draft final questions was administered as a keypad polling activity during interactive sessions on "technology in planning" at the 2007

Western Planners Conference (Dickinson, ND; 9 August 2007) and the Colorado chapter of the American Planning Association (Colorado Springs, CO; 6 October 2007). Keypad polling (also called "clicker response") is a wireless audience-response technology in which participants can answer yes-no, true-false, multiple-choice, Likert scale or ranking questions, with the potential for immediate calculation and display of results. Increasingly common in higher education classroom settings (Fies and Marshall 2006), the technique is also used in citizen engagement and collaborative decision making, including local government planning public participation activities (Snyder 2006).

The keypad surveys provided an opportunity to test the quality of question design for the Web survey. They also served to raise awareness among Mountain West planners about the forthcoming Web survey and provided preliminary data against which the reliability of the Web survey instrument could be compared. Finally, they resulted in valuable insight on the viability of keypad polling techniques for future survey purposes.

In summer 2007, an external review of the questionnaire content was solicited from six colleagues, identified as lay persons not possessing specific expertise in local government planning processes and/or information technology applications in the field. The purpose of this review was to provide face validity as the instrument was being designed (discussed in more detail in the Reliability and Validity Considerations section below), including an initial evaluation of question content and structure and the proposed organization and anticipated length of the instrument.

The questionnaire was automated using the UWyo Survey Tool survey authoring software, hosted by the University of Wyoming Division of Information Technology and developed using ClassApps SelectSurvey.NET, version 3.7.2 (Atomic Design, LLC; Overland Park, KS, USA). The SelectSurvey application provided a robust survey authoring and management environment, including support for 21 different question types, customizable page design, layout and condition logic, bulk user registration, and email invitation functionality.

Two pre-tests were conducted as part of the survey's automation. The alpha pre-test was conducted between 1 April and 6 April 2008, with six pre-selected respondents with knowledge in local government planning process and/or ICT use in the field. The purpose of the alpha test was review of final content and question structure, questionnaire organization, HTML formatting, and Web browser compatibility. The beta pre-test was conducted between 23 April and 2 May 2008, also with 6 pre-selected respondents having backgrounds similar to the alpha survey testers. The beta pre-test served as a means to check potential e-mail re-directs, question branching functionality, and automated post-survey communications with respondents.

A total of 32 questions were included in the final survey instrument, divided among 14 individual web pages (Appendix D). The format included a variety of "open-ended" questions, "matrix" ranking questions, and single- and multiple-response "choice" questions. The questionnaire consisted of an Introduction and a Wrap-Up, bracketing four substantive sections. The Introduction included an overview of the questionnaire's content and general instructions for completing the survey, as well as information on incentives for completion and an estimate of the time required to complete the questionnaire. Response was initiated by entering an individual email address to acknowledge agreement of informed consent (Best and Krueger 2004) and for internal quality assurance purposes with data coding and analysis.

Part I (Q1 - 11) – “You and Your Planning Department” – included single- and multi-part questions asking for information about the respondent, the location, size, function and operation of the planning department being represented and the jurisdiction it served. Included were two initial questions about tracking enforcement software and use of group community process tools.

Part II (Q12-15) – “Your Department’s Use of the Internet” – asked for information to minimally determine whether the respondent’s planning department made use of the World Wide Web for information, outreach and assistance with land development. Question 12 asked whether the respondent’s planning department currently had a World Wide Web presence of any kind. This was a “branching” question, with a “yes” response asking for additional information about the department’s Web site and a “no” response forwarding the respondent to Part III.

Part III (Q16-21) – “Use of GIS Technologies” – asked about the use of geographic information systems (GIS) in the respondent’s planning department and broader jurisdiction. The section began with a branching question, asking whether the respondent’s planning department currently was using GIS. A “yes” response asked for additional information about the department’s use of GIS and a “no” response forwarded the respondent to a question about overall GIS use/coordination in their broader jurisdiction.

Part IV (Q22 - 27) – “Use of Decision Support Technologies” – asked specific questions about the experience of the respondent and the planning department using planning support systems (PSS). Respondents were asked about their personal familiarity with five commonly used planning support system software applications and which types of PSS technologies have been used in the respondent’s planning department during the last five years, either by staff or an outside consultant. This was a branching question; if respondents respond “yes” to at least one type, they were asked a series of follow-up questions about which components of the planning process the technology was applied and its impact on a series of planning effectiveness measures. All respondents were asked about their perception of the potential usefulness of planning support technology in planning, and barriers to broad implementation in the workplace.

Wrap-Up (Q28 - 32) Respondents were asked to characterize their planning department's overall level of information technology use and the respondent's perception of the importance of information technology in the field. Respondents were then given an opportunity to provide additional comments about information technology in planning and/or the questionnaire, and to self-select to receive questionnaire results and/or be considered in the respondent GPS/book lottery. The lottery was an added incentive for participating in the study (Dillman 2000; Bourque and Fielder 2003).

Administration. Prior to fielding the survey, a personalized, signed, pre-notification letter (Dillman 2000) was mailed on 15 June 2008 to all 545 contacts in the initial sample frame database as a first form of formal contact regarding the survey (Appendix E). Mailing was timed to arrive approximately ten working days prior to publication of the questionnaire with the purpose of introducing the survey to the targeted respondents, making them aware of the questionnaire's pending release date, and serving as a means of confirming the accuracy of existing contact information and addressing incomplete contact email records.

The letter resulted in follow-up communication with approximately 20 planning department contacts, correcting email addresses or specifying alternate contacts. An additional 25 to 30 letters were returned as undeliverable. In the cases of those departments for which a working email address could not be obtained, the jurisdiction was excluded from the survey. This ultimately resulted in a final sample frame population of 487 departments.

On 10 July 2008, the survey was opened with an initial email invitation to the 487 potential respondents in the sample frame population (Appendix F). The survey was fielded for a total of 44 days, with access to the questionnaire closing on 22 August 2008. Three email reminders were sent to over the course of the 44 days (22 July, 11 August and 20 August). Reminders were sent to contacts who had not recorded a response prior to the date of the reminder. Upon submitting their questionnaire, survey participants received an automatically-generated thank you email message which included a formatted copy of their responses.

The cumulative questionnaire data were recorded and maintained on a secure network server managed by University of Wyoming Decision of Information Technology. Data files were subsequently exported in SPSS®-compatible format for analysis and reporting purposes.

Response Rate

Response rate refers to the number of completed instruments divided by the number of eligible reporting units in the sample (Frankel 1983, cited in AAPOR (2008)). For this study, the survey's response rate was calculated using the American Association for Public Opinion Research's Standard Definitions for Internet survey outcome rates (AAPOR, 2008).

An overall response rate of 33% was calculated for the survey questionnaire, based on the following formula, adapted from the AAPOR guidelines (2008):

$$(1) \qquad \boldsymbol{RR} = \frac{(\boldsymbol{C}+\boldsymbol{P})}{(\boldsymbol{C}+\boldsymbol{P})+(\boldsymbol{R}+\boldsymbol{NC}+\boldsymbol{O})+\boldsymbol{U}} * \mathbf{100}$$

where:

RR	=	**Response rate** (in percent)
C	=	**Completed questionnaires** (= 176)
P	=	**Partially completed questionnaires** (= 5)
R	=	**Refusals and break-offs** (= 13)
NC	=	**Non-contacts** (= 45)
O	=	**Other** (= 248)
U	=	**Unknown** (= 58)

Note that in partially completed questionnaires, respondents completed at least Part One of the questionnaire (through Question #11). There were seven refusals, in which respondents exited the survey immediately after submitting their email address (Question #1), and six break-offs where participants terminated the survey sometime before completing Question #11. The 45 non-contacts represent instances where potential respondents could not be invited to participate due to “bounced” email messages. The other category represents the remaining 248 non-responders who did not respond in any fashion to the survey invitation. Finally, the unknown category represents those 58 jurisdictions which potentially were eligible for surveying in the initial sample frame population, but for which no viable contact information could be attained, and thus were not included in the survey invitation email message announcement.

Related to response rate, is the concept of cooperation rate (AAPOR 2008) – that is, that proportion of the eligible sample frame population units who were contacted and returned a viable questionnaire. The cooperation rate (COOP) percentage for the questionnaire was calculated as follows:

$$(2) \qquad \boldsymbol{COOP = \frac{(C+P)}{(C+P)+R+O} * 100}$$

All variables are consistent with those defined for the response rate calculation in equation #1. The cooperation rate calculation differs from response rate calculation in omitting non-contacts and unknown values. Following this formula, a cooperation rate of 40 % was calculated, indicating that 40 % of those agencies who successfully received an email invitation to respond, eventually returned a completed (or partially completed) questionnaire.

Reliability and Validity Considerations

Survey questionnaires are typically characterized by distinctly measuring reliability as well as validity (Litwin 2003). Diligence in adhering to Dillman's Tailored Design Method (1978; 2000; 2009) was instrumental in implementing and completing a survey process with a relatively high level of reliability and validity. Both types of assessment are considered here.

Reliability. Assessing reliability requires consideration of four principal sources of survey error. Sampling error is the result of surveying only some, and not all, elements of the survey population. In this survey, the questionnaire invitation was sent to 487 of the 545 jurisdictions identified for the initial sample population frame, for a nominal sampling error contact rate of 11%.

Coverage error is the result of not allowing all members of the survey population to have an equal or known nonzero chance of being sampled for participation in the survey. In this study, the coverage error rate could be estimated at 16% of initial 545 jurisdictions in the sample frame population (i.e., 88 out of 545, including 58 jurisdictions with no email contact and 30 undeliverable emails).

Measurement error results from poor question wording or questions being presented in such a way that is inaccurate or uninterpretable answers are obtained. This type of error was minimized in a number of ways, including pre-survey review of questions by lay persons, planners and other professionals with knowledge of the subject, as well as by an extensive review of the published literature on effective questionnaire design and question construction associated with both traditional mail questionnaires and Web-based instruments (Fowler 1995; Dillman 2000; Schonlau et al. 2002; Couper 2008).

Several questionnaire design principles were incorporated into the survey that were uniquely made possible by the Web-based delivery mode. They included: use of supplemental iconic images in the introduction screen, partitioning of questions into more numerous, shorter pages versus fewer more lengthy pages (requiring extensive scrolling in navigation), and randomization of question response options to counter “first answer” convenience responses. An indication that measurement error was reasonably low was the small number of break-offs or incomplete surveys despite a fairly long average completion time of 19 minutes, which could further be interpreted as meaning that respondents were engaged in their participation and willing to take the time to complete the survey.

Nonresponse error occurs when the people who respond to a survey are different in some relevant way from the sampled individuals who do not respond (Dillman 2000, pp. 9-11). Non-response error may be considered relative to the response rate (33%) and cooperation rate (40%) calculated in the previous section. The survey's calculated response rate of 33% is relatively high in comparison to published response rates for previously conducted Web-based questionnaires (ranging from 7% to 44%; Schonlau et al 2002, Sue and Ritter 2007) and comparable to many mail questionnaire response rates as well (Dillman et al. 2009). No published cooperation rates for previous Web-based questionnaires could be found in the literature,

Response (and sampling) rates were notably improved by the use of the pre-notification letter and by the email reminders sent periodically throughout the time that the survey was being fielded. Response to the pre-mail notification letter was almost exclusively positive (with many planners expressing enthusiasm for participating in the pending survey) and was extremely valuable for identifying and correcting errors in the sample frame population contacts database. Figure 4.3 shows the daily number of questionnaire responses submitted over the fielding period for the survey. After the highest rate of response immediately following the survey's release, noticeable increases in daily responses were achieved following the reminder emails on 22 July, 11 August and 20 August, reflecting the value of follow-up communication with potential respondents (Bourque and Fielder 2003; Dillman et al. 2009).

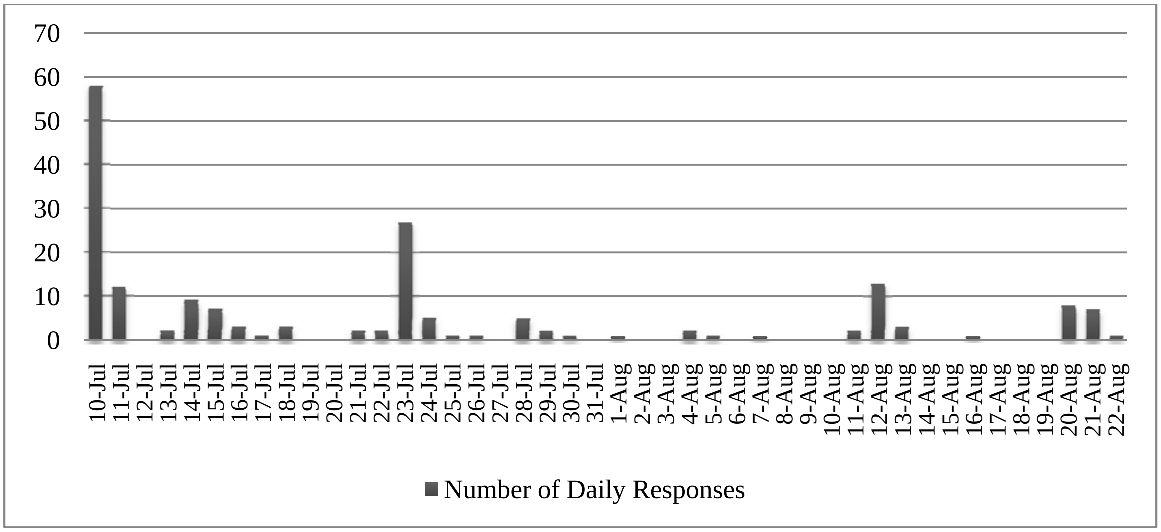


Figure 4.3. Daily record of valid questionnaire responses, 10 July 2008 – 22 August 2008.

Validity. Litwin (2003) also identifies four types of validity typically assessed for survey instruments. Face validity is simply a casual assessment of item appropriateness. In this survey, face validity was confirmed with a cursory review of the survey by untrained reviewers at an early stage of questionnaire development.

Content validity is a subjective measure of the appropriateness of items or scales by a set of reviewers with some knowledge of the subject matter. In this study, this was accomplished with the alpha and beta pre-tests of the questionnaire in spring 2008, as well as through feedback previously received from the keypad polling activities with professional planners in fall 2007.

Criterion validity represents how well a survey instrument compares to another instrument or predictor. This was addressed in questionnaire design by including certain questions that would allow for direct or indirect comparison with certain previously published survey instruments concerning ICT use among planners (e.g., Budic 1994; Simpson 2005; Vonk et al. 2005).

Construct Validity is a measure of how meaningful a survey instrument is when in practical use. As noted by Litwin (2003) construct validity is extremely difficult to assess, report and understand, particularly in the context of a one-time, short-term survey activity. One aspect of construct validity relates to convergence – the practice of utilizing multiple methods to attempt to achieve the same information. In that sense, some comparison may be made in this study with the initial keypad polling results from 2007 and with previous surveys by Simpson (2005) and Vonk et al. (2005). Beyond this, the survey does have the potential in the longer term, to contribute to both the dialogue of ICT use in urban and rural land planning and discussions of mixed method approaches in geographic information science research (through publication of results and replication of methods by others).

Results

All eight Mountain West states are represented in the 181 valid questionnaires, which include responses from 69 city planning departments, 92 county planning departments, and 20 joint city-county planning departments. Table 4-3 categorizes respondents by both jurisdiction type and urban-rural designation (Q5 in the survey). Overall, 69.6% of responding departments are in rural jurisdictions, with 30.4% in urban settings. The most frequent type of planning department responding is rural county planning departments, representing 34.3% of the survey participants.

Table 4.3. Categorization of planning department respondents
by urban-rural designation and jurisdiction type

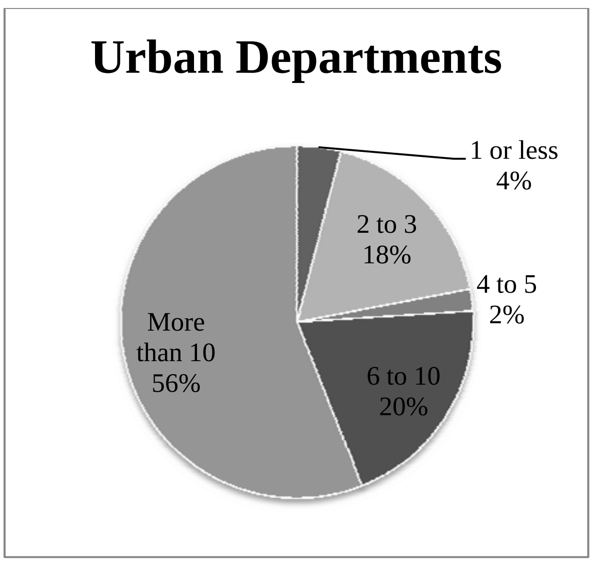
			Urban / Rural		Total
			Urban	Rural	
Jurisdiction Type	City	Count	21	48	69
		% of Total	11.6%	26.5%	38.1%
	County	Count	30	62	92
		% of Total	16.6%	34.3%	50.8%
	Joint City-County	Count	4	16	20
		% of Total	2.2%	8.8%	11.0%
Total		Count	55	126	181
		% of Total	30.4%	69.6%	100.0%

The population served by the departments varies greatly (Q6), ranging from 385 to 600,000 (mean = 40,000). More than 17% of the departments operate with one or fewer full-time equivalent employees, while 27% employ a staff or more than 10 people (Q4; Table 4-4). Of the 27% with more than 10 FTE positions, approximately two-thirds are in urban jurisdictions. Figure 4-4 compares staff size for urban and rural departments. A Chi-square test for independence indicated a significant though relatively weak association between urban-rural designation and staff size, $X^2 = 41.499$ (df=5, n=181), $p < .0005$, Cramer's V = 0.479.

Table 4-4. Planning department staff size

		Frequency	Percent
FTEs*	1 or less	31	17.2
	2 to 3	50	27.6
	4 to 5	18	9.9
	6 to 10	33	18.2
	More than 10	49	27.1
	Total	181	100.0

* Full-time equivalent employees



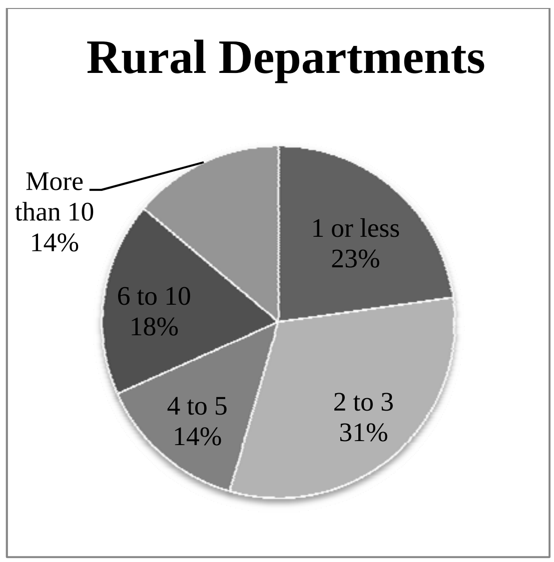


Figure 4.4. Comparison of department staff size between urban and rural departments.

In terms of departmental functions (Q7), almost all jurisdictions perform traditional zoning (86.7%) and subdivision administration (92.8) activities, while 64% administer building permits. Eighty-six percent (86%) perform comprehensive planning activities, with a similar percentage reporting that a comprehensive plan ("comp plan") update had been completed within the last ten years. Most departments (81%) rely on outside consultants for at least some services (Q8), the most common being comp plan development or revisions (48%), zoning code revisions (32%) and transportation analysis (31%).

As representatives of their agencies, more than 93% of the responding planners feel that the role of information and communications technology (ICT) in local government planning is "important" or "very important" (Q29). Overall, approximately 40% of respondents characterize their department as "capable" relative to ICT adoption and use (60% for urban departments and 33% for rural departments) (Q28). Less than 3% of all departments feel their departments are "advanced" in this area, and 7.5% view their departments as having "extremely low capability" (Table 4-5). Observed differences between urban and rural department responses are supported by a Chi-square test for independence, which indicated a significant association between urban-rural designation and level of IT coordination, $X^2 = 12.116$ (df=4, n=174), p=.017, Cramer's V = 0.264.

Use of Web Technology. Eight-six percent **(**86%), or 155, of the planning departments surveyed have some type of web presence (Q12). A Chi-square test for independence (with Yates Continuity Correction) indicated no significant association between urban-rural designation and web status, $X^2 = 2.157$ (df=1, n=180), p = 0.142, phi = -0.127. The Yates correction is typically applied for 2x2 tables to minimize overestimation of chi-square value.

Table 4.5
Respondent characterization of department's information technology capability

			Urban / Rural		Total
			Urban	Rural	
Capability	Extremely Low Capability	Count	3	10	13
		% within Urban /Rural	5.8%	8.2%	
		% of Total	1.7%	5.7%	7.5%
	Not Very Capable	Count	3	18	21
		% within Urban /Rural	5.8%	14.8%	
		% of Total	1.7%	10.3%	12.1%
	Somewhat Capable	Count	14	52	66
		% within Urban /Rural	26.9%	42.6%	
		% of Total	8.0%	29.9%	37.9%
	Capable	Count	29	40	69
		% within Urban /Rural	55.8%	32.8%	
		% of Total	16.7%	23.0%	39.7%
	Advanced	Count	3	2	5
		% within Urban /Rural	5.8%	1.6%	
		% of Total	1.7%	1.1%	2.9%
Total		Count	52	122	174
		% within Metro / Non-Metro	100.0%	100.0%	
		% of Total	29.9%	70.1%	100.0%

Of those with a web presence, 14% have an independent web site and 86% have a web presence as part of another group's site (most likely a city or county site) (Q13). Figure 4-5 portrays the types of information provided on department web sites (Q14). Most common is staff contact information, followed by planning documents, meeting information and application forms. A little over half of the departments make maps available on their web site. Only one percent support interactive forums, blogs or wikis.

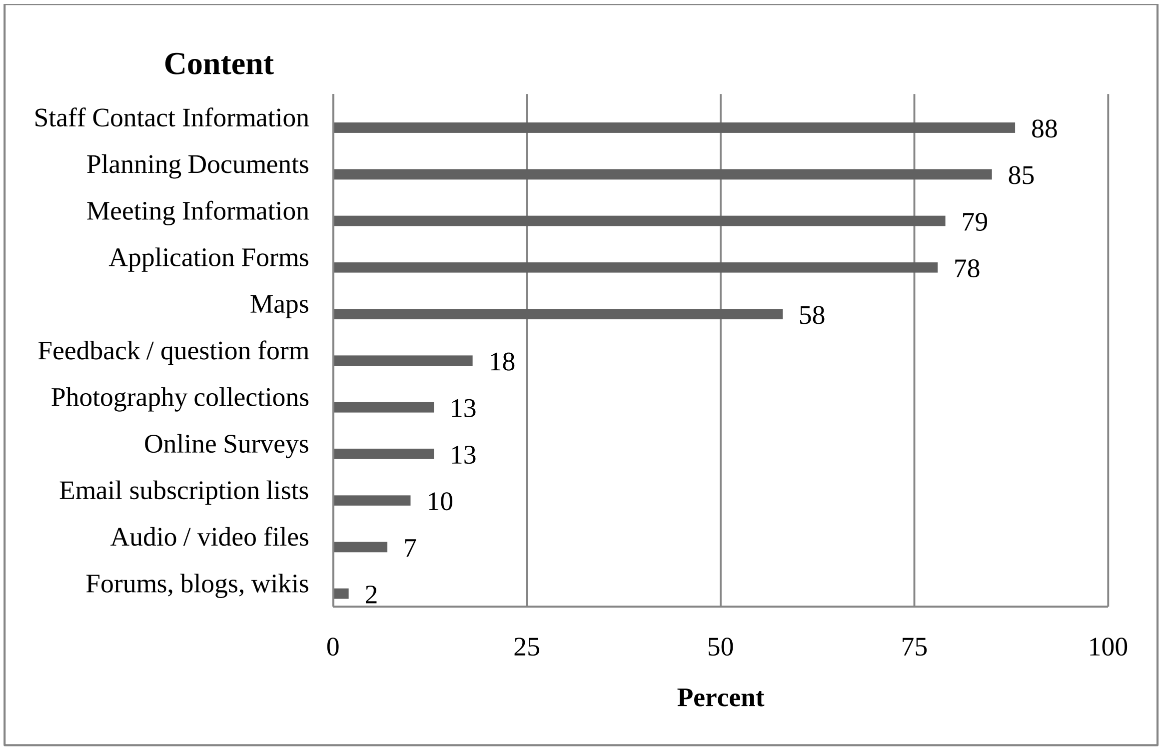


Figure 4-5. Reported use of selected web content.

Use of GIS Technology. One hundred forty-three (143) of the responding departments **(**79%) use GIS in their work (Q15). A Chi-square test for independence (with Yates Continuity Correction) indicated no significant association between urban-rural designation and GIS status, X^2 (df=1, n=180) = 2.322, p = 0.128, phi = -0.128.

Of those departments using GIS, 47% use a system maintained by another department, while 26% share maintenance of the system with one or more departments and 15% maintain their own, stand-alone system. The remaining 12% of departments with GIS operate their system under some other form of arrangement. Finally, about 50% of the departments with GIS capability also make planning related GIS data and mapping applications available through the Internet (Q19), though the percentage is higher among urban departments (55%) than it is among rural departments (40%).

GIS hardware and software implementation in planning departments is necessarily supported by access to and use of geospatial data. Figure 4-6 portrays planning department use of "framework" base data layers (Q17) (Hamerlinck 2008), considered common building blocks for most department-level GIS implementations. More than 90% of all responding departments utilize transportation and elevation data in their GISs (presumably street center lines and medium resolution digital elevation models). Seventy-three percent (73%) work with land ownership (i.e., cadastral) data, while 60 percent utilize orthoimagery and administrative boundaries. Only half of the respondents work with hydrography data (i.e., streams, lakes and reservoirs) and only 36% incorporate geodetic control (surveyed benchmarks and monuments) into their systems.

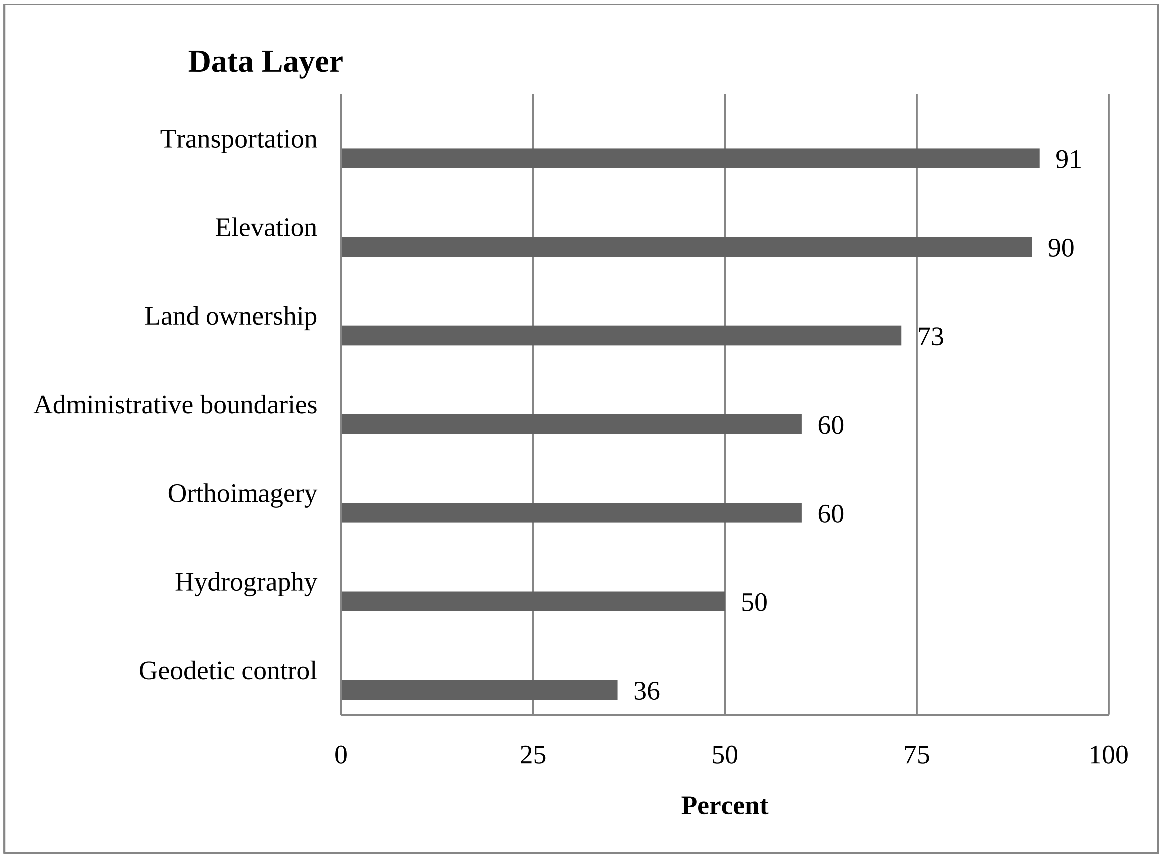


Figure 4-6. Framework GIS data available to and used by responding planning departments.

Figure 4-7 presents planning department use of planning-specific geospatial data (Q18). The majority of respondents work with data layers pertaining to special districts, land use designations, and buildings (footprints or centroids). Almost half (47%) work with utilities data, while less than one-third utilizes census units or zoning designations.

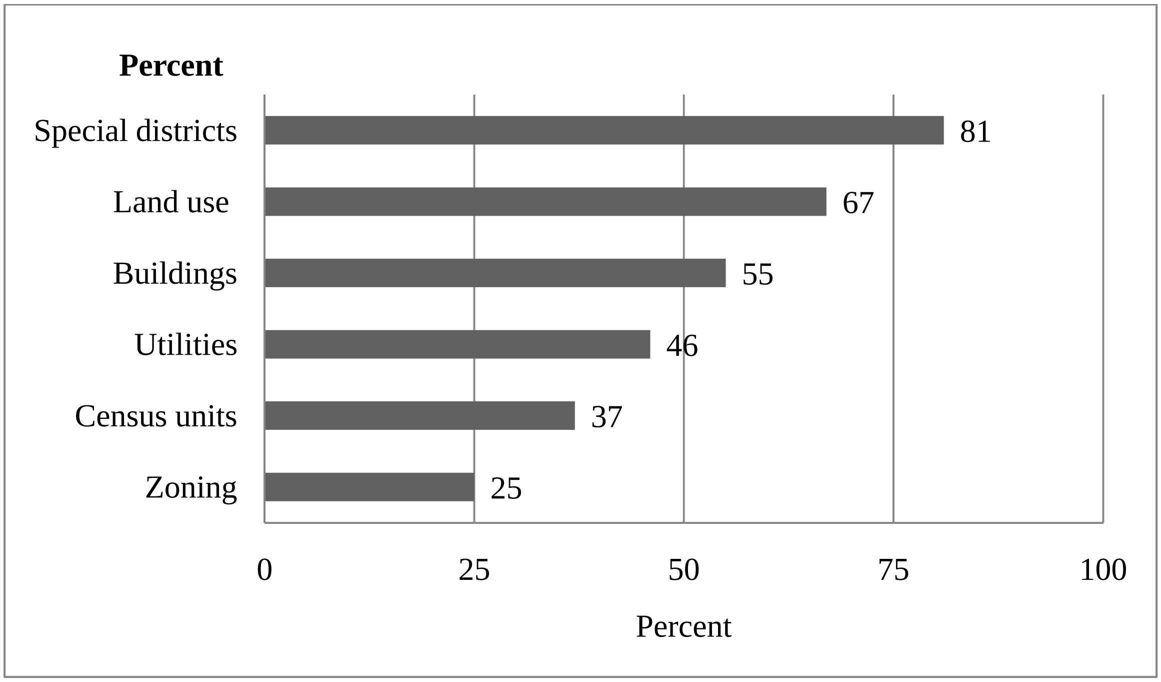


Figure 4-7. Planning-specific GIS data available to and used by responding planning departments.

In terms of application (Q20) (Figure 4-8), map making is overwhelmingly the most common use of GIS among planners (94%). One-half to three fourths of respondents also cite zoning administration, subdivision review, comp plan development and rural addressing as areas toward which GIS is applied. Further related to GIS use, survey respondents were also asked to characterize the degree to which GIS activities were coordinated in their jurisdiction (Q21). As portrayed in Figure 4-9, approximately half of the respondents indicated that GIS activities were either “coordinated” or “very coordinated” in their jurisdiction. Thirty-two percent (32%) felt

GIS was “somewhat coordinated” while only 13% felt there was no GIS coordination taking place.

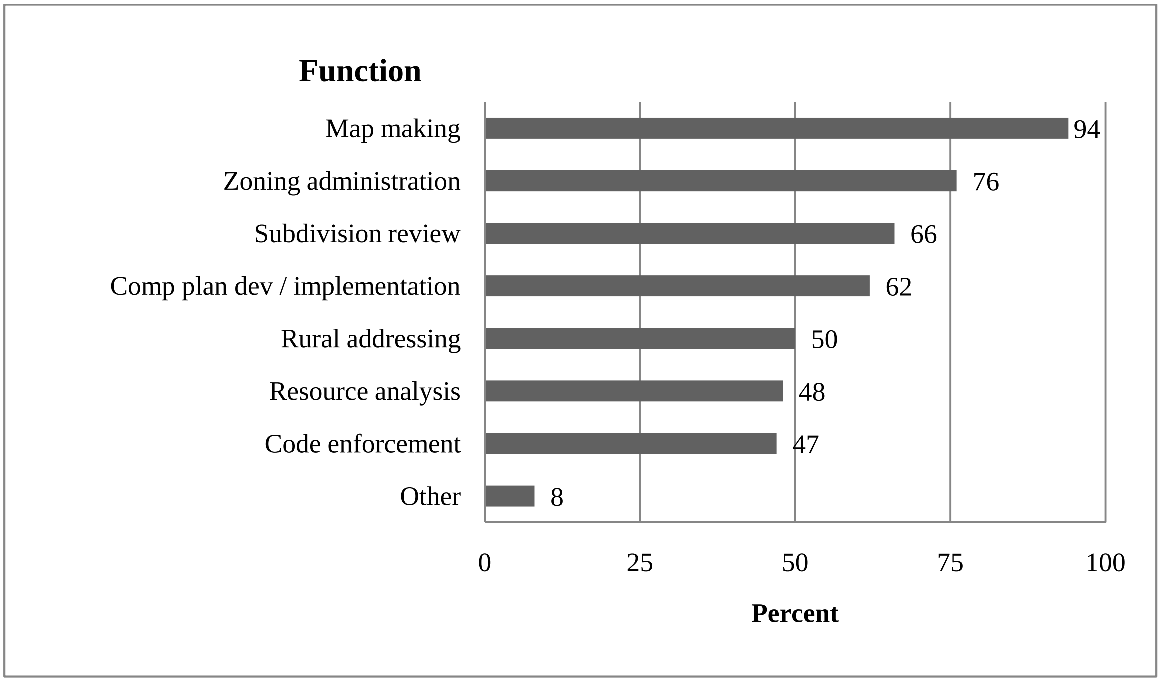


Figure 4-8. Planning functions toward which GIS has been applied by responding departments.

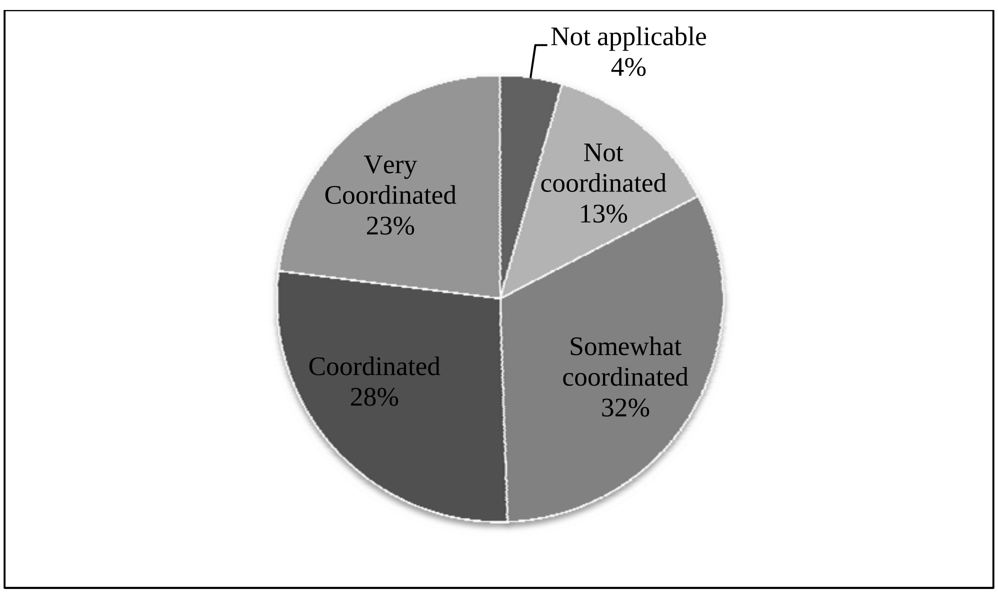


Figure 4-9. Respondent characterization of GIS coordination in planning department’s jurisdiction.

Planning Support System Implementation. Questions about the use of planning support systems (PSS) comprised the third major component of the survey (Q22 through Q27). Less than 40% of all respondents (70/181) indicated that their department had used some type of PSS in their activities over the last five years (Q23; Figure 4-10), with the most common application being related to "predictive modeling" (28%). There was a significant difference between urban and rural departments in PSS use; while 58.2% of urban departments responded affirmatively to some PSS application, only 31.7% of rural departments responded similarly. This was supported by a Chi-square test for independence (with Yates Continuity Correction) which indicated a significant association between urban-rural designation and PSS use, X^2 (df=1, n=181) = 10.093, p = 0.001, phi = -0.248.

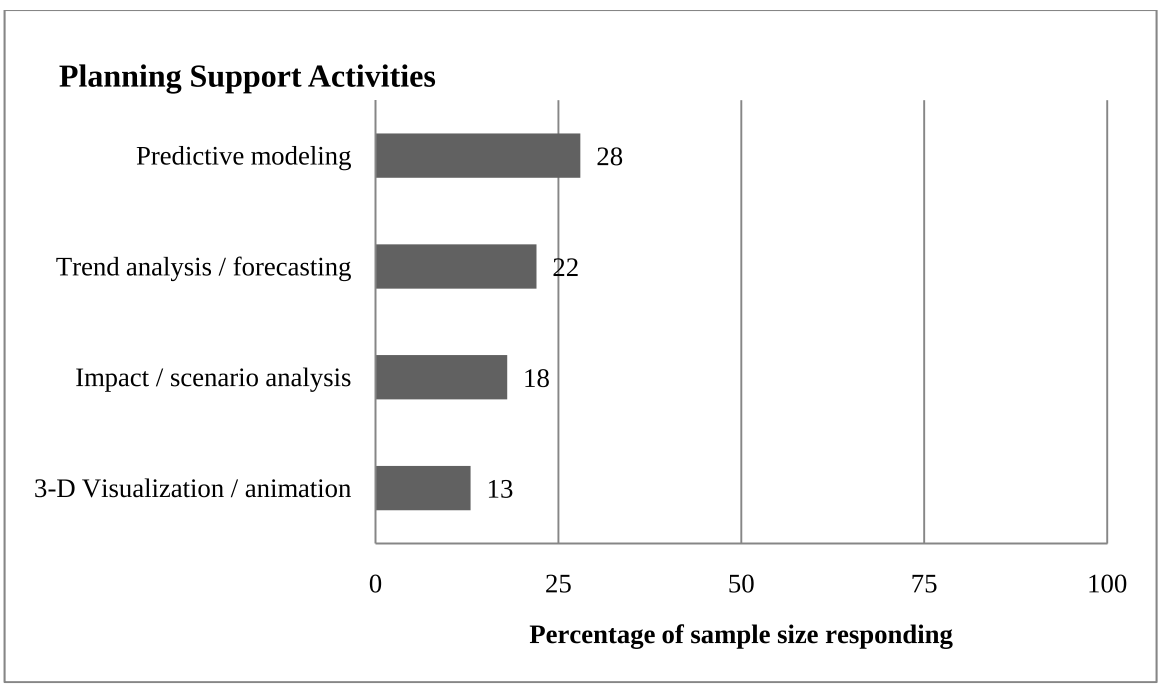


Figure 4-10. Type of activities conducted with planning support technologies in past five years.

Figure 4-11 (Q24) describes the stages in the rational planning process that PSS technology had been applied. Of the 70 affirmative respondents to Q23, most indicated that PSS technologies have been primarily used for “inventory/trend analysis” and “plan development”, followed by “issue identification, visioning, and goal setting”.

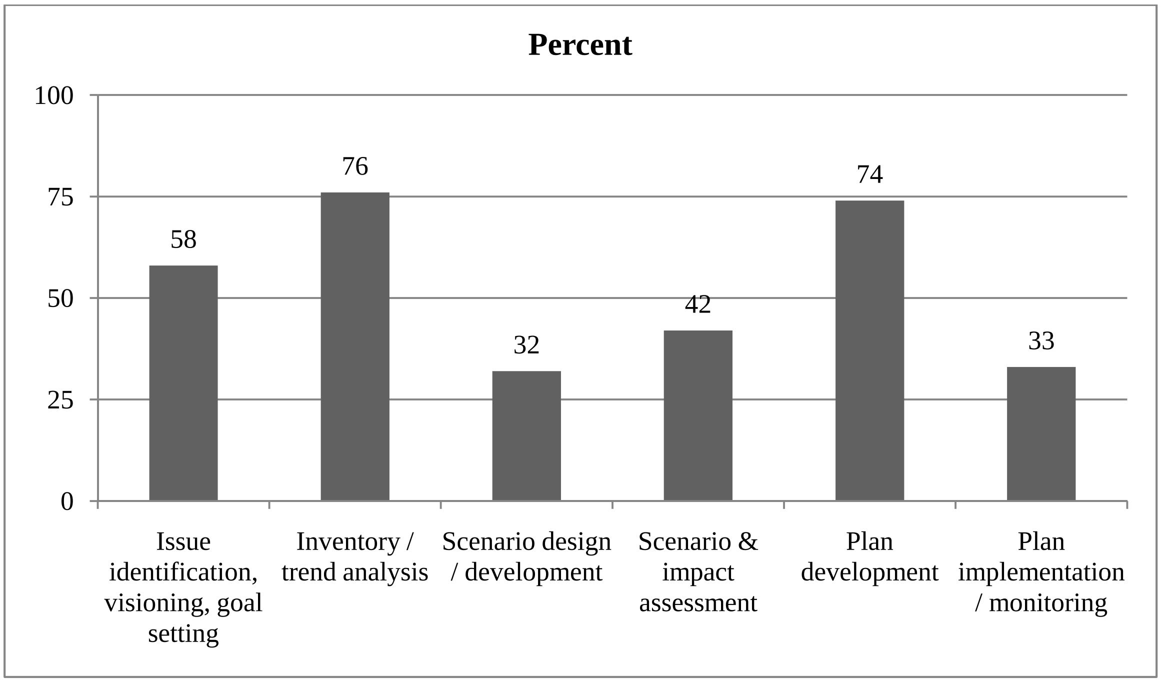


Figure 4-11. PSS application according to stages in the planning process (n = 69).

Table 4-6 summarizes the impacts of PSS use on decision-making effectiveness in planning activities (Q25). For all five indicators, the majority of respondents felt that PSS use had a positive impact, particularly with regard to the “communication of information” indicator (83%). While negative impact responses were relatively small, many respondents (16-20%, excluding “communication of information”) felt that PSS use had no impact. Further, a considerable amount of uncertainty existed (23%) regarding whether the technology improved the explicitness of the decisions made.

Table 4-6. Impact of PSS on decision-making effectiveness

Response	Positive Impact	No Impact	Negative Impact	Don't Know
Decision-Making Time	65.7%	20.0%	2.9%	11.4%
Explicitness of Decision	58.6%	17.1%	1.4%	22.9%
Identification of Conflicts	67.1%	15.7%	0.0%	17.1%
Communication of Information	82.9%	8.6%	0.0%	8.6 %
Confidence in Analysis	67.1%	15.7%	0.0%	17.1 %

n = 67

While relatively few planners are using PSS, the majority of those surveyed (59%) feel that the technology is potentially very useful (Q26). Based on weighted frequency counts, the overall greatest barrier to wider PSS use (Q27) was identified as “Hardware / software costs”, followed by “Lack of staff”, “Not enough time” and “Lack of training and/or technical support” (Table 4-7). As sub-sample populations, urban departments identified “Hardware / software costs” as the greatest implementation barrier, followed by “Lack of training / technical support” and “Lack of staff”. Rural departments also identified “Hardware / software costs” as the greatest implementation barrier, but ranked “not enough time” as the next greatest barrier, followed by “lack of staff”.

Table 4-7. Barriers to wider PSS use in local government planning

Barrier	Overall Rank (n=173)	Urban Department Rank (n=52)	Rural Department Rank (n=121)
Hardware / software costs	1	1	1
Lack of staff	2	3	3
Not enough time	3	4	2
Lack of training and/or technical support	4	2	4
Inadequate data	5	5	6
Lack of administrative support	6	6	5
Apprehension to work with new technology	7	8	7
Lack of needed functionality	8	7	8

Discussion

The questionnaire results provide considerable insight into the current level of ICT use by both urban and rural planning departments in the Mountain West region, and allow for comparison between the two sub-sample groups. Overall, planning departments in the Mountain West are at least minimally capable when it comes to ICT adoption and use. Responses to specific questions support this conclusion, though many departments appear to lack experience with innovative technologies. For example, while 86% of all departments have some type of web site, most function primarily to share contact and meeting information and online application forms and documents.

Relative to GIS, 79% of all departments use the technology on a regular basis in their work. (This percentage may have been higher if GIS professionals had been surveyed rather than planners.) The most common use for GIS, however, was to create maps rather than conduct analysis, modeling or visualization. Similarly, only 50% provide GIS resources over the Internet through Web-based map services.

Experience in applying GIS-based planning support systems (PSS) was considerably less than basic GIS use (40%), indicating that, to date, adoption of PSS technology by planners has been limited. (Preliminary case study findings and expert interviews indicate that the biggest PSS users may be the private sector consulting community.) Similar to GIS use in terms of level of sophistication, the most frequent area of PSS application is in inventory and trend analysis work.

Though limited in use, overall PSS impact was considered to be relatively positive, particularly in relation to communication effectiveness. Surprisingly, hardware and software costs are still considered to be the greatest barrier to wider PSS use, despite increasingly affordable desktop computers and vendor business models designed to make software acquisition initially accessible to a wide audience. More predictable is the identification of “lack of staff” and “not enough time” as implementation impediments. The development of credible and complete geospatial data sources in the last decade is reflected in its low ranking as a PSS implementation barrier.

Urban versus Rural. Certain differences were identified between urban and rural departments. While more than 60% of urban-based respondents perceive their departments as capable or advanced in terms of ICT adoption and use, only 34% of rural departments feel similarly. While both urban and rural departments provide web resources in their jurisdictions, urban departments tend to provide more diverse content and more sophisticated functionality. While no significant difference in GIS use was identified between urban and rural departments, Internet GIS functionality was considerably higher among urban departments (55%) than rural departments (40%). Finally, while the survey instrument did not identify notable differences between urban and rural PSS implementations, case study results and expert interviews reveal that rural planners may be more likely to become early adopters and consistent users of PSS given the "jack-of-all-trades" nature of their positions in contrast to the higher degree of specialization present in larger urban-based planning departments. Thus, while urban departments often have more resources, rural department staff can benefit in their exposure to technology through opportunity created out of necessity.

Limitations. Despite an above average Web-based response and relatively few refusals or incomplete questionnaires, the length of the survey instrument somewhat impeded the number and level of detail of questions asked. As a result, questions focused more on describing extent of use rather than the underlying factors of influence. In asking about PSS, it was also difficult to succinctly communicate differences between types of applications and functionality. Similar challenges were encountered in considering how best to present newer, Web 2.0-type tools without resorting to excessive jargon and specific trade names. Concerns over length also resulted in exclusion of a number of then-recently introduced Web 2.0 tools, many of which have since become much more common in practice. Finally, while a significant portion of the survey addressed GIS technology, data, and use as a means of understanding PSS implementation, strict comparisons of GIS development with previously conducted GIS surveys may prove problematic given that the questions were posed to planners rather than GIS departments or personnel.

Ongoing Research. The survey was unique in its "demand-side" assessment of ICT needs in planning and in its comparison of technology needs and use between urban and rural planning settings. As previously noted, the questionnaire results informed the design of a series of case studies on the role of PSS technology in rural comprehensive planning. Analysis of these cases is being conducted within an integrated theoretical context of Roger's Diffusion of Innovations framework (Rogers 1962; 2003) and Davis's Technology Acceptance Model (Davis 1989). This mixed-method approach is providing an opportunity to further explore the opportunities and barriers to wider ICT use in planning, and more specifically understand the inter-relationships between PSS implementation and GIS development, as well as the influence of external, consulting expertise in evolving PSS use from project-centric adoption and use to broader integration in day-to-day planning department workflows.

Chapter V

ASSESSING PLANNING SUPPORT SYSTEM IMPLEMENTATION:

A MULTI-CASE ANALYSIS OF COMMUNITYVIZ®

IN RURAL LOCAL COMPREHENSIVE PLANNING

This chapter reports Phase Two of the dissertation's mixed-method research design. Phase Two conducted a multi-case holistic case study inquiry in four different local government planning jurisdictions. In this circumstance, the focus was both confirmatory and explanatory, with the objective of gaining a deeper understanding of the technical, organizational and institutional factors influencing geographic information system (GIS)-based planning support system (PSS) adoption and use. Cases included two city and two county rural planning jurisdictions, all of which adopted the CommunityViz® PSS application in a comprehensive planning activity.

First, an overview of case study methods in information systems research is presented, followed by a description of the case study design, including case selection and analysis protocols. Next, each of the four case studies is presented and individually summarized, followed by a discussion of cross-case comparisons and urban-rural differences. The chapter concludes with a discussion of the challenges encountered in conducting the studies and limitations of the results.

Case Study Design

In this study, case research was employed to address research questions two (Q2) and three (Q3) of the dissertation, focused on how geospatially-enabled PSS are currently being utilized in rural local government planning (including differences in implementation at various stages in the planning process) and the relationships between PSS implementation and spatial data infrastructure (SDI) development in rural local government planning. The cases also explored the role of outside consultants in PSS implementation. The cases were designed to be confirmatory and explanatory in nature (Eisenhardt 1989; Harder 2010, p. 370) with an objective to test emerging theoretical concepts of PSS adoption.

Context. As described in Chapter II, Vonk et al.'s PSS Adoption Framework (2005) provides the primary theoretical context for the case study research design. Case study design was also informed both by the results of the Phase One survey and PSS expert interviews introduced in Chapter III, and by experience gained by the author's participation in a recent PSS implementation in Albany County, Wyoming (Lieske et al. 2009). This resulted in contextually "bounding" the case research design (Elger 2010, p. 55) with a number of "natural control" parameters (Lee 1989) for the purpose of constraining extraneous variation and improving external validity (Eisenhardt 1989, p. 533). These controls were common to all cases and included:

- a single PSS software application,
- implemented for a consistent purpose
- across a mix of jurisdictional settings

- in the same state.

The result can best be described as providing an overview of CommunityViz® in rural local comprehensive planning in the State of Colorado. The following sections summarize the design's major characteristics.

PSS Software Studied. The PSS studied in each of the case studies was CommunityViz® (Placeways LLC; Boulder, CO), a GIS-based software application designed to support planning analysis through rule-based scenario impact assessment and 3-D visualization (Kwartler and Bernard 2001; Klosterman and Pettit 2005). Development of CommunityViz began in the late 1990s, with support from the Orton Family Foundation (www.orton.org), then based in Rutland, Vermont.[5] From its beginning, the vision for the application was to make the planning process more accessible to citizens, especially in rural and small town settings (Kwartler and Bernard 2001). In fact, inspiration for the application's concept is purported to have come to Orton Family Foundation founder Lyman Orton from the popular Maxis™ Software SimCity™ simulation game (Kwartler and Longo 2008; Brenda Faber, personal communication, 16 September 2009).

The first commercial version of the CommunityViz Suite was released in 2001. Built on the ArcView 3.x platform (ESRI, Inc.; Redlands, CA USA), it included three separate modules: Scenario Constructor for interactive analysis, SiteBuilder 3D for 3D visualization, and Policy Simulator for agent-based modeling of future outcomes resulting from present-day policy decisions. CommunityViz Version 2 and Version 3 were released in 2003 and 2005, respectively,

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[5] Current headquarters in Middlebury, VT and Denver, CO.

built for the new architecture of ESRI's ArcGIS platform. With Version 2, the Scenario Constructor module was redesigned as Scenario 360, as was SiteBuilder 3D, which retained its original name (Placeways LLC 2010). As portrayed in Figure 5-1, Scenario 360 provides functionality for creating and assessing the potential impacts of specific, proposed land use actions by facilitating scenario building and monitoring change in a series of associated indicators. It extends the quantitative capabilities of ArcGIS by allowing spreadsheet-like calculations to be performed on geographic data layers and associated tables (Kwartler and Bernard 2001; Donley 2002). Sitebuilder 3D allows three-dimensional display of landscape and structure information with object manipulation and real-time movement in a photo-realistic setting (Kwartler and Longo, 2008).[6]

Over the last decade, CommunityViz has been utilized in many planning applications from rural growth management (Mullen 2001; Lieske et al. 2009) and urban redevelopment (Wendt 2002) to watershed modeling (Prisloe and Hughes 2002), aquifer protection (Lieske et al. 2003) and floodplain management (Nedovic-Budic et al. 2006). According to Placeways LLC, CommunityViz is currently being used in 40 countries worldwide (Placeways 2010). An Internet search engine query, conducted in April 2010, generated approximately 25,000 results, from which more than 50 documented summaries of specific applications of the software were readily identified in the peer-reviewed and "grey" literature.

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[6] Beginning with Version 2, the Policy Simulator module was discontinued from the application suite. The current version of CommunityViz (Version 4) was released in 2009. It includes a new 3D component - Scenario 3D, which replaced the original SiteBuilder 3D visualization module. (Source: *http://placeways.com/communityviz/history.php*, accessed 28 August 2010).

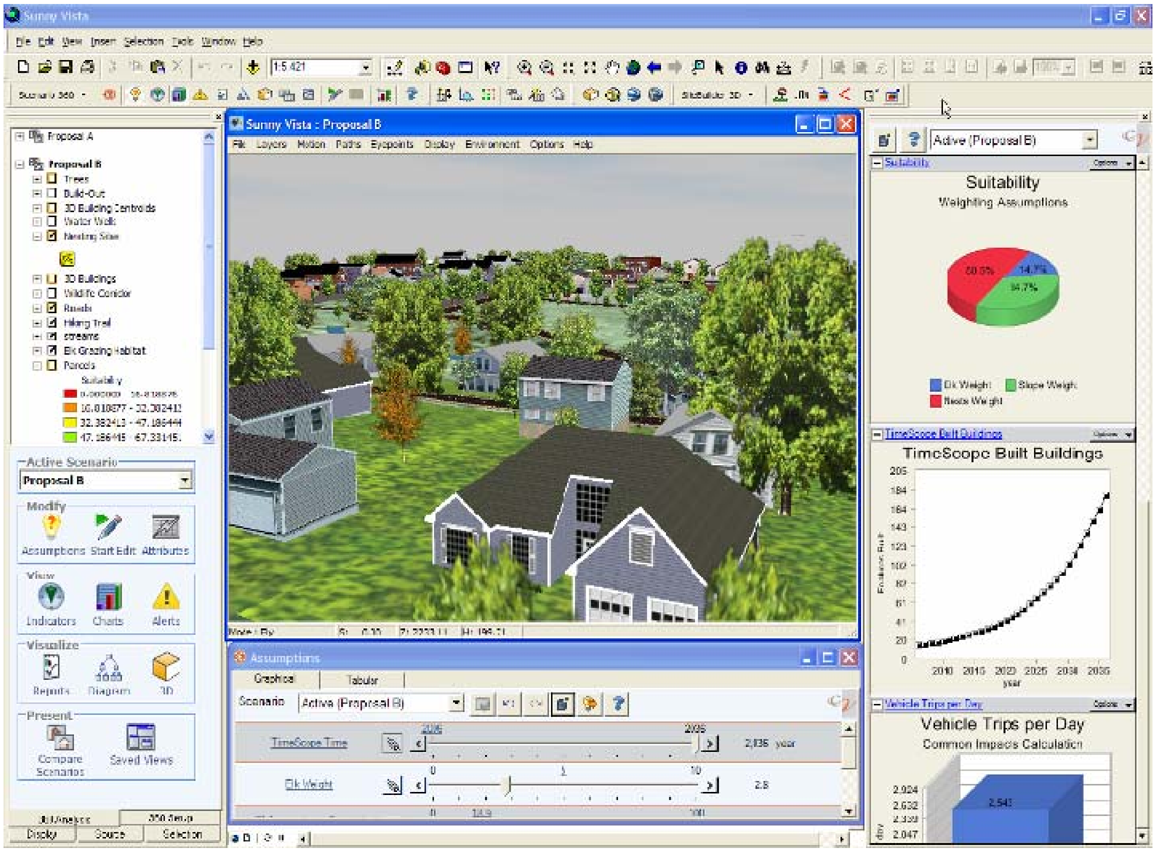

Figure 5.1. CommunityViz interface circa 2003, showing components of Scenario 360 and SiteBuilder 3D. Courtesy of Placeways LLC, Boulder, Colorado, USA.

Three factors provided the rationale for selecting CommunityViz for this research: (1) its extensive application in both urban and rural planning settings; (2) the results of the Phase One survey which identified CommunityViz as the only PSS software with which more than one respondent had experience (Chapter IV); and (3) the author's prior familiarity with the software's functionality and experience in its application (Hamerlinck et al. in preparation). Further, by making the software application constant in all cases, it allowed the research focus to center on institutional and organizational factors of implementation, rather than on functional variation among potentially different technology solutions.

Planning Application. The type of planning activity common to all cases studied was "comprehensive plan development or revision". With its roots dating back to the Standard City Planning Enabling Act of 1928, comprehensive planning can be defined in the USA as an effort to address the entire range of interrelated land use, transportation, and growth issues facing a community (Juergensmeyer and Roberts 2003; Miller 2009). Local government comprehensive planning is characterized by inclusivity in three dimensions: 1) geographic coverage, i.e., a plan for an entire planning service area, such as a city or county; 2) subject matter, where a land use-based, physical planning focus is integrated with transportation, housing, environmental and social concerns; and 3) time horizon, addressing both near- and long-term (i.e., 20 to 50 years) goals (Kelly and Becker 2000).

In the last thirty years, comprehensive plans have become as much a process as static development guide, including and coordinating plans with implementation programs and accompanying procedures, and often resulting in ongoing revisions for specific areas of growth, economic development and environmental sensitivity (Hollander et al. 1988). As the predominant form of local government planning in the United States, comprehensive planning processes are well documented and widely studied (Branch 1985; Hammack 1988; Kent and Jones 1990; Scott 1995; Kelly 2010). Choosing the comprehensive plan update process as a "constant" among the cases provided an opportunity for a widely-accepted process to serve as the unit of analysis in each case, and through which the work of the lead planning agency (city or county planning department) could be examined in interactions with supporting entities (e.g., other departments, consulting firms) and the public.

In Colorado, comprehensive land use planning is guided by enabling legislation codified in the Colorado Revised Statues (CRS) and implemented primarily at the local government level. All county (C.R.S. 30-28-106) and municipal (C.R.S. 31-23-206) planning commissions are required to prepare and adopt a comprehensive plan (termed “master plan”) for the physical development of their jurisdictions. In 2001, legislation was passed requiring the more populous and faster growing jurisdictions to formally adopt their plans within a two-year time frame if they had not previously done so (Colorado Department of Local Affairs, 2010a). Comprehensive plans can be either advisory, or binding and enforceable, depending on the political will of the planning body and its citizens. State statues do not mandate specific content for the plans, though at a minimum, most include material on land use, transportation, infrastructure and housing. Since 2001, the one element required by statute in all comprehensive plans is a section addressing “recreation and tourism” concerns (Colorado Department of Local Affairs, 2010b).

Case Selection. Much has been written about factors influencing case selection and optimal number of cases in case study research design. By employing a multi-case (or multi-site) research design, data was sought to support both within-case patterns and cross-site synthesis (Cavaye 1996, p. 237; Bishop 2010, p. 587; Chmiliar 2010, p. 582). Following the rationale described by Flyvbjerg (2006) and Bleijenbergh (2010, p. 61), actual case selection was based on an interest in identifying specific conditions and characteristics of documentable PSS implementation characteristics, previously only conceptualized by Vonk et al.’s PSS adoption and use framework (2005). Further, potential sites where similar planning processes could be anticipated were of particular interest given their potential to provide “literal replications” for comparison (Yin 1984 cited in Benbasat et al. 1987, p. 373; Yin 2003). From a more logistical viewpoint, case selection criteria also included case actors' accessibility and willingness to participate, and financial cost and time requirements associated with conducting field work (Darke et al. 1998).

Based on survey results and input from interviews with PSS experts (Appendix A), 12 jurisdictions in the State of Colorado were identified and considered for inclusion in the study. Colorado was selected primarily because it is the state in the Mountain West region study area where the most local government CommunityViz® implementations have taken place. Confining cases to the same state also provided an opportunity to isolate a single state GIS coordination structure consistent for all of the case jurisdictions, an important consideration given the nature of research questions related to relationships between spatial data infrastructure (SDI) development and PSS implementation.

Given the bounding controls and other selection criteria described above, four cases were ultimately selected for analysis. As noted by Cavaye (1996), the literature is vague in specifying the actual number of cases to study. Eisenhardt's oft-cited 1989 publication on theory building in case study research recommends that between four and ten cases be studied in a multi-case design, but that the number should be flexible during field work and ultimately determined by whether the data currently collected is sufficient to enable appropriate analysis. Royer (2010, p. 616) supports this viewpoint by positing that in multi-case research, careful theory-based selection of cases allows reducing their number without impacting validity, though reducing the number of cases is easier for theory testing (as in this study) than it is for theory building. Two of the sites were cases associated with municipal planning departments and two of the sites were cases associated with county planning. The choice of two cities and counties allows for comparison between the two cities and between the two counties. All four jurisdictions were classified as non-metro (i.e., rural) by the USDA Economic Research Service's Urban-Rural Continuum (described in Chapter IV).

Table 5.1 provides a basic contextual background for the four case sites. Though not initially planned, the two cities selected happen to be located within the two counties being studied (Figure 5.2). While each case maintains its own independent context, the geographic relationships between the jurisdictions provide the opportunity to examine potential issues of geographic scale and adjacency and explore some finer resolution, regional spatial data infrastructure issues.

Table 5.1. Case study site summaries

Alias	Alpine County	Watertown	Valley City	Plateau County
Lead Agency	Planning, Blding & Env Health; GI Services	Community Development & Planning	Community Development	Planning and Development
Pop. / Area Served	14,000 3,300 sq mi	5,500 3 - 4 sq mi	12,500 11 - 12 sq mi	34,000 2,300 sq mi
Type of Process	Corridor Master Plan, 2003 - 2005	City Comp Plan, 2004 - 2007	City Comp Plan 2007 - 2008	County Comp Plan 2008 - 2010
Partner	Private Foundation	In-House	In-State Consultants	Consultants / In-House
Key Issues	Early CommunityViz adopters; GIS & planning combined	CommunityViz used by in-house staff only; 3D applications	Consultant-guided; build-out analysis; use of regional data consortium	CommunityViz and other technology de-emphasized as project progressed; GIS in-house; natural resource issues

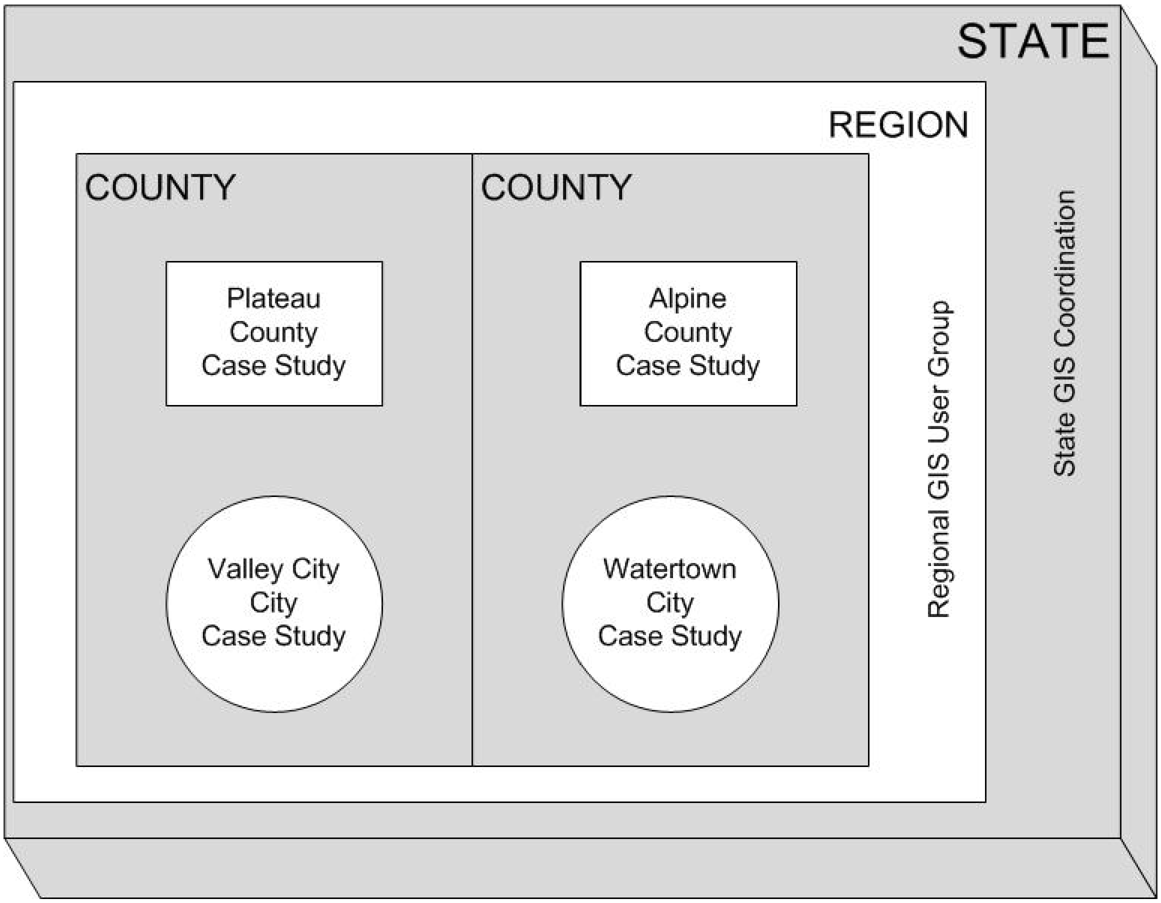

Figure 5.2. Conceptual proximity of case study sites within region and state.

Data Collection and Analysis Protocol. Data collection was conducted between July 2009 and October 2009 through on-site visits, telephone interviews, and World Wide Web-based document retrieval. For each case, data describing PSS adoption and use was collected from three main sources of evidence: (1) documentation; (2) archival records; and (3) semi-structured interviews (Yin 2003).

Approximately 25 individuals were interviewed across the four cases, representing government staff, consultants, and elected local officials associated with each jurisdiction's comprehensive plan activities. Several additional interviews were conducted with individuals who were not directly involved in any of the specific CommunityViz® implementations, but who added to the overall context of PSS use in the state. They included the Colorado State GIS Coordinator, the President of the Colorado Chapter of the American Planning Association, the original lead software developer for CommunityViz, and the President of Placeways LLC, current distributors of CommunityViz®.

The majority of the interviews were conducted as one-on-one, face-to-face conversations. Two interviews involved two participants and one interview involved three participants. Three interviews were conducted by telephone, as were all follow-up inquiries with prior interviewees. When possible, interviews were scheduled several days prior to on-site visits. Upon agreeing to participate, interviewees were provided with background documentation describing the scope of the case study research design (Appendix G). Prior to beginning the interview, participants were asked to confirm their willingness to participate by signing an informed consent letter (Appendix H). With permission, all interviews were digitally recorded for later transcription. Data coding and analysis were based on well-established protocols outlined in Miles and Huberman (1994), including coded summaries, and checklist and conceptually-clustered matrices.

Maintaining Anonymity. Institutional Review Board protocols for the case study interviews specified anonymity for case study interviewees.[7] Due to the relatively small population of both the local government planning and geographic information systems

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[7] See Chapter III for details.

communities in the state, it was also necessary to establish aliases for the case study cities and counties, and to refer to individuals by functional titles only (e.g., planning director, GIS manager, etc.) (Wallace 2010, p.22). The few exceptions to this include the state GIS coordinator and the President of the state chapter of the American Planning Association. Anonymity was not possible in these cases, given that it was impossible to mask entirely the fact that all of the cases were in Colorado and there might only be a single person in a given functional role. In these cases, permission was sought and granted by these individuals to identify their affiliations, if not their names. Other interviewees waiving anonymity included individuals associated with CommunityViz itself (i.e., developers and software managers), since the software's functionality and usability could not be readily masked in the case study evaluations. Note, also that the 12 PSS experts have been identified by name and affiliation for the purposes of establishing credibility. All interviewees agreed to these conditions, and any reporting of individual responses will be confidential in the dissertation unless permission for use of a direct quote was granted by the interviewee.

Case Study Summaries

The four case studies are presented below, organized in chronological order according to the initiation date of each jurisdiction's comprehensive planning process.

Case #1: Watertown. The Watertown case study examines the use of CommunityViz in development of the City of Watertown's comprehensive plan. (Henceforth, also referred to "comp plan".) Watertown is an incorporated municipality and county seat of government for Alpine County, Colorado. The county's largest city, Watertown's population in 2000 was 5,409 and projected at 5,374 at the time that the updated plan was adopted in 2007.[8] Major economic activities include education, tourism, and health and social services.

Current Status of Planning and ICT. The department responsible for conducting community planning in Watertown is the Department of Community Development and Planning. The department has a staff of three planners, including a Community Development Director, a City Planner, and a Planning/GIS Technician. Other department staff includes the Building Official and Fire Marshall.

The city does not have a separate information technology department, but the planning staff consider the city to be "fairly advanced" in its adoption and use of information technology with "lots of technology being used" across a wide range of departments, including Public Works, Finance, and Parks & Recreation. The city funds a part-time position to maintain its web site (including the Community Development and Planning pages).

With no separate GIS department, the Department of Community Development and Planning, according to its director, serves as the "de facto GIS department for the city" supporting Public Works and Parks & Recreation with their mapping needs. The GIS software platform used by the department is the industry standard ArcGIS.

The major use for GIS in the Department of Community Development and Planning is to assist with long-range planning efforts. The department does not use GIS for permit tracking or code enforcement, employing a basic spreadsheet application for those purposes. According to

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[8] For all case study sites, the source for the 2000 calendar year populations is the U.S. Census Bureau 2000 Decennial Census of Population. The source of all other reported population values are annual estimates calculated and provided by the Colorado Division of Local Government, State Demography Office.

the Community Development Director, the department is in “good shape in terms of [geospatial] data” adding “we’ve got a great data set for a small community”. Both the director and planner identified non-standardized addressing as the biggest geospatial data challenge. The department does not maintain an online GIS for public access, but is considering coordination with Alpine County for such an effort, as well as better coordination between city and county with cadastral (i.e., land parcel) information.

Case Study Context. Development of the comp plan occurred over a three year period, from beginning of data collection in summer 2004 to final adoption in spring 2007. Data collection included a GIS-based land use and land resource inventory, a telephone-based public opinion survey of community issues, and a series of structured interviews with community leaders. The plan’s development was supported by a steering committee and an ambitious public outreach strategy with local business and community groups. The result was a 100+ page document that laid out a vision for the community through 2027. Included were goals and policies addressing the relationships between community character, environment and natural resources, land use, housing, transportation and utilities, as well as education, recreation and the arts.

Case-Specific Role of GIS and CommunityViz. For the comp plan’s development, GIS was utilized for cartographic production, and combined with CommunityViz to develop a build-out scenario of future land-uses. CommunityViz, Version 3 includes a generic build-out model and wizard (i.e., user interface) with pre-determined density variables. However, the department chose to customize it significantly before applying it in their community. The Community

Development Director noted that the build-out module was a “brutal model to use, in and of itself, so we modified it.”

The decision to utilize CommunityViz in Watertown’s comp plan creation largely stemmed from the Community Development Director’s past exposure and experience with the application. The Director self-described as being strongly interested in computers and technology in planning. He was self-taught in use of GIS during the mid- to late-1990s after receiving his formal planning education. He was first exposed to CommunityViz at an Orton Family Foundation presentation at a Colorado Association of Ski Towns meeting in ca. 2001-2002, while working as a planner for a different community and later received a training scholarship from the foundation to assist in learning more about the software’s capabilities. When he moved to Watertown in 2004, he acquired a CommunityViz license for the department and encouraged the Planning/GIS Technician to learn the software for the comp plan project. The technician was also self-taught in GIS, and subsequently, CommunityViz. In 2007, she was promoted to City Planner and continues to be the primary user of both applications.

Outcomes. Among the four sites analyzed, the Watertown case is unique in its lack of consultant involvement. Consultants were used sparingly for the comp plan process as a whole and not at all for the GIS-based CommunityViz build-out analysis:

> You hire a consultant to have them look at your watch and tell you what time it is. It’s really, really time consuming to sit down and direct a consultant to write a plan for your community... you end up finishing it yourself. – Watertown Community Development Director.

Overall, the planning staff felt that the use of CommunityViz in the comp plan process had been beneficial, but noted that it would not have been possible without considerable extra time spent learning the software outside of normal working hours and being driven by a natural curiosity in technology, a trait jointly shared by the small, seemingly close-knit group.

Today, the department continues to use CommunityViz on a regular basis, though not every day. The current primary use of the application is for 3D animated visualization associated with an ongoing annexation plan (initiated as an outcome of the comp plan). In particular, planning staff have found animations useful for communicating design forms to the planning and zoning commission, but have reservations about its wider utility in public meetings:

> Technology in a public setting… you really have to be very careful about using it. You can put people to sleep, or you can get them so caught up in something that's nebulous… not important, that you lose the big picture in the scheme of things. So, you know, we utilize technology, but I think we utilize it on a sparing basis... I've found, for example, using 3d fly-throughs in CommunityViz, people are so enthralled with "Where's my house?" [when] we're trying to visualize what the new annexation is going to look like. - Watertown Community Development Director.

Planners also felt that citizens in general don't grasp the investment required to develop things like high-resolution animations, considering it a "Hollywood animation" and not recognizing it as a decision support aid. As a result, Watertown planners use CommunityViz primarily as an in-house tool and not something incorporated into community process activities.

Case Study #2: Alpine County. The Alpine County case study examines the role of CommunityViz in development of a regional comprehensive plan within Alpine County, Colorado. Alpine County is over 3,000 square miles in size, more than 75% of which is federally owned. The county population in 2000 was approximately 13,900 and projected at 14,500 in 2005 when the plan was completed. The county contains five incorporated municipalities. The county seat of government is Watertown, with a population of 5,400 in 2000. Crown Mesa is the next largest municipality, having had a population of 1,500 in 2000. Almost half of the county's residents live in unincorporated areas, reflecting the rural nature of the county. Primary economic activities include ranching and tourism.

Current Status of Planning and ICT. Planning responsibilities in the county are distinctly divided between two departments: the Community Development Department; and the Geographic Information Services Department. The Community Development Department includes three offices: Current Planning, Building, and Environmental Health. The offices are collectively staffed by eight people, three of whom are formally trained as planners. According to the department web site, the Office of Current Planning " … is primarily responsible for ensuring that land uses within the county are developed and maintained in compliance with the County's adopted codes and regulations, and overseeing permit reviews for those uses." In these efforts, the Office of Current Planning interacts closely with the City of Watertown through an intergovernmental agreement (IGA) to permit development in a three-mile area around the city. Most work is done in-house, with little involvement by consultants aside from local legal counsel on retainer to the county.

The Geographic Information Services Department has a staff comprised of a GIS Manager; GIS Coordinator; and GIS Technician. The department is charged with two primary functions: maintaining the county's geographic information system (GIS); and conducting long-range planning (including planning coordination with other jurisdictions, federal project reviews, and special projects).

In terms of GIS maintenance, the department is responsible for database development and maintenance, including county parcel information (first digitized ca. 1996) and addresses stewarded for 911 emergency responses (services also coordinated with the county's municipalities). With no dedicated GIS positions in other departments, the Geographic Information Services Department supports extensive use of geospatial technologies by personnel in Community Development, Public Works, and the County Assessor's Office. An important resource is a customized query and display application developed using MapMaker software (Mapmaker Ltd, Argyll, Scotland UK), a relatively obscure, but easy-to-use and customize application. The department also maintains an ArcGIS map server for sharing basic geographic data with the public. Analysis for special projects is primarily conducted using Manifold GIS (CDA International, Ltd, Las Vegas, NV), which, like MapMaker, was adopted as a choice of personal preference by the current GIS Manager. According the current GIS Manager, major ongoing GIS-related challenges for the department include resolving accuracy issues in county-wide parcel data and "high overhead" (i.e., time requirements) for sharing data between software systems.

Case Study Context. The Crown Mesa-Watertown Corridor Comprehensive Plan was the first of two sub-county, regional comprehensive plans undertaken in Alpine County in the 2000s. When initiated in 2002, the Geographic Information Services Department was called the Long-Range Planning Department and was the designated lead on the overall effort. Long-Range Planning had been separated from the Community Development Office in ca. 2000-2001, with a goal of freeing up certain planning staff to focus solely on guiding future development, rather than supporting immediate development activities. In 2002, the county's GIS group became a part of Long-Range Planning as well, having previously been situated in the county's Department of Information Technology. According to the director of Long-Range Planning at that time, the reason for this merger was specifically to better integrate the use of GIS technology in comprehensive land use planning activities.

Development of the plan occurred over a three year period, from initial issue identification in summer 2002 to final adoption in fall 2005. According to the plan's Introduction,

> [the plan] ... is a general, conceptual statement of intended land use and environmental practices in the Corridor. It is designed as a tool for citizens, County staff and elected officials... [and] provides a foundation for decisions and policies that guide and direct the physical, social, economic and environmental development for the Corridor.

The effort was initially overseen by the Director of Long-Range Planning, who had joined the County in 2001. The Long-Range Planning Director resigned in early 2005, and the project was completed by his replacement, who remains the current GIS Manager today. During the initial stages of the plan's development, an unusually large number of external planning groups were involved the process. According to archival documentation, these included two private consulting firms, as well as the Sonoran Institute, the Nature Conservancy, and the Colorado Conservation Trust, all widely recognized non-profit land conservation organizations.[9] According to the former Long-Range Planning Director, the initial impetus for doing the plan came in part from grants promoted and funded by the Sonoran Institute and Colorado Conservation Trust to address concerns with potential elk habitat fragmentation stemming from increased rural residential development.

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[9] These are the actual names of the organizations. In this case, pseudonyms were not used, as all of these organizations have been involved in numerous planning efforts throughout Colorado and no organization representatives were interviewed for the study.

Case-Specific Role of GIS and CommunityViz. GIS was used extensively for background mapping throughout the plan, specifically for portraying existing land ownership and land use, topography and land cover. GIS was also used to project the extent and location of future development based on a trend extrapolation of projected population increases and environmental and infrastructure constraints.

CommunityViz was used in the plan development process to develop a series of land use alternatives based on the initial 2002 survey of community concerns and interests. Reference geospatial data layers were collected and mapped for three major categories of information: environmental; economic; and social. Input from focus groups was used to define and weight a collection of “values” variables for each category, representing 27 discrete issues identified by the original community survey and focus group input. Utilizing the interactive “slider bar” interface to assign values in CommunityViz Scenario 360, a linear combination overlay technique was applied to generate a series of parcel-level suitability maps. The maps portrayed alternate development opportunities based on a range of environmental and economic preferences.

The decision to utilize CommunityViz was the result of the Long-Range Planning Director’s past experience as a consultant conducting beta testing for the first public release of software; this provides a representative example of an early adopter. He had also participated in the initial CommunityViz training offered by the Orton Family Foundation in 2000-2001. As a part of that training, he was introduced to another consultant/beta tester, who was later hired as an Orton Family Foundation CommunityViz consultant to assist with the land use alternatives component of the Crown Mesa-Watertown Corridor Plan.

Outcomes. In early 2005, the Long-Range Planning Director left the county, prior to the plan's completion. With this loss of in-house expertise, the CommunityViz component of the plan was subsequently de-emphasized in the remaining land use analysis and relegated as a supplemental appendix with little or no bearing on the plan's recommendations. Viewpoints are mixed on the success of the CommunityViz implementation. From the former Long Range Planning Director's perspective, the CommunityViz methodology was valuable in providing a new level of "quantitative rigor" to traditionally manual "McHargian analysis" and a means for handling large amounts of data and still making meaningful recommendations to decision makers:

> It's not just – "Oh, well, it is close to water and sewer." - Well, how close to water and sewer is it? [pause] Um – "It's environmentally sensitive." - Well, prove that. Show me what environmental resources are being impacted or protected or whatever... So, I think that was its greatest value. – Former Alpine County Long Range Planning Director

In contrast, the planner who saw the plan to completion shared that the county commissioners abandoned the process because it was complicated and was taking too long:

> Basically the CommunityViz thing was too obscure, I guess. They didn't get enough out of it to even include it in the comp plan. It was referenced that it was used but the results of it didn't really [get used]. I think that the results of it helped… certainly helped show people, you know, that compact development is, has less negative impacts. And so that was reflected in all of the various components of the comp plan, but the CommunityViz exercise itself was kind of dropped. – Current Alpine County Geographic Information Services Manager

Today, GIS continues to be a crucial part of all planning activities in Alpine County, though CommunityViz is not currently being used. While CommunityViz did not have a lasting impact in Alpine County, its application does have a significant legacy, in that it was one of the first examples of combining a PSS application with community process technologies like keypad polling and the "Growth Challenge Chip Game", an approach since adopted and applied extensively by planning consultants in many jurisdictions through Colorado and other parts of the Mountain West (Lieske et al. 2009).

Case Study #3: Valley City. The Valley City case study involves a 2008 update of the 1998 Valley City Comprehensive Plan. Valley City is an incorporated municipality and county seat of government for Plateau County, Colorado. The county's largest city, Valley City's population in 2000 was 12,400 and projected at 18,000 in 2008 when the comprehensive plan update was completed. The city is a major regional commercial center and hosts both a hospital and airport serving a three-county area. Other major economic activities in the community include agriculture services and recreation-based tourism.

Current Status of Planning and ICT. The Valley City Planning Department, a division of the Valley City Community Development Department, is responsible for planning activities in Valley City. The office facilitates and manages the city's development process, evaluating development proposals and reporting to the planning commission on subdivisions, zoning, special requests and master plan updates. The department also works on short- and long-term planning goals and special studies to support the needs of the city. Trained planners assigned fully or part-time to the Planning Department include the Community Development Director, a senior planner, an assistant planner, and a community development specialist.

All Community Development staff interviewed agreed that Valley City was very advanced in terms of information technology development and "ahead of most" for a community its size. The city has a separate Information Technology Department and has hosted its own citywide web site for more than ten years. However, the Community Development Department has primary responsibility for the content and maintenance of its own web pages.

The city's GIS Department is separate from Information Technology, with a staff of 1.5 full-time equivalent positions. GIS services have been provided since roughly 1994. The city was an early developer in the state in terms of Internet mapping services. Today the department maintains both publicly accessible and internal versions of its ArcGIS system. A major difference between the two versions is that certain land parcel details are masked in the public version per Plateau County policy of not making ownership information available over the Internet.

The Planning Department is the group most supported by the GIS Department, followed by Engineering, Public Works, and to a lesser extent, Recreation. According to the Senior Planner, "GIS makes us a lot more efficient and improves our customer service". As noted by the GIS Coordinator, while the GIS Department has primary responsibility for data development and maintenance, planning staff are fairly self-sufficient in making maps, carrying out queries and conducting basic proximity analyses. Since a revision of the city's subdivision regulations in 2000, all development applicants are required to submit all plan drawings in digital (CAD) format. Beginning in 2007, the Planning Department has utilized a GIS-based permit tracking software (CRW Systems PermitTRAK; San Diego, CA).

Case Study Context. The Valley City comprehensive plan update was begun in early 2007 in response to a need to better guide future development in the face of significant population growth (an average of 4.7% per year between 2000 and 2006). The plan's development was lead by the city's Senior Planner and Community Development Director with input from both technical and citizen advisory committees. Two principal and four secondary consulting firms were hired to assist in completing the plan. The two principal consultants, both Colorado based, were Prime Planning Consultants and Futures Design[10]. The completed plan (including 11 chapters, six appendices, and 22 maps) centers around eight guiding principles related to growth efficiency, development of high density retail and commercial centers, diverse housing choices, management of important environmental resources, and adequate provision of public services. Implementation calls for the next revision in 2013.

Case-Specific Role of GIS and CommunityViz. Overall, the use of ICT in developing the plan was closely tied to the community engagement process conducted by Prime Planning Consultants and Futures Design. The consultants established and maintained a plan-specific web site with public commenting capability for the duration of the project. In addition, four workshops were conducted, all integrating GIS, CommunityViz, keypad polling and (non-digital) group board games, for collecting public input and shaping future planning alternatives.

At the first workshop, Futures Design facilitated the “Growth Challenge Game” (also known as a “chip game”). Participants located new housing and new jobs on a “game board” map of the community. Workshop participants produced 30 different maps, each digitized using GIS, studied for commonalities, and synthesized to develop three broad alternative scenarios for further analysis. Citizen participants used keypad polling in the workshop to indicate their priorities with respect to “sensitivity factors” (e.g., agricultural land preservation) and “growth efficiency factors” (e.g., emergency service response time, proximity to schools), which were utilized in analysis of the alternatives.

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[10] Both pseudonyms.

For Workshop #2, Futures Design analyzed the three scenarios using CommunityViz, taking into account the participant-ranked sensitivity and efficiency factors. Workshop participants again used keypad polling, this time to indicate their policy priorities and to comment on the relative merits of each scenario.

Relationships between transportation and land use were explored in Workshop #3, again utilizing keypad polling technology to determine citizen preferences. At Workshop #4, the consulting team presented a fiscal analysis for the City, relating capital costs and operational costs to the pattern of development, and they also presented a Synthesis Plan. The Plan included a "Tier System" of concentric regions around the City's center to guide future development, with development policies varying among tiers in large part due to different costs of development depending upon proximity to services. Keypad polling was used a final time to validate citizen opinion of the outcomes.

Outcomes. The Valley City comprehensive plan was successfully adopted in spring 2008. The consultants' use of ICT was well received by both the planning staff and the public. In a 2009 interview, the Valley City Community Development Director shared: "The combination of the chip game, the keypad polling, and the analyses using CommunityViz worked really well to involve the community and to help us move towards decisions. We had more than usual suspects involved—we had people from all walks of life".

According to the City's GIS Coordinator, the consultants relied heavily on the GIS Department for all base data, including land ownership and land use, transportation, utilities, and natural resources. Consultant-generated GIS data was limited to scenario development associated with the public participation process. Use of CommunityViz in the planning process was promoted by the consultants as part of their bid for the contract. The Community Development Director noted that the technology was appealing in terms of potential for presenting visualizations to decision makers, though ultimately, no 3D visualizations were incorporated into the content of the plan. In terms of other benefits, planning staff also noted that the extent of the build-out analyses generated by CommunityViz scenarios was likely unrealistic over the next 10 to 15 years, but served the purpose of garnering buy-in from participating citizens.

In terms of ongoing use of ICT, the city has not used keypad polling since the four public workshops conducted for the plan revision, but are strongly considering incorporating it as a requirement in future Requests for Proposals on projects involving public input.

Relative to plan implementation, day-to-day decisions are currently being conducted by planning staff using the internal city-wide GIS system. A unique aspect of this case study was that as part of consultant's contract, the GIS Department staff was provided with a permanent, three-user CommunityViz license and a half-day training session for GIS and planning personnel. However, since the plan's completion, neither the Planning Department nor the GIS Department have used the application, citing lack of sufficient training (due to time and budget constraints) to support use. Finally, the City's GIS Coordinator views that responsibility as one primarily for the Planning department if it wants to use the software over the long term, stating: "I'm not going to do CommunityViz. I'll help them, [pause] provided we get more staff to support them, but [learning CommunityViz is] the planner's job."

Case Study #4: Plateau County. The Plateau County case study examines the use of CommunityViz in developing a comprehensive plan for Plateau County, Colorado. Plateau County is approximately 2,300 square miles in size, more than half of which is federally owned.

The county population in 2000 was approximately 34,000 and projected at 41,000 in 2008, when demographic analysis for the plan was completed. The county contains four primary incorporated municipalities. The county seat of government is Valley City, with a projected population of 18,000 in 2008. In 2000, 55% of the county's residents lived in unincorporated portions of the County. By 2008, that number had dropped to 48%. Primary economic activities include farming, ranching, energy development, and outdoor recreation-based tourism.

Current Status of Planning and ICT. The Planning & Development Department is the agency with primary responsibility for planning in Plateau County. The Department has five employees, including three in the Building Division and two in the Planning Division. The Building Division provides plan review, inspections and enforcement of the currently adopted building codes and is responsible for review and approval of individual sewage disposal systems (septic systems). The Planning Division plans and provides for growth in accordance with County Subdivision Regulations, Zoning Resolution and Master Plan. The division provides support, processes and presents applications to the Planning Commission and Board of County Commissioners. Traditionally, the Planning Division has made little use of external consultants to assist in carrying out its responsibilities.

The County has an autonomous Information Technology Department and the county's IT infrastructure is well regarded by planning staff:

> When I got here, it was one of the things that really surprised me, for this rural county to have that kind of technology is fantastic... to have that information available... which makes it then easy for us as a planning group to just grab a hold of that and just add on as we need to. – Plateau County Planning & Development Director

Similar to the county as a whole, the Planning & Development Department has an extensive web site. Maintenance is provided by the Information Technology Department, with Planning & Development responsible only for providing content updates as needed via file transfer. In 2009, the Planning Division instituted a high-speed Internet videoconferencing system to facilitate communication with the more remote areas of the county.

GIS in Plateau County began in 1994 in the Engineering and Information Technology departments, and has been its own department since 2001. Staff size is relatively large, including three full-time employees and one half-time employee. Though originally running MapInfo GIS (Pitney Bowes Software Inc., Troy, NY), the department currently supports ArcGIS and, to a lesser extent, AutoCad Map 3D (AutoDesk, Inc., San Rafael, CA). The Department's data holdings are extensive, including county-wide parcel and rural addressing data.

Major GIS users in the county include the County Assessor's Office, the Engineering and Road & Bridge Departments, as well as the Planning Division of the Planning & Building Department. GIS is viewed by the planning staff as critical to carrying out their jobs. Notes the Senior Planner: "For current review, if I'm reviewing a subdivision, GIS has been just awesome, because it's a central location for maps and things I need to check."

Case Study Context. The Plateau County comprehensive plan update was completed in spring 2010, following a protracted process which first began in summer 2006 as a minor update of maps and definitions for the existing 2001 plan. As noted in the 2010 plan's Preface, community interest was both greater than expected and contentious, with public input quickly outpacing in-house staff resources. Following a 2007 mail survey, the County received a grant from the Colorado Department of Local Affairs, and subsequently a consulting firm was hired to facilitate additional meetings and public involvement in 2008 and 2009.

The consultants hired to complete the planning process were Prime Planning Consultants and Futures Design, the same Colorado-based firms who were involved in applying CommunityViz and planning support instruments in the comprehensive plan revision for Valley City (Case #3). It should be noted that most of the case study data collection for the Plateau County case was conducted in August 2009, after the community input and CommunityViz portions of the plan had been completed, but prior to completion of the overall plan. Shortly after the interviews, in September 2009, the County initiated a termination of their contract for services with Prime Planning Consultants and Futures Design. Based on follow-up communication with both the Plateau County planning staff and representatives from the consulting firms, it seems that both lack of communication and delays in intermediate product delivery were responsible for the termination of the contract. Following this action, the Plateau County Planning & Building Department completed the comprehensive plan in-house over the next six months, with the extensive assistance of the County's GIS Department.

Case-Specific Role of GIS and CommunityViz. During the portion of the plan update involving Prime Planning Consultants and Futures Design, the process closely mirrored that of the Valley City plan revision, including a series of workshops employing keypad polling, the "Growth Challenge Chip Game", and CommunityViz-generated growth alternatives for four distinct regions within the county. However, as a result of the County terminating the consultant services and completing the plan in-house, none of the information generated through the Prime Planning Consultants/ Futures Design work was incorporated in the final document. The final document, is nonetheless “mapping rich”, with 28 maps generated by the Plateau County GIS Department on a wide range of topics from land use and transportation to wildlife, natural hazards and mineral extraction.

Outcomes. Given the termination of services from the CommunityViz consultants, the Plateau County case could be considered not viable for inclusion in this research. However, with the exception of final analysis, the use of CommunityViz in the Plateau County comp plan revision can be documented and does provide considerable insight into the real and perceived value of ICT in planning.

Throughout interviews, planning staff repeatedly emphasized that the role of ICT in planning was extremely important, and in particular, that GIS was critical in completing the comprehensive plan update. Interestingly, the importance placed on ICT-supported planning was reflected in the consultant Request for Proposals issued by the Planning & Building Department, which specifically required an ICT component in the scope of services:

> We wanted to make sure somebody could produce maps, I mean because that was going to be a big part of it. [pause] Quantifiable data was one of the things we really stressed… [pause] You know, this data’s gotta be quantifiable, and that came from [citizens], you know, complaining, “Oh, well, just because a bunch of people got together and wrote on some butcher paper, doesn’t mean that’s the community consensus...
>
> So, we didn’t pin it down exactly, you know, how the quantifiable data was going to be provided, but we said we preferred the use of technology in the deliverance of quantifiable data. [The winning consultant] really was about as good as anybody in that respect and that helped them ultimately win the contract. – Plateau County Senior Planner

As it turned out, all applying consultants offered to develop a web site and utilize GIS in their work; only one out of 30 proposed using CommunityViz.

Of the technologies employed by Prime Planning Consultants/ Futures Design, the Plateau County planning staff most appreciated keypad polling, another resource few of the proposing consulting firms offered. As for the analyses generated using the Chip Game and CommunityViz:

> We haven't done a lot with it... [The] Chip Game outcomes didn't need the CommunityViz concept. ...Most of the stuff that they were doing, it was almost like they were just taking initial data that was already on GIS and just saying "O-K, here's a fire hazard area, so we should be, you know, dealing with the land use issues because of it". It really didn't change anything; it didn't change anybody's thinking. That's how I saw it. – Plateau County Planning & Building Director

While these quotes support an opinion among professionals that CommunityViz may not be much different than a generic GIS, the following additional insight shared by Plateau County Planning & Building Director potentially reveals a different, more local reason for the cool reception to the technology:

> [It's] parcel map boundaries that are important in this community; [citizens] don't like conceptual generalizations. This county reacts very strongly to things that they can understand and get a feel for… People in this town, don't want this conceptual circle [generated by CommunityViz]. "If you're going to give us a 'no', then tell us where that line is". They want to know that 'the commercial goes right there; am I in or am I out [with my parcel]?" And so, without... being able to draw that down to that kind of [precise] level, people don't get it. - Plateau County Planning & Building Director

Looking forward, the planning staff doesn't envision using CommunityViz again. (No technology transfer or training was offered by Prime Planning Consultants/ Futures Design.). Concludes the Plateau County Senior Planner: "My impression of CommunityViz is that it's a dying technology… I haven't seen CommunityViz do anything that GIS can't do".

Discussion

Cross-Case Comparisons. In this section the four cases are compared relative to factors influencing PSS adoption, and in terms of city planning jurisdictions versus rural planning jurisdictions.

Adoption Factors. Table 5.3 is a predictor-outcome matrix (Miles and Huberman 1994) that summarizes observed influence of eight categories (italicized below and itemized in the table) of PSS adoption factors (Vonk et al. 2005) on use of CommunityViz software in the four cases. Cases were all similar in terms of persuasive influences. All were positively impacted by *provider marketing* efforts, though in the earlier Watertown and Alpine County cases, the influence was from the Orton Foundation developers, in contrast to the consulting firms in the Valley City and Plateau County cases. None of the cases were influenced by *organizational facilitators* as persuasive influences. This may be a factor of the cases all being in smaller sized government organizations with awareness and consideration of use for new technology occurring at a department-specific level, rather than a city manager or county administrator level.

In terms of social influences, both the Watertown and Alpine County cases were again positively influenced by interconnectedness (a component of *social network* influence) of the nascent CommunityViz community of practice of the early 2000s. This was especially true of the Alpine County case, with a high degree of backing from the non-governmental organizations involved. In Valley City and Plateau County, this network did not have an impact on adoption. This was especially difficult to discern in Plateau County, as it was not easy to judge the influence of Valley City’s decision to use CommunityViz on the same decision in Plateau

County. In terms of *social usage*, while the influence of adoption by peers predictably had a positive influence in Valley City, overall it was a neutral factor in the actual adoption decision. In Plateau County, as with social network influences, the impact of peer usage could not be assessed from the comments of the Community Development Director and Senior Planner, with questions remaining on whether Plateau County's decision to select the Prime Planning Consultants / Futures Design team and their proposed methodology was influenced in any way by the fact that their neighbors in Valley City had just utilized the same expertise to complete their plan.

Table 5.2. Influencing factors on PSS adoption

	Alpine County	**Watertown**	**Valley City**	**Plateau County**
Persuasive Influences				
Provider Marketing	POSITIVE+	POSITIVE	POSITIVE+	POSITIVE
Organizational Facilitators	NEUTRAL	NEUTRAL	NEUTRAL	NEUTRAL
Social Influences				
Social Network	POSITIVE+	POSITIVE	NEUTRAL	(NEUTRAL)
Social Usage	POSITIVE	POSITIVE	NEUTRAL	(UNKNOWN)
Adopter Characteristics				
Organizational	NEGATIVE	POSITIVE	NEUTRAL	NEUTRAL
Personal	POSITIVE+	POSITIVE+	NEUTRAL	NEUTRAL
Perceived Innovation Characteristics				
Ease of Use	(NEUTRAL)	NEGATIVE	POSITIVE	NEUTRAL
Usefulness	BOTH POSITIVE & NEGATIVE	NEGATIVE	POSITIVE	NEGATIVE+
Plus (+) signs indicate stronger influence in positive or negative direction. Parentheses ( ) reflect uncertainty (see text for explanation).				

The influence of organizational adopter characteristics was more inconsistent across the cases. Only in the Watertown case could organizational characteristics be deemed a positive influence, and then only because with such a small city staff, the planner and his staff were the organization. In Alpine County, organizational impacts were negative, especially after the departure of the Long-Term Planning Director and champion of the technology. With a change in leadership, support waned and the software was not embraced by either planning or GIS staff. Reinforced by the aforementioned persuasive influences, personal adopter characteristics were very important in Watertown and Alpine County. In both cases, those individuals ultimately responsible for making the decision to adopt were receptive to both computing and innovation in general. In contrast, both the Valley City and Plateau County cases lacked an internal "early adopter" champion.

In terms of perceived innovation characteristics, perceptions of ease of use also varied across the cases. Interestingly, while cited as a negative in Watertown, the difficult learning curve was ultimately overcome and staff now self-identify as proficient in using the application. In Valley City, this characteristics would have to be characterized as a positive influence, but only because all of the use was carried out by the consulting team. The factor was deemed neutral in the other two cases, but for different reasons. In Alpine County, the fact that so many technical experts were involved made it easier to learn and apply the software; in Plateau County, the process never got far enough along for it to be a factor.

The ease-of-use variable includes hardware and data issues, two factors also closely tied to GIS development. Despite different relationships between planning and GIS functions in the four jurisdictions, all could be characterized as possessing mature and well functioning spatial data infrastructures. Relative to GIS and SDI, the cases were also similar in that all jurisdictions are members of both the same state and regional GIS networks. While statewide coordination mechanisms have not been a significant factor in local GIS/SDI development until the last few years (John Gottshagen, CO State GIS Coordinator, personal communication, 25 September 2009), the regional GIS users group in which the jurisdictions participate has been influential. According to the Valley City and Plateau County GIS coordinators, the users group has been in existence since the mid-1990s and has been influential both in coordinating data development, and facilitating data discovery and access across jurisdictional boundaries.

Finally, in terms of usefulness, a positive influence was identified in the Watertown and Valley City cases. This factor proved challenging to assess in that perceptions of usefulness can change with different stages in adoption process (consideration of use, adoption decision, etc.). In only one case – Watertown, has there been continued use since completion of the comp plan. While usefulness was perceived in employing CommunityViz in the Valley City case, it has not been used since the consultants completed their work. For Alpine County, even five years later, the perception of usefulness remains a matter of differing viewpoints, though the software hasn't been used since the former Long-Range Planning Director's departure.

City-versus-county observations. The inclusion of two city cases and two county cases provides an opportunity to explore potential differences between CommunityViz use for city planning versus county planning. In terms of GIS use, cities and counties are very similar, supporting the results of the Phase I survey results which indicated that approximately 80% of all planning departments utilize GIS technology in some fashion (Q15). Because county governments tend to be larger than city governments in rural settings, county staffing for IT and

GIS may be somewhat greater than for cities. Emphasis in planning functions is somewhat different as well. Much of this may be attributed to the significant difference in the size of city versus county jurisdictions in rural areas (in this instance, 3 to 12 square miles versus 2,300 to 3,300 square miles). As described by Plateau County Community Development Director: “Clientele is different. [Countries] deal with lots of people with large acreage... Lots of [natural] resource issues.... All in all, I think when it comes to land use, we’re much more diverse in what we deal with...”. In evaluating CommunityViz function and adoption, the one place where this was reflected was in use of the SiteBuilder 3D module, which was used in both of the city cases but neither of the county cases. The principal for the Futures Design consulting firm and participant in the Valley City and Plateau County cases observed, “I like to use 3D, but it really makes more sense at a neighborhood scale, you know, or a specific plan kind of scale, be it downtowns or neighborhoods where you are literally designing setbacks and things like that.”

Limitations. Two primary limitations of this case research can be noted. First, the CommunityViz applications examined were relatively narrow in scope, and to a certain degree, overlapping in the case of consultant involvement in Valley City and Plateau County. This situation reflects the challenge experienced in identifying viable rural local government cases for analysis, as few seem to exist. As noted in the Phase One survey results, only 40% (70/181) of the respondents (both urban and rural) to the questionnaire indicated that their departments (or consultants) had actual experience applying some type of GIS-based PSS. Further, only 29 respondents indicated personal knowledge or experience with CommunityViz. Of those cases that have been documented, less than one third involved a process led by a rural local government planning entity. Closer evaluation also revealed that almost all documented cases were characterized as unequivocal success stories, perhaps unrealistically so.

A second limitation is that with the exception of Watertown, all cases involved the application of CommunityViz in singular, one-time projects. For this reason, it was difficult to assess the continued use aspect of the PSS Adoption Framework, or to address issues of information system success (Delone and McLean 1992; 2003).

Summary

Though limited to project-level experiences, the case studies provide a viable exploration and description of CommunityViz PSS implementation in rural local comprehensive planning. The study also provides the first known empirical confirmation of the Vonk et al (2005) PSS Adoption Framework. Key factors identified as influencing positive adoption decisions include provider marketing, social network influence and peer usage. Factors identified as adoption barriers include perceived usefulness and ease of use. In all cases, the existence of a mature GIS and SDI infrastructure prior to adoption is universal. Finally, the role of external consultants in facilitating PSS use is identified as critical in three of the four cases.

CHAPTER VI

CONCLUSIONS AND FUTURE RESEARCH

This dissertation has explored the adoption of planning support instruments (PSI) in local government, and the implementation of planning support systems (PSS) – a special type of PSI - in rural local planning settings. The study utilized a two-phase, mixed-method research design to assess current levels of PSI use by local government planning departments, and explore the opportunities and barriers to PSS applications in rural comprehensive planning. A Web-based survey was employed to characterize and assess the extent and nature of PSI use by planning departments in the U.S Mountain West region, inventorying planning office web site content and functionality, community process tools, geographic information systems (GIS) infrastructure and PSS use. Case research, grounded in diffusion of innovation and technology acceptance theory, was conducted on PSS implementations in four rural local governments in Colorado. All cases involved CommunityViz® PSS software in comprehensive planning, and were assessed using a combination of semi-structured interviews and content analysis of administrative and policy-related documents.

Chapter VI summarizes the study's major research findings, highlighting differences between urban and rural planning departments in information and communication technology (ICT) needs and use, and providing a unique demand-side evaluation perspective of PSI and PSS adoption. A discussion of the research's theoretical and methodological contributions is presented, followed by implications of the study's results for planning education and practice. The chapter concludes with an identification of needs and opportunities for future research.

Summary of Research Findings

Current Use of Planning Support Instruments in Local Government Planning. Research Question One (Q1) asked: "How are planning support instruments (PSI) currently being incorporated into local government planning?" That is, what different types of technology are being implemented and for what purposes? What factors influence their adoption and use?

The results of the Phase One survey indicate that, overall, Mountain West planners are capable in adoption and use of information and communications technology (ICT; including planning support instruments, or PSI). The most frequently identified type of PSI technology employed is World Wide Web (WWW) technology, with 86% of all planning departments publishing some type of Web presence. The purpose in PSI use, including WWW applications, is predominately communication (e.g., web site supported meeting announcements and document sharing).

Two a priori propositions are linked to the first research question. Proposition One (P1) posits that most existing PSI implementations focus on well-established technologies. By considering basic Web site functionality and mapping-focused geographic information systems (GIS) to be well-established today, this proposition is assessed to be true. However, the survey and follow-on interviews indicate that few departments use Web technology for any type of feedback or "two-way" interaction with the public. While this lack of functionality supporting citizen input may have changed in the last two years as a result of the exponential growth of social networking applications like FaceBook® and their expanding use by government agencies and non-government organizations in community engagement activities, such applications were not assessed in this scope of work.

Proposition Two (P2) poses that “innovative” PSI use is typically limited to one-time project-specific implementations and more prevalent in urban planning environments. Both direct experience and this research indicate that the first part of this proposition is true. For example, while keypad polling is increasingly being used in university teaching environments, the technology is still considered novel in planning practice, with only 10% of all survey respondents indicating that their department had used the technology in the last five years. The uses of keypad polling identified in this study were all for the public participation phase of a city or county comprehensive plan update. Of those jurisdictions identified as having employed the technology for that purpose, none had used it in any subsequent planning activities. However, as “crowdsourcing” technology (Howe 2006) moves from keypads toward wider use of commonly available ICT appliances (e.g., GPS-enabled mobile telephones), the use of such methods for citizen input will likely increase.

Based on this study, it is difficult to say with certainty that innovative PSI use is more prevalent in urban (versus rural) planning environments. As discussed in Chapter IV, certain differences were identified between urban and rural departments. Among them was the determination that while both urban and rural departments provide web resources in their jurisdictions, urban departments tend to provide more diverse content and more sophisticated functionality. Similarly, Internet GIS functionality was considerably higher among urban departments than rural departments. This is indicative of urban departments in general possessing greater information technology resources to develop innovative applications, including larger IT support staff with more specialized training and access to professional development training.

Rural Planning Support System Implementation. Research Question Two (Q2) asked, "For what reasons are geospatially-enabled planning support systems (PSS) being utilized in rural local government planning, and further, how are they being applied?" Q2 was addressed as a component of the Phase One survey and was also the focus of the Phase Two analysis of four PSS implementations for comprehensive planning related activities in rural planning environments. As discussed in Chapter V, one restriction on this aspect of the research was the limited number of identifiable PSS implementation examples. Only 40% of the Phase One survey respondents indicated that their departments (or contracted consultants) had experience with some type of GIS-based PSS, and less than one-third of these involved a process led by a rural local government planning entity.

Among survey respondents and case participants, the most common reasons for PSS implementation include predictive modeling, trend analysis/forecasting, and impact/scenario analysis. Visualization of existing or proposed conditions did not rank high among users. City and town planners saw more benefit in visualization capabilities than did county planners and indicated that such functionality was more useful in projects with smaller geographic footprints (e.g., main street historic preservation, versus land conversion analysis associated with low-density rural sprawl). One of the ways in which Q2 was addressed was by exploring possible ways in which PSS implementations differ at various stages in the planning process. The corresponding premise (P3) is that use of PSS occurs most often in the “information gathering” and “issue / scenario characterization” phases of the planning process. This appears to be true for PSS implementers as a whole in the Mountain West region. Along with “plan development”, PSS implementers identify PSS use with the early “community engagement” stages of the planning process (i.e., information gathering and issue characterization) and view “communication of information” as being the greatest benefit of PSS use. While not strongly evident in practice, this particular response may reflect a growing recognition by planners over the last 15 years to engage more in “communicative” planning (Innes 1998), influencing public and private actions in direct and indirect ways.

Proposition 4 (P4) further explores implementation reasons by contrasting categories of adoption factors across the planning process, stating: “the relative influence of technical and institutional factors on PSS adoption will vary at different stages in the planning process.” Overall, survey respondents identified “Hardware / software costs”, “Lack of staff”, “Not enough time” and “Lack of training and/or technical support” as factors hindering wider adoption of PSS technology. All of these factors reflect requirements of significant “up-front” or long-term investment of resources. Because they influence all aspects of the planning process, it may be interpreted that adoption bottlenecks have equal influence throughout the planning process and are likely only mitigated when a commitment of resources has been made for either a long-term, comprehensive planning activity or where the frequency of PSS use can justifiably be routinized within an established workflow.

PSS and Spatial Data Infrastructures. Research Question Three (Q3) asked: “How is planning support system implementation in rural local planning affected by spatial data infrastructure (SDI) development?" and what relationships exist between institutional GIS development and PSS use? Two propositions are associated with this question. Proposition Five (P5) proposes that more advanced PSS implementation will coincide with more advanced SDI, and that a well-developed SDI is a prerequisite for enterprise-level PSS implementation. Proposition Six (P6) concludes that despite adoption of GIS and geospatial data development, use of PSS in day-to-day planning process workflows has not been widespread.

Overall, this research indicates that a well-established spatial data infrastructure for a city or county - regardless of whether it was centered in the planning department – was important for successfully supporting adoption and use of PSS technology through data development and software access. As indicated by the Phase One survey results, unlike PSS, GIS technology itself is nearly ubiquitous in planning departments today. Issues related to data (or lack thereof) are no longer significant in most jurisdictions, including rural cities and counties. However, it is concluded here that technical expertise with ICT is often a lynch pin for more sophisticated SDI maintenance and PSS use. While widespread, most GIS use within rural planning departments is limited to map making, tabular queries and basic proximity analysis, with little evidence of use involving more complex analysis. Part of the reason for this unrealized potential is directly associated with insufficient staff size, lack of time, and fiscal resources for hardware/software. However, more sophisticated applications, such as scenario development and indicator-based impact assessment functionalities mentioned above, also require a higher level of knowledge and training with both software capability and problem solving skills.

A sub-component of Q3 asks specifically what roles outside experts (i.e., consultants) play in PSS implementation. This research supports the corresponding Proposition Seven (P7) that consultants play an especially critical role in PSS adoption decisions in rural local planning environments (though not necessarily sustained PSS use). This view point is supported by the case analyses in which consultants are prominent in PSS implementation, all of which involved a tractable, project-specific application with a definable lifespan (i.e., a comprehensive plan update). Interestingly, all four cases studied in-depth were supported by well-established spatial data infrastructures, including adequate GIS hardware and software, data, training, and staff expertise. The PSS expert consultants interviewed in the study indicated that, while not absolutely necessary, the presence of an existing local government SDI greatly improved the efficiency and long-term viability of PSS adoption and use, in particular citing data availability and technical support from a local GIS specialist as key characteristics. In contrast to the local government planners queried, consultants also saw complexity of planning issues and usability as major barriers to use, emphasizing standards and training components of an SDI as also important in fostering PSS use.

Reliability and Validity of Results. Issues of reliability and validity for both the survey and case studies are addressed in Chapter IV and V respectively. With regard to the survey design and administration, it's particularly important to acknowledge the potential for non-response bias in considering questionnaire results. By definition, non-response bias refers to "the mistake one expects to make in estimating a population characteristic based on a sample of survey data in which, due to non-response, certain types of survey respondents are under-represented," (Berg 2005, p. 865). In this study, non-response bias is equated to the difference between the actual results obtained and those results potentially attainable for unit non-responders (in this case, non-participating planning departments). As a Web-based questionnaire with email initiation, exclusion of planning departments lacking email access is a valid concern.

It is acknowledged that because participation required email access, the survey may have utilized a non-representative (or non-random) sample. As described in Chapter IV, a coverage error of 16% was estimated, though this number was minimized through diligent efforts to acquire valid email addresses for as many units as possible in the sample population via telephone and mail contacts. Further, criterion validity measures, based on comparisons with keypad polling of PSI/PSS use by planners attending state and multi-state professional planners conferences in the same region, support the accuracy of questionnaire results. Nevertheless, conservative interpretations should consider a slight decrease in overall planner ICT use percentages, if attempting to estimate the impact of non-response bias.

As discussed in Chapter V, reliability concerns with the case study analyses (i.e., "demonstrating replicability with similar results" (Yin 2003, p. 33-39)), were addressed by establishment and adherence to formalized case study protocols and scripted, semi-structured interviews. Construct validity – "establishing correct operational measures for the concepts being studied" (Yue 2010, p. 959) - was addressed by utilizing multiple sources of evidence and conducting second interviews with certain individuals to ensure accuracy and clarification. Due to the relatively narrow topical focus of case studies involved and the emphasis of empirically validating the PSS Adoption Framework, internal validity, that is, the establishment of causal relationships (Yin 2003), was confined to examining the impact of SDI presence and maturity of PSS adoption. Similarly, external validity – specifying the generalizability of results (Yin 2003) – was somewhat confined to comprehensive planning applications of PSS implementation (though such applications are by far the most widely identifiable use of the CommunityViz software application, not only in the Mountain West, but throughout the United States).

Theoretical and Methodological Contributions

Empirical Validation of Existing Information System-Based Theory. This research makes theoretical contributions to the fields of geography and planning in several significant ways, in particular responding to past and current calls for more theory-building case studies on PSS use (Harris and Batty 1993; Geertman 2006). First, the case study analyses empirically validate aspects of the PSS Adoption Framework presented by Vonk et al. (2005). Introduced in Chapter II, the PSS Adoption Framework integrates aspects of both technology acceptance and diffusion of innovation theories and combines both organizational and individual factors determining PSS adoption in a mutual top-down and bottom-up process.

Overall, the research supports the individual user acceptance constructs of the Framework: "ease of use"; and "usefulness". While both factors weigh heavily into individuals' and organizations' intentions to adopt and use PSS technology, ease of use is particularly important for smaller staffed, less technically innovative rural planning departments. In terms of "persuasion" and "social" influences the case analyses revealed "provider marketing efforts" to be the most influential persuasive factor and "social usage" to be the most important social influence. As discussed in Chapter V, this reflects the fact that PSS technology (including the CommunityViz software application studied in the cases) is still a relatively new innovation and current users may still be characterized as innovators and early adopters (Rogers 2003). Subsequently the PSS/CommunityViz "community of practice" is a relative small and close-knit one, manifesting in strong influences among peers and between technical experts and engaged users.

“Personal” adopter characteristics align closely with the dominant persuasion and social influences, reflecting individuals with strong personal interests in technology innovation, beliefs in the value of technology, and a willingness to adopt and apply innovative solutions regardless of whether formal training and technical support is available. Organizational adopter characteristics (i.e., organization size, structure and innovativeness) were not significant factors in any of the cases studied, reflecting bureaucratic structures to be of lesser importance in PSS adoption in rural planning environments which are typically supported by smaller staff sizes and information system infrastructures.

Finally, the case study analyses provided limited validation for four out of five of the Framework’s diffusion factors: “awareness”; “consideration of use”, “intention to use”, and “adoption decision” (based on Roger’s Innovation-Decision Process (2003)). The validation is considered limited in the sense that, in the Framework, the decision process was viewed from an individual (rather than organizational) viewpoint, and that CommunityViz adoption in all cases studied was ultimately the choice of an individual planner or team of two to three individuals. The final stage in the Innovation-Decision Process – “continued use” – was not formally assessed in the case analyses. This was due primarily to limitations in research design associated with the relatively small case sample and the single-project nature of available cases. Such an assessment would also necessarily require explorations of information systems success and related theories (see Future Research section below). Initial conclusions recommend a reconsideration of including this final factor in the adoption framework.

Methodology Refinement. A second contribution of this work is found in the domain of case research methods, and more generally, mixed-method research methodology. During the

1990s, both geographers and planners studying GIS implementation adopted case study research methods originating in the information systems (IS) field (Onsrud et al. 1992; Masser and Onsrud 1993; Budic 1994; Robey and Sahay 1996; Sahay and Robey 1996; Assimakopoulos 1997). Since then however there has been a noticeable paucity of research along these lines. At GIScience 2000 in Savannah, GA, the first in an ongoing series of international conferences on geographic information science, Nedovic-Budic (2000b, p. 260) argued for pursuing more mixed-method research opportunities with the benefit of "… more comprehensive and diverse perspectives on the representation of spatial phenomena and the use of geographic information". A decade later, this idea has not been realized. While a handful of studies exist describing mixed-method research that uses GIS (i.e., "studies with GIS"), the literature is scant in similar approaches on "studies about GIS".

This dissertation demonstrates the mixed-method approach advocated by Nedovic-Budic, revisiting the qualitatively-oriented case study approach and combining it with complementary quantitative methods. The dissertation's research design is uncommon in its sequential quantitative-qualitative chronology. In common practice, sequential mixed designs pursue exploratory and confirmatory questions chronologically in a prespecified order. Most typical for an exploratory study is a qualitative-quantitative sequence (Teddlie and Tashakkori 2009). However, Phase One of this study used a quantitative survey instrument to first explore the nature and extent of current PSI use in local government planning departments, followed by a more explanatory-focused qualitative component with the Phase Two case study analyses. The design was also non-traditional in incorporating a second, parallel qualitative component- a series of interviews with identified PSS experts – conducted throughout both phases of the study.

It is recommended that future mixed methods approaches in geographic information studies consider such design variants and hybrids.

Planning Theory Linkages. More than forty years ago, Britton Harris explored planners' nascent use of computers in calling for strengthening linkages between the science of planning (theory) with the science in planning (methods and technologies) (Harris 1967). Beginning even earlier, many philosophically diverse theories of planning have been developed (Alexander 1998). Hoch (1984) however, argues that despite a breadth of philosophical positions, all of the most well-developed American planning theories incorporate common attempts to bridge the gap in planning between "doing good" versus "doing right" (p. 335). He notes that this duality of planning has oft been cited in the planning literature under a variety of labels, including "art and science", "politics and rationality" or "means and end" (Hoch 1984, p. 335). Planners interested in doing good view planning as a "predominantly moral and political occupation... [justified] in terms of the good effect it will have". In practice this may be equated to short-term planning projects with concrete (though sometimes fragmented) benefits. In contrast, planners interested in being right, "focus on the methodological or technical qualities of planning activities...", referring to the validity and reliability of the analytical procedures used to justify them. In practice, this perspective has been associated with comprehensive plans and planning for the purpose of achieving long-range (but often abstract) goals (Hoch 1984, p. 335). Hoch further posits that the philosophy of pragmatism underpins all of these planning paradigms through three major pragmatic concepts: (1) problem definition as a form of experience; (2) plan formulation as a form of inquiry; and (3) plan implementation as a form of democratic participation.

The dialectic views of doing good and being right provide a potentially useful context for extending this study further within a theoretical framework of planning. Based on the results presented here, it can be argued that while some PSI technologies support shorter-term and concrete project-specific needs (doing good), most of the PSS identified have been developed for conducting longer-term comprehensive planning applications (being right). While this emphasis may be shifting (see Insight for Developers section below), tying PSS design to a more pragmatic-based "middle ground" justification could provide opportunities for sustainable integration of PSS in daily planner workflows in the future.

Implications for Planning Education and Practice

Curricular Considerations. Participants in both the survey results and case study interviews alluded to the need for planners to obtain more formal education in GIS and planning support technologies. During the last ten years, this need has been addressed to a certain extent within the planning discipline for GIS, with Montagu (2001, p. 192) advocating for "… instructional strategies that contextualize GIS as an integral part of the planning process". Relative to ICT skills, Hoyt (2002, p.35) provides a conceptual framework for ICT instruction that is "… place-based, planning-relevant... and [complimentary to] departmental philosophy". While planning departments continue to refine approaches blending theory and applications, academics note that they can't change their curriculum every time a new technology product is introduced and must rather focus on concepts over technology familiarity (Ahern 2008).

Based on this study's results, it is recommended that academic planning departments continue to pursue a curriculum that goes beyond basic computer literacy (i.e., rote learning of specific hardware and software applications) to also include technology fluency, focusing on understanding underlying concepts of technology and applying problem-solving and critical thinking using technology (NRC 1999; 2002). Given the place-based nature of the planning discipline and its practice, such teaching should also extend to incorporate spatial literacy in learning, emphasizing knowledge about geographic space, how it may be represented, and spatial reasoning to support decision-making activities (NRC 2006). Teaching planning students these concepts will enable them in the future to more easily acquire new skills independently after their formal education is complete and competently adapt to continuously changing ICT environments throughout their careers. This, in turn, could have positive influences on adoption and use of more complex PSS, by providing planners with stronger and more relevant personal adopter characteristics necessary for successful implementations.

Support for Practicing Planners. In practice, even newly graduated planners are often faced with a much less sophisticated technology environment than what they were exposed to in planning school, where students benefit from both a forward-thinking learning environment and state-of-the-art information infrastructures (Ahern 2008). With this in mind, practicing planners would benefit from expanded professional development opportunities offered by professional organizations (e.g., the American Planning Association's Technology Division webinar series).

Another concept to assist in raising awareness about ICT applications and benefits include planning support regional resources centers, combining support staff and access to technology to assist communities (especially those with limited staff and budget) in conducting scenario-based planning and alternatives evaluation (Henton 2001). Initial examples of such resources from academia and the private sector include: PlaceMatters, Inc. (www.placematters.org), the USDA Cooperative Extension Service's National Geospatial

Technology Extension Network (www.geospatialextension.org); and the University of Wyoming Plan-IT Wyoming Initiative (www.planitwyoming.org).

Many of the information resources devoted to ICT and planning support include directories describing the functionality of various PSI and PSS and organized by functionality and/or application. What is often lacking, however, is useful guidance on how planners and planning departments can successfully implement these technologies, especially more complex PSS. A need exists for development of accessible and understandable best practices to assist in PSS implementation. Based on the research presented here, such guidance could incorporate both a typology of PSI contextual dimensions (Figure 6.1), and a set of first principles for PSI implementation.

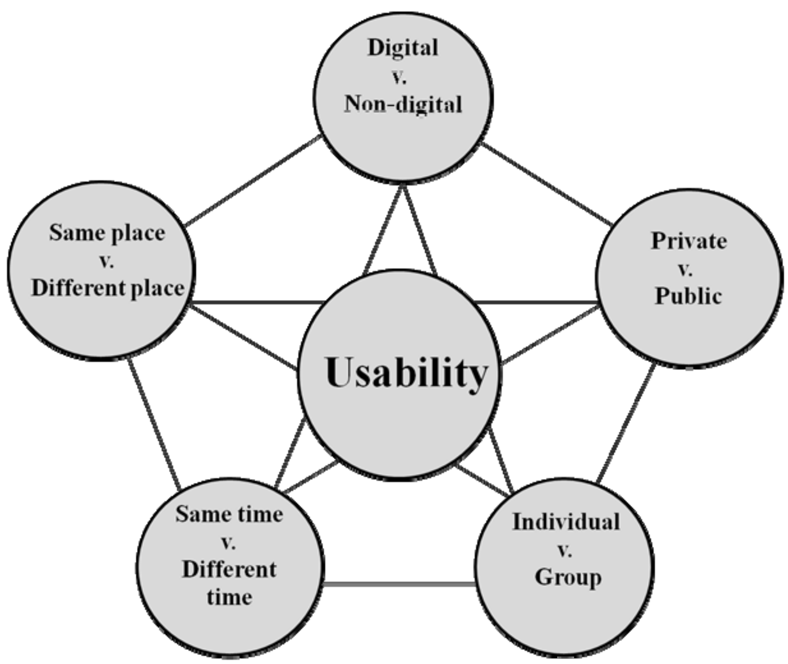

Figure 6.1. Planning support instrument usability dimensions.
Source: Hamerlinck, J.D. 2010. Implementing Planning Support Tools: Trends & Best Practices for Adoption & Use, a national webinar presented as part of the American Planning Association PDO 2009-2010 webinar series. Sponsored by the APA Technology Division, 14 May 2010.

A recognizable starting part with the implementation process is to carefully define needs and feasibility constraints and then select technology accordingly. Associated factors in such an assessment include determining the contextual setting for the PSI application (e.g., public process versus in-house analysis) and identifying necessary supporting resources (i.e., staff, data, network connectivity). A second principle urges caution before climbing on the bandwagon of "early adopter" trends. This supports a "try before you buy" maxim and urges planners to proceed incrementally with new technology at each stage of significant "new" investment. Though not always without challenges, this research also reinforces the long-term value in planning department coordination with their jurisdiction's Information Technology Department, in order to ensure compatibility and support with underlying operating systems and network configurations. This is particularly important for PSS implementation, given the necessity of maintaining a strong and flexible underlying GIS foundation. Finally, it's important to recognize when to utilize outside expertise when implementing PSI/PSS technology. Many forms of assistance are available, including third-party consultants. When relying on outside assistance, it's also important to negotiate for training and other forms of technology transfer and to understand options for long-term support beyond the initial timeframe of the initial project.

Insight for Developers. Finally, putting this work into context for developers on the supply side of PSS, more attention should be paid to understanding the ICT needs of planners in varying contexts. To date, most PSS development has been in the application area of “plan making”. Given past difficulties in securing wider adoption and use, it appears that the pendulum may in fact be swinging back to more narrowly-defined, task specific applications, to support for example, the needs of planners in general administration and development control (Yeh 2008). One promising supply-side example reflecting this change in emphasis is the Performance

Planning System (PPS) software, a computer-aided design (CAD)-GIS hybrid site planning application from Neighborhood Innovations, LLC (Golden Valley, MN). Based on the Prefurbia design concepts of Richard Harrison (Harrison 2009; Brite 2009), PPS may be characterized as a highly specialized PSS applications, specifically targeting site design at the parcel-level intersection of landscape design and site engineering.

Over the last 15 months, a renewed interest has also emerged in integrating geographic analysis and design in a wide range of applications, including land use planning. Termed GeoDesign, the concept is characterized as "… a design and planning method which tightly couples the creation of design proposals with impact simulations informed by geographic context" (Zwick 2010, p. 20). First considered by academics, developers and practitioners convened at a multi-disciplinary summit hosted by Environmental Systems Research Institute in Redlands, CA in January 2010, it's too early to evaluate whether the concept is something new or another repackaging of planning and GIS technology integration (Vargas-Moreno 2010). As a participant in the January 2011 GeoDesign event convened in follow-up to the original summit, it is my observation that the concept is centered on bringing geography and geographic information into design-centered processes and in "scaling up" design processes from traditional building and site project scales to broader geographic footprints. In this sense, GeoDesign shares some qualities with the land use design process articulated by planners Kaiser, Godschalk and Chapin, Jr. (1995), which emphasizes spatial land use patterns in resource allocation and development; such linkages may have merit as a future focus for PSS development. Relative to GeoDesign-based ICT development, a great deal of initial attention has been paid to incorporating "sketching" functionality into GIS environments. Other areas of interest in the GeoDesign ICT arena include applications capable of supporting spatially-informed models, iterative evaluation of future scenario alternatives, and support for stakeholder participation (Abukhater and Walker 2010). Interestingly, all of these functions may also be associated with existing PSS development efforts. One difference with GeoDesign however, may be a broader purpose in including architects, landscape architects and engineers as potential end-users, in addition to the recognized community of planners who more exclusively have constituted the focus of PSS.

Future Research Needs and Opportunities

The research presented here constitutes a small piece of the overall body of work conducted over the last ten years on planning support technology development and implementation. It is evident that, while most planning departments are proficient in basic ICT use, many planning support technologies do not address practicing planners' real needs, and are either technically too difficult to use or require more personnel and fiscal resources than most departments have at their disposal. Despite collective contributions in identifying and understanding implementation barriers, a need exists for further investigations of technology diffusion, acceptance and adoption in order to achieve wider PSI and PSS use by planners, and increase the effectiveness of the technology in both specialized and routine planning workflows.

Several potential extensions of this dissertation can be identified. In terms of general PSI use in local government, research should be undertaken on the effectiveness of Web 2.0 technology on community engagement in planning activities. A major challenge with assessing such use is the difficulty in asking timely questions about emerging technology, given their rapid and constant evolution. Another challenge is a potential bias favoring research participants who already possess a certain level of awareness about these cutting edge technologies, including familiarity with the jargon that characterizes them.

Relative to PSS use in local government, more examples of rigorous case research need to be conducted (as opposed to the atheoretical promotional cases that dominate existing examples). One potential source for identifying other viable PSS adoption cases lies in applications involving integrated land use-transportation planning. Along this line of inquiry, a follow-up study to this dissertation is under consideration, exploring the use of PSS applications in a selection of Metropolitan Planning Organizations (MPOs) and Councils of Government (COGs) in Colorado and Utah over the coming several years.

Extending PSS evaluation to other, non-planner actors in complex planning processes is also a viable future direction for this research. As discovered in this study, external consultants continue to play a significant role in current PSS adoption decisions. This role should be explored further in terms of both motivation and benefit for the consulting community as well as their clients. Other groups increasingly engaged in planning support technology applications include citizen groups and non-government organizations (NGOs), both of whom warrant comparison with use by training planning professionals.

Finally, the opportunity exists to evaluate not only indicators of adoption, but PSS success as well. This could extend previous research on models of success in information systems research. Examples include multiple variations of the Delone and McLean (1992; 2003) IS Success Model which assesses constructs associated with use, user satisfaction, and net benefits. Such research will be dependent on PSS adoption growing considerably over the next three to five years and planning entities being are able to sustain ongoing use of the technology.

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APPENDIX A

PLANNING SUPPORT SYSTEM SUPPLY-SIDE EXPERTS

Elliot Allen (Developer)
Principal
Criterion Planners (Index software)
Portland, OR

Patrick Crist (Developer / Consultant)
Director/Conservation Planner
NatureServe
Boulder, CO

Brenda Faber (Developer)
Principal
Fore Site Consulting, Inc.
Loveland, CO

Richard Harrison (Developer)
Principal
RHSD Studio
Golden Valley, MN

Dick Klosterman (Developer)
Principal
What If?, Inc.
Hudson, OH

Steve Mullen (Consultant)
Principal
FOREsee Consulting, Inc.
Lyons, CO

Milton Ospina (Developer)
Enterprise Americas Biz Development Mngr
NAVTEQ (formerly with ESRI, Inc.)
Denver, CO

Gabe Preston (Consultant)
Senior Associate
RPI Consulting
Durango, CO

Breece Robertson (Developer/Consultant)
National GIS Director
Trust for Public Land
Santa Fe, NM

Doug Walker (Developer)
Principal
Placeways, LLC
Boulder, CO

Ken Wall (Consultant)
Geodata Services, Inc.
Missoula, MT

Steve Ventura (Consultant)
Director Rural GIS Consortium
University of Wisconsin-Madison
Madison, WI

APPENDIX B

PLANNING SUPPORT SYSTEM EXPERTS BACKGROUND INFORMATION

[provided to interviewees for review prior to interview]

Note: the following information has been reformatted to conform to dissertation style requirements:

Planning Support System Experts Interview Protocol

Thank you for agreeing to participate in the planning support system (PSS) experts interview portion of our research project. The purpose of this activity is to gain some "supply-side" insight from PSS technology developers and consultants on opportunities and barriers to PSS implementation in local government (i.e., city and county) planning, and especially rural planning environments. The input received will be combined with "demand-side" data collected through an online survey of approximately 200 local government planning agencies in the U.S. Mountain West region and will assist in selecting three to four case study PSS implementations for more in-depth study.

For purposes of this study, **planning support systems** are defined as,

> …*geoinformation-technology-based* [planning support] instruments that incorporate a suite of components (theories, data, information, knowledge, methods, tools) which collectively support all or some part of a unique professional planning task (Geertman 2006; 864).

PSS developers are defined as individuals with competencies and significant experiences associated with the PSS software development process, including some combination of design and coding, software project management, and software product management. PSS developers may also contribute to the overview of the project on the application level rather than component level or individual programming tasks. ***PSS consultants*** are defined as individuals with competencies and significant experience in the use and application of PSS technology and who have demonstrated experience in assisting other individuals or organizations with the adoption and use of PSS software.

Interviews will be conducted primarily via telephone. Interviews are semi-structured in nature and should not require more than 45 minutes to complete. In addition to a few background experience questions, the interviews will include a standard series of seven to eight questions regarding the interviewee's opinion on PSS adoption and use (see sample questions on second page). Interviewees will also be asked for suggestions on past or ongoing PSS implementations for case study review.

Administration of these interviews has been approved by the Human Subjects Institutional Review Board of the University of Wyoming, Laramie, Wyoming. Unless you object, the interview will be recorded for accuracy purposes. The ten to twelve experts interviewed will be listed with their current affiliation in an appendix to the project's final publication. However, all individual responses will be confidential and reporting of results will maintain individual anonymity unless permission is explicitly granted by the interviewee.

APPENDIX C

PLANNING SUPPORT SYSTEM EXPERTS INTERVIEW SCRIPT

1. How many years experience have you had working with and around PSS technology?

2. Would you consider yourself a PSS software developer, a PSS application consultant, or both?

3. In your opinion, how is a PSS different than a GIS? What does it provide that can't be achieved with standard GIS functionality?

4. How important is the existence of a well-established GIS infrastructure for successful PSS implementation?

5. Based on your experience, how would you characterize the usefulness of PSS applications for the various stages of the planning process:
    a. Public input, issue identification, visioning, goal setting
    b. Inventory of existing conditions, trend analysis
    c. Scenario design and development
    d. Impact assessment
    e. Plan development
    f. Plan implementation and monitoring

6. Based on your experience, how would you characterize the usefulness of PSS applications for the following types of information technology functions:
    a. Data storage and management
    b. Query and analysis
    c. Visualization
    d. Modeling
    e. Communication

7. To what extent do the following end-user groups benefit from PSS application?
    a. Professional planners
    b. Elected officials / administrators
    c. GIS specialists
    d. Citizens
    e. Professional stakeholders (NGOs, etc.)

8. What roles and impacts do you think outside experts have in PSS application in local government planning?

9. In your opinion, what are the greatest barriers / challenges to wider PSS use in local government planning?
    a. Does this vary between urban and rural planning settings?

10. What are the greatest opportunities for increasing PSS utility and impact in local planning?

11. We are hoping to identify examples of PSS implementation and use in local planning settings in the eight state mountain west region (AZ, CO, ID, MT, NV, NM, UT, WY). We are especially interested in small town/rural applications in Colorado.
    a. Examples could be perceived as successes or failures.
    b. Other influencing factors on case study selection include:
        i. level of PSS implementation;
        ii. uniqueness of (planning process) situation;
        iii. extremeness or “non-uniformity” of examples;
        iv. willingness of planning department to participate in case study analysis
        v. ability to generalize results.
    c. Do any case studies come to mind?
    d. Do you have a local name and contact info with whom we can follow-up?

12. Looking forward, what are the greatest opportunities for increasing PSS utility and impact in local planning?

13. Are there any other PSS experts/developers you’d recommend we speak with?

APPENDIX D

SURVEY QUESTIONNAIRE SCREEN LAYOUT

Information Technology & Local Government Planning

Page 1

INTRODUCTION

Thank you for agreeing to participate in this survey on Information Technology and Local Government Planning in the Mountain West. Your responses will be invaluable in helping other practitioners and researchers gain a clearer understanding of the role and impact of information technology on planning practices.

INSTRUCTIONS

There are four parts to the survey, covering about 30 questions in total:

Part I: You and your planning department
Part II: Your department's use of the Internet
Part III: Your department's use of GIS
Part IV: Decision support system technologies

During the survey, please do not use your browser's FORWARD and BACK buttons. Instead, use the buttons provided at the bottom of each survey page to navigate through the questionnaire.

By providing your email address, you are eligible to receive a copy of the summary of the survey results.

Those completing the survey may also enter a drawing to win a Brunton recreation-grade GPS receiver and collection of GIS books from ESRI Press.

It is estimated that the survey will take approximately 15 minutes to complete.

GETTING STARTED

To begin the survey, enter a valid email address in the space provided and click the "Next" button below. In doing so, respondents consent to the use of the information they supply during the course of this survey. All personally identifiable information will be kept confidential.

1. **Your email address:***

Information Technology & Local Government Planning

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PART I: YOU AND YOUR PLANNING DEPARTMENT

This section of the survey asks for information about you and your planning department. All data provided will remain confidential and used only for the research purposes previously described.

2. Your Contact Information
(valid email required to receive summary of results or to enter GPS and book lottery)

Name:

Position title:

3. What local government office are you representing in this survey?

Department name:

Name of city or county government:

Street address or PO box:

City:

State:

Zip code:

4. How many full-time or full-time equivalent staff does your department employ?
(include office/clerical staff and yourself)

- ◯ Less than 1
- ◯ 1
- ◯ 2 - 3
- ◯ 4 - 5
- ◯ 6 - 10
- ◯ More than 10

5. Which of the following best describes your department's service area?

◯ City ◯ County ◯ Joint City-County
◯ Other, please specify

6. What is the estimated population served by your department?
(no commas)

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7. Which of the following functions does your department perform in your service area?
(check all that apply)

- ☐ Zoning administration
- ☐ Subdivision administration
- ☐ Building permit administration
- ☐ Rural addressing
- ☐ Mapping / GIS
- ☐ Comprehensive planning

8. For which of the following activities has your department contracted with an outside consultant in the last five years?
(check all that apply)

- ☐ Zoning code revisions
- ☐ Subdivision code revisions
- ☐ Land use / build-out analysis
- ☐ Transportation analysis
- ☐ Housing analysis
- ☐ Recreation / open space analysis
- ☐ Environmental analysis
- ☐ GIS development / implementation
- ☐ Comprehensive plan development or update

9. Which of the following is currently being used by your planning department?
(check all that apply)

- ☐ Permit tracking software
- ☐ Zoning / code enforcement software

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10. In what year did your planning department's service area (i.e., city or county) complete its most recent comprehensive plan update?

11. Which of the following group community process tools has your planning department used for planning purposes in the last five years?
(check all that apply, and include use by hired consultants)

- ☐ Visual preference survey / before-after photography
- ☐ Board games (i.e., future land allocation; e.g., Chip Game)
- ☐ Miniature modeling (i.e., creating physical models from found objects; e.g., Box City)
- ☐ Key pad polling (i.e., "clicker" surveys)

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PART II: YOUR DEPARTMENT'S USE OF THE INTERNET

This section of the survey asks for information about your department's use of the Internet and World Wide Web technology.

12. Does your department have a web presence?*

◯ Yes ◯ No

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13. Which of the following best describes your web presence?

◯ Planning department has an independent web site

◯ Part of another group's web site

14. Which of the following items are currently provided through the department's web site?
(check all that apply)

☐ Staff contact information

☐ Meeting information

☐ Planning documents

☐ Maps

☐ Photography collections

☐ Audio / video files

☐ Application forms (permits, variances, etc.)

☐ Feedback / question form

☐ Online surveys

☐ Email subscription lists

☐ Interactive comment/discussion (forums, blogs, wikis)

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PART III: USE OF GIS TECHNOLOGIES

This section of the survey asks about GIS use in your department and city or county.

15. Does your department currently use GIS? *

○ Yes ○ No

Screen captures continued on next page.

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16. Which of the following best describes your department's GIS use?

- ◯ Planning Department maintains its own, stand-alone system
- ◯ Planning Department utilizes a system maintained by another department
- ◯ Planning Department shares maintenance of a system with one or more other departments
- ◯ Other, please specify

17. Which of the following kinds of "reference" GIS digital data layers are available and used by your department?
(check all that apply)

- ☐ Orthoimagery
- ☐ Transportation
- ☐ Hydrography
- ☐ Land ownership
- ☐ Elevation
- ☐ Administrative boundaries
- ☐ Geodetic control

18. Which of the following "planning-specific" GIS data layers are available digitally and used by your department?
(check all that apply)

- ☐ Zoning designations
- ☐ Census units - tracts, blocks, etc.
- ☐ Utilities - water, sewer, electrical, etc.
- ☐ Building footprints or centroids
- ☐ Special districts - school, voting, etc.
- ☐ Land use categories

19. Are planning-related GIS data and/or mapping applications for your service area accessible through the Internet?

- ◯ Yes
- ◯ No
- ◯ Don't know / unsure

20. For which planning functions has GIS been applied in your department during the last five years?
(check all that apply)

- ☐ General map making
- ☐ Zoning administration
- ☐ Subdivision review
- ☐ Code enforcement
- ☐ Resource analysis (environmental, cultural, etc.)

Question #20 response options continued on following page.

Continuation of Question #20 response options:

- [ ] Rural addressing
- [ ] Comprehensive plan development / implementation
- [ ] Other, please specify

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21. Overall, how coordinated is GIS development and use in your department's jurisdiction (i.e., city, county, etc.)?

- Not coordinated
- Somewhat coordinated
- Coordinated
- Very coordinated
- Not applicable

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PART IV: USE OF DECISION SUPPORT TECHNOLOGIES

In addition to the types of information technology previously discussed, planners sometimes use more sophisticated visualization, analysis, modeling and expert system tools to support decision making at various stages in a planning process.

22. Please identify which of the following planning decision support applications you have worked with as a professional planner:
(check all that apply)

- [ ] VISTA (NatureServe)
- [ ] Place3s (US Department of Energy)
- [ ] What If? (Klosterman)
- [ ] INDEX (Criterion Planners)
- [ ] CommunityViz (Orton / PlaceWays)

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23. Which of the following types of decision support technologies have been used in your planning department's activities during the last five years?
(check all that apply, and include use by hired consultants)

- ☐ Trend analysis / forecasting
- ☐ 3-D visualization / animation
- ☐ Impact / scenario analysis
- ☐ Predictive modeling of future conditions (e.g., population growth, land use change, etc.)

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24. You indicated that either you or a consultant used some of the technologies listed on the previous page. For which of the following tasks was the technology used?
(check all that apply)

- ☐ Issue identification, visioning, goal setting
- ☐ Inventory of existing conditions, trend analysis
- ☐ Scenario design and development
- ☐ Scenario and impact assessment
- ☐ Plan development
- ☐ Plan implementation / monitoring
- ☐ Other, please specify

25. When applied, how did these technologies impact the following aspects of decision-making making effectiveness?

	Negative Impact	No Impact	Positive Impact	Don't Know
Decision-Making Time	○	○	○	○
Explicitness of Decisions	○	○	○	○
Identification of Conflicts	○	○	○	○
Communication of Information	○	○	○	○
Confidence in Analysis	○	○	○	○
	Negative Impact	No Impact	Positive Impact	Don't Know

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26. What is your perception of the potential usefulness of decision support technologies in local government planning?

- Not Useful
- Somewhat Useful
- Very Useful

27. In your opinion, what are the 1st, 2nd and 3rd greatest barriers to wider decision support system technology use in local government planning?
(Enter a "1" for greatest barrier, "2" for second greatest barrier, and "3" for 3rd greatest barrier)

- Hardware / software costs
- Inadequate data
- Lack of needed functionality
- Lack of staff
- Apprehension to work with new technology
- Lack of training and/or technical support
- Not enough time
- Lack of administrative support

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WRAP-UP

28. With respect to adoption and use of technology, how would you characterize your department?

- ◯ Technologically advanced-on the cutting edge
- ◯ Technologically capable
- ◯ Somewhat technologically capable
- ◯ Not very advanced technologically
- ◯ Extremely low technological capability

29. How would you rate the overall importance of information technology in local government planning?

- ◯ Very important
- ◯ Important
- ◯ Somewhat important
- ◯ Unimportant

30. Is there anything else you'd like to share about your experiences with information technology in the planning profession, or about this survey in general?

31. Would you like to be notified when a summary report of the survey results has been published?

◯ Yes ◯ No

32. Would you like to be entered into the drawing for the Brunton GPS receiver and ESRI Press GIS book collection?
Winner will be announced by September 15, 2008.

◯ Yes ◯ No

APPENDIX E

SURVEY SAMPLE CORRESPONDENCE

Initial Contact: Pre-Survey Letter (15 June 2008)

UNIVERSITY
OF WYOMING

Information Technology and Local Government Planning in the Mountain West

www.planitwyoming.org

A research project of the Plan-IT Wyoming Initiaitive
at the University of Wyoming

June 15, 2008

Dear colleague:

The University of Wyoming is currently undertaking a new research project titled *Information Technology and Local Government Planning in the Mountain West.* The project concerns the opportunities and challenges in adopting and using information technologies such as web sites, online mapping and geographic information systems in city and county planning practice.

Using a Web-based questionnaire, we're attempting to survey the primary city and county planning agency in each of the 280 counties in the states of Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah and Wyoming. Results from the questionnaire will be used to better understand the unique needs of local government planning agencies and in turn will assist in educating planning professionals about the wide range of planning technologies available to them.

Based on input from public web sites and available published directories, you have been identified as the person most appropriate for providing information about your city or county's planning agency. Within the next week, you'll be receiving an email message inviting you to participate in the survey with a web link for accessing the questionnaire. We hope you'll take a few minutes out of your busy schedule to reply. As incentive to participate, all respondents will be eligible for a one-time lottery opportunity to win a recreation-grade GPS receiver from Brunton, Inc. or a collection of planning-related GIS books from ESRI Press.

Our records indicate that your current email address is: <email@address> .

If this is not correct, or if you'd prefer that someone else in your office or a different department respond to the survey, feel free to email me that information at *itasca@uwyo.edu* with "IT and Planning Survey" in the Subject line. Or, when your email invitation arrives next week, you may forward it along to the most appropriate person to respond.

Once again, please watch for an email invitation in your Inbox soon. Thank you in advance for your time and consideration. It's only with the generous help of people like you that this research can be successful in better understanding and benefitting our profession.

Sincerely,

Jeff Hamerlinck, AICP
Project Manager, Information Technology and Local Government Planning in the Mountain West
Dept 4008, University of Wyoming, Laramie, WY 82071
Ph: (307) 766-2736   FAX: (307) 766-2744   Email: *itasca@uwyo.edu*

Second Contact: Initial Email Invitation (10 July 2008)

FROM: Jeff Hamerlinck, AICP
SUBJECT: IT & Local Government Planning Survey

Dear Colleague,

I am writing to ask your help in a study of city and county planning agencies in the Mountain West Region of the United States. This research is being undertaken by the University of Wyoming to learn more about the current and potential use of information technology (e.g., web sites, GIS, decisions support systems) by planning professionals in the workplace.

Using an online, Web-based questionnaire, we are attempting to survey the primary city and county planning agency in each of the 280 counties in the states of Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah and Wyoming.

Results from the questionnaire will be used to better understand the unique needs of local government planning agencies and in turn will assist in educating planning professionals about the wide range of planning technologies available to them.

Based on input from state planning organizations and local government web sites, you have been identified as the person most appropriate for providing information about your agency. The survey is voluntary. However, you can help us very much by taking a few minutes to share how information technology currently is and isn't be used in your agency.

If you'd prefer to have some else in your office respond in your place, please feel free to forward this email to the appropriate person.

Responses are completely confidential and will be released only as summaries or anonymous quotes in which no individuals, agencies or jurisdictions can be identified. However, if you choose to do so, your name will be included in a one-time opportunity to win a recreation-grade GPS receiver from Brunton, Inc. (Riverton, WY) or a collection of planning-related GIS books from ESRI, Inc. (Redlands, CA).

The online questionnaire may be accessed by clicking on the following web link address (or by entering the address directly into the location bar of your Web browser):

https://survey.uwyo.edu/TakeSurvey.aspx?EID=981B4p46B865B1m533B776BM453B74J

If you experience difficulty in accessing and/or completing the questionnaire or if you have any related questions or comments about this study, please feel free to email me at *itasca@uwyo.edu* , or you may contact me by telephone at (307) 766-2736.

Thank you very much for helping with this important study.

Sincerely,

Jeff Hamerlinck, AICP
Project Manager, IT & Local Govt Planning in the Mountain West
Wyoming Geographic Information Science Center
University of Wyoming
Laramie, WY 82071

Sample Email Reminder (Three sent in total)

FROM: Jeff Hamerlinck, AICP
SUBJECT: IT and Local Gov't Planning Survey - Reminder

Dear colleague,

About two weeks ago, we sent you an email invitation to participate in an online survey being conducted by the University of Wyoming on the use of information technology in local government planning offices.

This message is a reminder of that invitation and a request that if you haven't already responded, to please do so soon. We realize this is a busy time of year for planners and we will be especially grateful for your input in helping us better understand the current extent and barriers to information technology use in planning practice throughout the Mountain West Region. As mentioned before, all answers are completely confidential and will be released only as summaries or anonymous quotes in which no individuals, agencies or jurisdictions can be identified.

You may respond to the survey by clicking on the following link:

#SurveyLink#

As before, if you'd prefer to have some one else in your office or another department respond in your place, please feel free to forward this email to the appropriate person. (If you've already done so, please ignore this email.)

If you experience difficulty in accessing and/or completing the questionnaire or if you have any related questions or comments about this study, please feel free to email me at *itasca@uwyo.edu* , or you may contact me by telephone at (307) 766-2736.

Thanks once again for helping with this important study.

Sincerely,

Jeff Hamerlinck, AICP
Project Manager, IT & Local Govt Planning in the Mountain West
Wyoming Geographic Information Science Center
University of Wyoming
Laramie, WY 82071

APPENDIX F

QUESTIONNAIRE RESPONSE SUMMARY

This appendix supplements the presentation and discussion of the survey questionnaire results in Chapter IV. It contains frequency/percentage response summaries for all questions asked in the survey with a nominal or ordinal measurement-level response (excluding questions pertaining to respondent contact information). Numbering and ordering of all questions is consistent with the original format used in the survey (see Appendix D). Included are responses to questions 4 through 29.

Q 4. How many full-time or full-time equivalent staff does your department employ? (include office/clerical staff and yourself)

# of FTEs	Frequency	Percent
Less than 1	9	5.0
1	22	12.2
2 to 3	50	27.6
4 to 5	18	9.9
6 to 10	33	18.2
More than 10	49	27.1
Total (n) =	181	100.0

Q 5. Which of the following best describes your department's service area?

Type	Frequency	Percent
City	69	38.1
County	92	50.8
Joint City-County	20	11.0
Total (n) =	181	100.0

Q 6. What is the estimated population served by your department? (reclassed)

Category	Frequency	Percent
Less than 2,500	18	10.1
2,500 - 9,999	67	37.4
10,000 - 24,999	40	22.3
25,000 - 49,999	21	11.7
50,000 - 99,999	16	8.9
100,000 - 249,999	12	6.7
250,000 +	5	2.8
Total (n) =	179	100.0

Q7. Which of the following functions does your department perform in your service area? (check all that apply)

Function	Frequency	Percent
Zoning Administration	157	86.7
Subdivision Administration	168	92.8
Building Permit Administration	115	63.5
Rural Addressing	85	47.0
Mapping / GIS	93	51.4
Comp. Planning	155	85.6

n = 181

Q8. For which of the following activities has your department contracted with an outside consultant in the last five years? (check all that apply)

Activity	Frequency	Percent
Zoning code revisions	57	31.5
Subdivision code revisions	41	22.7
Land use / build-out analysis	45	24.9
Transportation analysis	56	30.9
Housing analysis	38	21.0
Recreation / open space analysis	21	11.6
Environmental analysis	26	14.4
GIS development / implementation	42	23.2
Comp plan development or update	87	48.1

n=181

Q 9. Which of the following is currently being used by your planning department? (check all that apply)

Activity	Frequency	Percent
Permit tracking software	67	37.0
Zoning / code enforcement software	29	16.0

n=181

Q 10. In what year did your planning department's service area (i.e., city or county) complete its most recent comprehensive plan update? (reclassed)

Category	Frequency	Percent	Cumulative Percent
Within last 5 years	95	58.3	58.3
Within last 10 years	48	29.4	87.7
Within last 15 years	12	7.4	95.1
Within last 20 years	2	1.2	96.3
More than 20 years ago	6	3.7	100.0
Total (n) =	163	100.0	

Q 11. Which of the following group community process tools has your planning department used for planning purposes in the last five years? (check all that apply, and include use by hired consultants)

Activity	Frequency	Percent
Visual preference survey / before-after photography	68	37.6
Board games	22	12.2
Miniature modeling	4	2.2
Key pad polling	18	9.9

n=181

Q 12. Does your department have a web presence?

Response	Frequency	Percent
No	25	13.9
Yes	155	86.1
Total (n) =	180	100.0

Q 13. Which of the following best describes your web presence?

Response	Frequency	Percent
Planning department has an independent web site	21	14.0
Part of another group's web site	129	86.0
Total (n) =	150	100.0

Q 14. Which of the following items are currently provided through the department's web site? (check all that apply)

Activity	Frequency	Percent
Staff contact information	136	87.7
Meeting information	123	79.4
Planning documents	132	85.2
Maps	90	58.1
Photography collections	20	12.9
Audio / video files	10	6.5
Application forms (permits, variances, etc.)	121	78.1
Feedback / question form	28	18.1
Online surveys	20	12.9
Email subscription lists	15	9.7
Interactive comment/discussion (forums, blogs, wikis)	3	1.9

n=155

Q 15. Does your department currently use GIS?

Response	Frequency	Percent
No	37	20.6
Yes	143	79.4
Total (n) =	180	100.0

Q 16. Which of the following best describes your department's GIS use?

Response	Frequency	Percent
Department maintains its own, stand-alone system	21	15.1
Department utilizes a system maintained by another department	66	47.5
Department shares maintenance of a system with one or more departments	36	25.9
Other	16	11.5
Total (n) =	139	100.0

Q 17. Which of the following kinds of "reference" GIS digital data layers are available and used by your department? (check all that apply)

Data Layer	Frequency	Percent
Elevation	128	89.5
Land ownership	104	72.7
Hydrography	71	49.7
Orthoimagery	85	59.4
Administrative boundaries	85	59.4
Geodetic control	51	35.7
Transportation	130	91.0

n=143

Q 18. Which of the following "planning-specific" GIS data layers are available digitally and used by your department? (check all that apply)

Data Layer	Frequency	Percent
Land use categories	96	67.1
Census units - tracts, blocks, etc.	53	37.1
Building footprints or centroids	79	55.2
Special districts - school, voting, etc.	116	81.1
Utilities - water, sewer, electrical, etc.	65	45.5
Zoning designations	35	24.5

n=143

Q 19. Are planning-related GIS data and/or mapping applications for your service area accessible through the Internet?

Response	Frequency	Percent
No	71	50.7
Yes	63	45.0
Don't Know / Unsure	6	4.3
Total (n) =	140	100.0

Q 20. For which planning functions has GIS been applied in your department during the last five years? (check all that apply)

Function	Frequency	Percent
General map making	134	93.7
Zoning administration	108	75.5
Subdivision review	94	65.7
Code enforcement	67	46.9
Resource analysis (environmental, cultural, etc.)	68	47.6
Rural addressing	71	49.7
Comprehensive plan development / implementation	89	62.2
Other	11	7.7

n=143

Q 21. Overall, how coordinated is GIS development and use in your department's jurisdiction (i.e., city, county, etc.)?

Response	Frequency	Percent
Not Applicable	8	4.5
Not Coordinated	23	12.9
Somewhat Coordinated	57	32.0
Coordinated	49	27.5
Very Coordinated	41	23.0
Total (n) =	178	100.0

Q 22. Please identify which of the following planning decision support applications you have worked with as a professional planner: (check all that apply)

Application	Frequency	Percent
VISTA	1	0.6
What If?	1	0.6
Place3s	1	0.6
INDEX	0	0.0
CommunityViz	28	15.5

n=181

Q 23. Which of the following types of decision support technologies have been used in your planning department's activities during the last five years? (check all that apply, and include use by hired consultants)

Type	Frequency	Percent
Trend analysis / forecasting	40	22.1
3-D visualization / animation	24	13.3
Impact / scenario analysis	32	17.7
Predictive modeling of future conditions	50	27.6

n=181

Q 24. You indicated that either you or a consultant used some of the technologies listed on the previous page. For which of the following tasks was the technology used? (check all that apply)

Task	Frequency	Percent
Issue identification, visioning, goal setting	42	58.3
Inventory of existing conditions, trend analysis	55	76.2
Scenario design and development	23	31.9
Scenario and impact assessment	30	41.7
Plan development	53	73.6
Plan implementation / monitoring	24	33.3

n=172

Q 25. When applied, how did these technologies impact the following aspects of decision-making effectiveness?

Response	Positive Impact	No Impact	Negative Impact	Don't Know
Decision-Making Time	65.7%	20.0%	2.9%	11.4%
Explicitness of Decision	58.6%	17.1%	1.4%	22.9%
Identification of Conflicts	67.1%	15.7%	0.0%	17.1%
Communication of Information	82.9%	8.6%	0.0%	8.6 %
Confidence in Analysis	67.1%	15.7%	0.0%	17.1 %

n=70

Q 26. What is your perception of the potential usefulness of decision support technologies in local government planning?

Response	Frequency	Percent
Not Useful	7	4.4
Somewhat Useful	58	36.3
Very Useful	95	59.4
Total (n) =	160	100.0

Q 27. In your opinion, what are the 1st, 2nd and 3rd greatest barriers to wider decision support system technology use in local government planning? (Enter a "1" for greatest barrier, "2" for second greatest barrier, and "3" for 3rd greatest barrier) [recoded 3-2-1 and ranked]

Barrier	Cumulative weighted (and un-weighted) Scores	Rank
Lack of staff	190 (94)	2.5 – tie (2)
Lack of training and/or technical support	191 (87)	1 (3)
Lack of needed functionality	48 (20)	8 (8)
Inadequate data	81(42)	6 (6)
Apprehension to work with new technology	69 (28)	7 (7)
Hardware / software costs	190 (113)	2.5 – tie (1)
Lack of administrative support	99 (45)	5 (5)
Not enough time	158 (85)	4 (4)

n=173

Q 28. With respect to adoption and use of technology, how would you characterize your department?

Response	Frequency	Percent
Extremely Low Capability	13	7.5
Not Very Advanced	21	12.1
Somewhat Capable	66	37.9
Capable	69	39.7
Advanced	5	2.9
Total (n) =	174	100.0

Q 29. How would you rate the overall importance of information technology in local government planning?

Response	Frequency	Percent
Unimportant	4	2.3
Somewhat Important	7	4.0
Important	57	32.6
Very Important	107	61.1
Total (n) =	175	100.0

APPENDIX G

CASE STUDY BACKGROUND INFORMATION

Note: the following information, provided to interviewees for review prior to interview has been reformatted to conform to dissertation style requirements:

Research Activity Description:

Assessing Planning Support Technology Adoption and Use

in Rural Local Government Planning Agencies

through Case Study Interviews

Thank you for considering being a participant in the research activity *Assessing Planning Support Technology Adoption and Use in Rural Local Government Planning Agencies through Case Study Interviews.* This document will provide you with an overview of the project's overall goals and objectives, the methods used in data collection and analysis, and the anticipated outcomes and benefits.

The overall goal of the project is to identify opportunities and barriers for using information technology to strengthen and streamline land planning processes in rural local government planning offices in the Mountain West Region and across the United States. The project includes two major components. The first component was an online survey questionnaire administered to a population of approximately 560 city and county planning departments in Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah and Wyoming in summer 2008. The primary purpose of the survey was to assess how and to what degree these planning departments are currently using various types of planning support technologies in their planning activities.

The second component of the project is to identify and analyze a series of case studies in the Mountain West region which represent the use of geographic information systems and planning support tools in local land planning settings. Case studies will be primarily analyzed by conducting semi-structured interviews of key individuals familiar with these implementations.

You have been identified as a person with local knowledge of one of the case studies selected for analysis. Should you choose to participate, you will be interviewed either in your community or by telephone. You will have the opportunity to respond to questions about the role of planning support system applications in the case study, the factors influencing your awareness and consideration of the technologies employed, and the overall positive and negative impacts of the technologies on the project's end result.

It is anticipated that individual interviews will be approximately 60 minutes in length. With subject permission, interviews will be audio recorded. Audio files and/or notes will be transcribed and retained by the project manager for five years after analysis has been completed and published. All responses provided by participants will be treated with full confidentiality in all reporting of results, unless explicit permission is given by an individual subject to identify his or her responses by name or position title (e.g., "city planner"). All participants will be provided access to the final project report upon completion of the project in summer 2010.

Participation in this research is voluntary and you are also free to terminate your involvement in the project at any time. At the time of your interview, you'll be asked to indicate your willingness to participate by signing an *informed consent* form which details the interview process and associated risks, benefits, and confidentiality of responses.

APPENDIX H

CASE STUDY INTERVIEW INFORMED CONSENT LETTER

Note: the following information has been reformatted to conform to dissertation style requirements:

University of Wyoming
Consent to Participate in a Research Study
Adult Participant

Title of Study: Assessing Planning Support Technology Adoption and Use in Rural Local Government Planning Agencies through Case Study Interviews

Institutional Review Board Approval: 7 May 2008

Principal Investigator: Jeffrey D. Hamerlinck
Title and Department: Director
Wyoming Geographic Information Science Center
Address: Department 4008, 1000 E. University Ave
University of Wyoming, Laramie, WY 82071
Phone: (307) 766-2736
FAX: (307) 766-2744
E-mail: *itasca@uwyo.edu*

What are some general things you should know about research studies?

You are being asked to take part in a research study. To join the study is voluntary. You may refuse to join, or you may withdraw your consent to be in the study, for any reason, without penalty.

Research studies are designed to obtain new knowledge. This new information may help people in the future. You may not receive any direct benefit from being in the research study. There also may be risks to being in research studies.

Details about this study are discussed below. It is important that you understand this information so that you can make an informed choice about being in this research study. You will be given a copy of this consent form. You should ask the researcher named above any questions you have about this study at any time.

What is the purpose of this study?

The overall goal of this project is to identify opportunities and barriers for using information technology to strengthen and streamline land planning processes in rural local government planning offices. A major objective of this effort is to identify and analyze a series of case studies in the Mountain West region which represent the use of geographic information systems and planning support tools in local land planning settings. Case studies will be primarily analyzed by conducting semi-structured interviews of key individuals familiar with these implementations.

How many people will take part in this study?

You are being asked to be in the study because you have been identified as a person with local knowledge of one of the case studies selected for analysis. If you decide to be in this study, you will be one of approximately 20 to 30 people in this research study.

How long will your part in this study last?

Your active involvement in this study will primarily involve a one-hour interview by the principal investigator to be conducted either on-site in your community or via telephone. A short follow-up telephone conversation may be required after the interview for clarification of responses you may have provided.

What will happen if you take part in the study?

Should you choose to participate, you will be interviewed by the principal investigator either in your community or by telephone. You will have the opportunity to respond to a series of semi-structured questions about the role of planning support system applications in the case study, the factors influencing your awareness and consideration of the technologies employed, and the overall positive and negative impacts of the technologies on the project's end result.

It is anticipated that individual interviews will be no more than 60 minutes in length. With participant permission, interviews will be audio recorded (see below). All responses provided by participants will be treated with full confidentiality in all reporting of results, unless explicit permission is explicitly requested and granted by an individual to identify his or her responses by name or position title (e.g., "city planner").

What are the possible benefits from being in this study?

Research is designed to benefit society by gaining new knowledge. You may not benefit personally from being in this research study. However, case study results will be used to better understand the unique needs of local government planning agencies and in turn will assist in educating planning professionals about the wide range of planning technologies available to them.

What are the possible risks or discomforts involved from being in this study?

There are no known physical or psychological risks, nor is it anticipated that you will experience any physical discomfort in participating in this study.

How will your privacy be protected?

Every effort will be taken to protect your identity as a participant in this study. Neither you or your jurisdictional affiliation will be identified in any report or publication of this study or its results. Individually identifiable data on transcripts and audio files will only be accessible to the principal investigator. This data will be kept in a locked office file cabinet and destroyed five years after final publication of the study results.

The audio recording of interviews is requested to help ensure the accuracy of interview responses. Initial the line that best matches your choice:

_____ OK to audio record me during the study

_____ Not OK to audio record me during the study

Note: you may request that audio recording devices be turned off at any time during an interview.

Will you receive anything for being in this study?

You will not receive anything for taking part in this study.

_____ Initial here if you'd like to be informed when an initial summary of case study results have been published. (anticipated in summer 2010)

Will it cost you anything to be in this study?

There will be no costs for being in the study. If a scheduled interview conflicts or infringes on work activities, an alternate interview time can be arranged.

What if you have questions about this study?

You have the right to ask, and have answered, any questions you may have about this research. If you have questions, or concerns, you should contact the researchers listed on the first page of this form.

What if you have questions about your rights as a research participant?

All research on human volunteers is reviewed by a committee that works to protect your rights and welfare. If you have questions or concerns about your rights as a research subject you may contact, anonymously if you wish, the University of Wyoming Institutional Review Board at 307-766-5320.

- -

Title of Study: Assessing Planning Support Technology Adoption and Use in Rural Local Government Planning Agencies through Case Study Interviews

Principal Investigator: Jeffrey D. Hamerlinck

Participant's Agreement:

I have read the information provided above. I have asked all the questions I have at this time. I voluntarily agree to participate in this research study.

____ __________________

Signature of Research Participant Date

Printed Name of Research Participant

Signature of Person Obtaining Consent

Date

Printed Name of Person Obtaining Consent

APPENDIX I

CASE STUDY INTERVIEW SCRIPT

General Planning Operations:

1. Tell me a little about how planning is done in [...]?
    a. Has it always been that way? Is it effective?
    b. How do you utilize outside consultants?
    c. How about coordination with the city planning efforts?

2. In general and here, how do you think county planning is different than city planning?

General Technology – Web and GIS:

3. Describe your Web site:
    a. Content / functionality
    b. Does it serve an important purpose? Much overhead?

4. Permit tracking / code enforcement software?

5. In general, does GIS play a significant role in planning here?

6. Describe GIS capabilities…
    a. How long using GIS? Who manages it?
    b. Data issues, staff, hardware/software, web?
    c. Connections to other jurisdictions? Fed, State, NGOs…?
    d. Standards? Coordination?

Comprehensive Planning

7. Last county comp plan… / current comp plan effort
    a. Driving issues...
    b. When undertaken?
    c. Documentation?
    d. Describe the process… What groups were involved? Citizen participation?
    e. Successful? What would you have done differently?

8. Role of technology in comp plan…
    a. GIS? / How used?
    b. Role of CommunityViz? / How used? / By whom?
        i. What factors influenced adopting and using (GIS and) CommunityViz?
        ii. How did you hear about CViz?
        iii. Who implemented GIS / CViz? Challenges in doing so?
        iv. What was its impact? Save time, explicit decisions, id conflicts, communication / transparency / confidence…
        v. Benefits? Shortcomings?
    c. Role of other technology in comp plan development?
    d. Was GIS/CViz/Other IT used in plan implementation?
    e. Is CViz still being used today? Why or why not? Do you see using it again? Considering using something else? Why or why not?

Impact of Technology

9. How would you rate the overall importance of IT in planning?

10. Your thoughts on potential usefulness of tools like GIS? PSS?
    a. When best used?
    b. In general, why aren't they being used more by planners?