Case Study Analysis of Planning Support System Implementation in Local Comprehensive Planning

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Abstract

To realize the full potential of PSS technologies in local planning environments, it is necessary to gain a better understanding of the technical and institutional factors influencing adoption and use. This paper describes the design and outcomes of a qualitative case study analysis of current utilization of geospatially-enabled PSS in U.S. local planning. All cases involved CommunityViz® PSS software in comprehensive planning, and were assessed through semi-structured interviews and document content analysis. Results provide a viable description of PSS implementation in rural comprehensive planning, and serve as an empirical assessment of Vonk et al's *PSS Adoption Framework* (2005). 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. Prior existence of a mature GIS and spatial data infrastructure is universal. The role of external consultants in facilitating PSS use is also notable.

1. Introduction

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 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). Planning support systems (PSS) are a special type of PSI representing, "geo-information-technology-based 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 (Brail and Klosterman 2001; Geertman and Stillwell 2003, 2009).

The utility of PSS is broadly supported in the literature (Klosterman 1997; Snyder 2003; Couclelis 2005). In spite of the potential benefits of PSS however, the literature makes clear that usage of PSS is not on par with utility. Geertman (2006) puts forth that planners have not embraced the tools available to them, identifying a mismatch between supply, demand and applications of PSS, while Vonk et al (2005) identifies numerous general (e.g. institutional) and specific (e.g. too complex) reasons for underutilization.

A Case Study Analysis of PSS Implementation

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).

This paper describes the design and outcomes of a qualitative, multi-case case study analysis of current utilization of geospatially-enabled PSS in U.S. local planning. The research was conducted as part of a broader, mixed-method study of overall planning support technology implementa-

tion by local governments in the United States Mountain West region (Hamerlinck 2011). The case study analysis 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 results of a related survey questionnaire component of the broader mixed-method study, 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 (and non-rural) locations.

The overall goal of this case study research was to gain a better understanding of the specific opportunities and barriers to PSS implementation in rural local planning processes. This paper specifically emphasizes an empirical assessment of PSS adoption factors outlined by Vonk et al (2005). It also preliminarily explores specific relationships between PSS use and spatial data infrastructure (SDI) components, including GIS development and utilization of internal (i.e., staff) and external (i.e., consultant) technical capacity.

2. Methodology

Theoretical Context

The 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 information and communication technology (ICT) systems. ICT systems and their implementation have been studied within a number of domains, particularly diffusion research and management science. Vonk et al.'s *PSS Adoption Framework* (2005) integrates aspects of diffusion of innovation (Rogers 2003) and management science (specifically, technology acceptance theory; Davis 1989) and provides the primary theoretical context for this study's research design. Building on similar integrative work by Frambach and Schillewaert (2002), the Vonk 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 1, three major sets of factors-"perceived innovation" characteristics, "adopter" characteristics, and "external conditions" directly influence the innovation-decision process. Both "persua-

sion" 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.

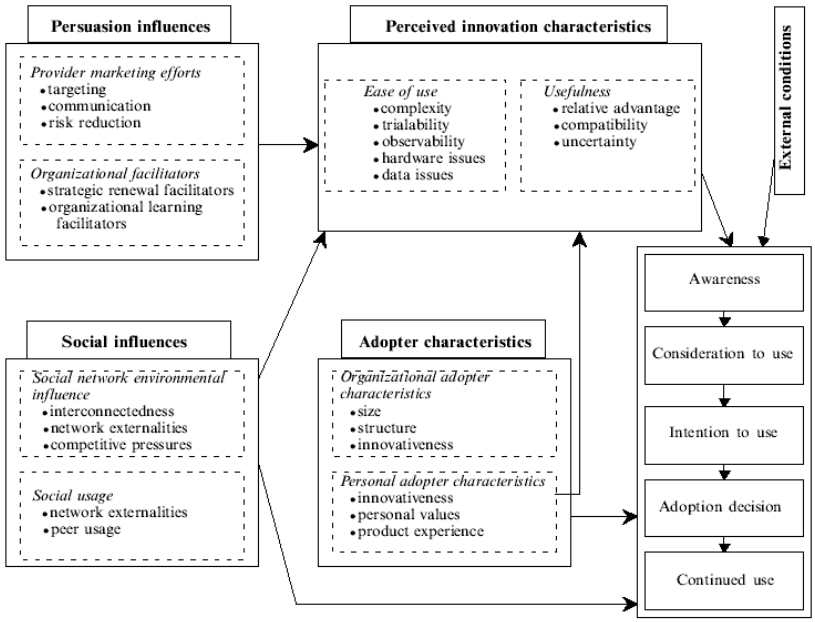

Fig. 1. Planning support system adoption framework.
Source: Bottlenecks blocking widespread usage of planning support systems, by G. Vonk, S. Geertman and P. Schot, 2005, Environment and Planning A, Volume 37 (5), pp. 909-924. Copyright 2005 by Pion Limited, London. Reprinted with permission.

Case Study Design

The case study design was contextually bounded by a number of "natural control" parameters (Elger 2010; Lee 1989) for the purpose of constraining extraneous variation and improving external validity (Eisenhardt 1989). These controls were common to all cases and included:

- a single PSS software application (CommunityViz®)
- implemented for a consistent purpose (comprehensive plan development/revision)
- across a mix of jurisdictional settings (municipal and county)
- in the same state (State of Colorado, USA)

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 (Walker and Daniels 2011). CommunityViz 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), and 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). Over the last decade, CommunityViz has been utilized in many planning applications from rural growth management and urban redevelopment to watershed modeling, aquifer protection and floodplain management (Walker and Daniels 2011).

Three factors provided the rationale for selecting CommunityViz for this research: (1) its extensive application in both urban and rural planning settings; (2) prior survey questionnaire results which identified CommunityViz as the only PSS software with which more than one respondent in the region had experience; and (3) the author's familiarity with the software's functionality and past experience in its application (Hamerlinck 2011). Making the software application constant in all cases also allowed the research focus to center on institutional and organizational factors of implementation, rather than on functional variation among potentially different technology solutions.

The type of planning activity common to all cases studied was "comprehensive plan development or revision" (Juergensmeyer and Roberts 2003). 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 could be examined in interactions with supporting entities.

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). Following the rationale described by Flyvbjerg (2006), ultimate case selection was based on 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 2003). From a more logistical viewpoint, case selection criteria also included case actors' accessibil-

ity 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 (Hamerlinck 2011), 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 had 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. 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) 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.

Given the bounding controls described above, four cases were ultimately selected for analysis. Two of the sites were cases associated with city 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, or rural (Beale 2004).

Table 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 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 1. Case study site summaries

Alias	Alpine County	Watertown	Valley City	Plateau County
Lead Agency	County Planning, Blding & Env Health; GI Services	Community Development & Planning	Community Development	County Planning and Development
Pop. / Area Served	14,000 8,550 km^2	5,500 10 km^2	12,500 31 km^2	34,000 5,950 km^2
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

Data collection was carried out 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 35 individuals were interviewed across the four cases, representing government staff, consultants, and elected local officials associated with each jurisdiction's comprehensive plan activities. 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. Human subject protocols for the case study interviews specified anonymity for case study interviewees. Due to the relatively small population of both the local government planning and geographic information systems 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.).

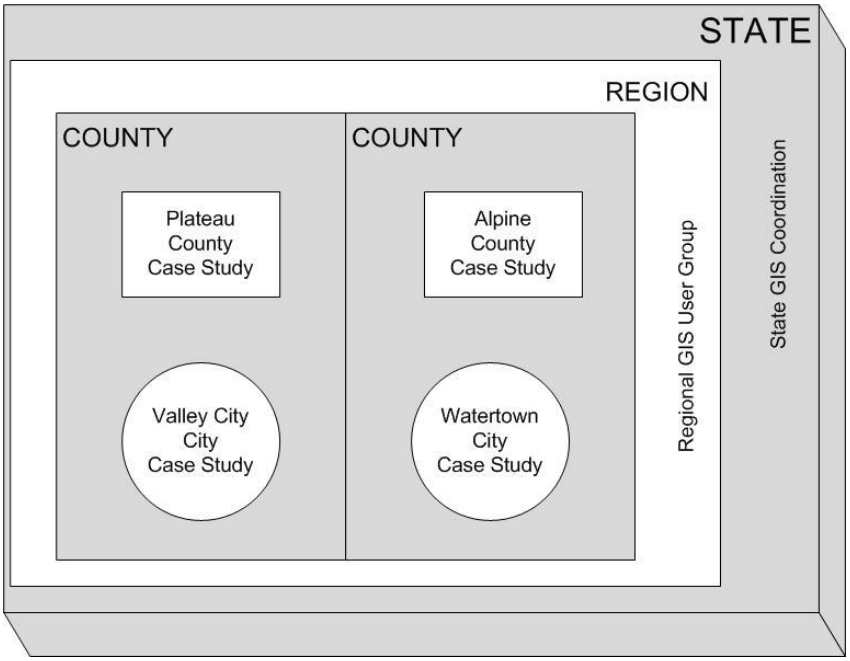

Fig. 2. Conceptual proximity of case study sites within region and state.

3. Case Study Summaries

Case #1: Watertown

The Watertown case study examines the use of CommunityViz in an update of the City of Watertown's comprehensive plan ("comp plan"). 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. 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 1990s after receiving

his formal planning education. He was first exposed to CommunityViz at professional development seminar in 2001 while working as a planner for a different community, and later received a training scholarship to 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.

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.

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 annexation activities. 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. 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. During the initial stages of the plan's development, an unusually large number of external planning groups were involved the process, including two private consulting firms and several non-profit land conservation organizations. GIS was used extensively for background mapping throughout the plan and 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, a linear combination overlay technique was applied to generate a series of parcel-level suitability maps.

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 application's developers in 2000-2001. As a part of that training, he was introduced to another consultant/beta tester, who was later hired as a CommunityViz consultant to assist with the land use alternatives component of the Crown Mesa-Watertown Corridor Plan.

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. 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

Valley City is an incorporated municipality and county seat of government for Plateau County, Colorado. 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. The plan's development was led 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.

Overall, the use of ICT in developing the plan was closely tied to the community engagement process conducted by primary consultants. 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.

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. According to the City's GIS Coordinator, the consultants relied heavily on the GIS Department for all base data. 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.

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. 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.

The consultants hired to complete the planning process were 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. In September 2009, the County initiated a termination of their contract for services with the initial consultants. 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.

During the consultant-led portion of the plan update, 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 consultants' work was incorporated in the final document.

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 RFP issued by the Planning & Building Department, which specifically required an ICT component in the scope of services… 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 consulting firm, the Plateau County planning staff most appreciated keypad polling, another resource few of the proposing consulting firms offered. Looking forward from the analysis generated by CommunityViz, 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".

4. Discussion

Table 2 is a *cross-case construct table* that summarizes observed influence of eight categories of PSS Adoption Framework factors (Vonk et al. 2005; italicized below and itemized in the table) on use of CommunityViz software in the four cases. Cross-case construct tables are employed in qualitative research to evaluate the nature of core concepts by examining the way individual variables operate in and across different contexts (or cases). Such matrices are typically built iteratively through qualitative judgment of interview responses, analysis of questionnaire data and document content analysis (Miles and Huberman 1994).

In this study, 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 the interconnectedness 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. 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 actu-

al 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 choose a particular consulting 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 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).
Scaling categories were adapted from Miles and Huberman, Chaps Seven and Eight (1994).

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. 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 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, the regional GIS users group in which the jurisdictions participate – established in the mid-1990s - has been influential.

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.

5. Conclusions and Future Research

Summary of Case Study Findings

The case studies, though limited to project-level experiences, provide a viable exploration and description of CommunityViz PSS implementation in rural local comprehensive planning. The study also provides a valuable empirical confirmation of many components 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.

The cases also indicate that a well-established spatial data infrastructure for a city or county - regardless of whether it was centered in the planning department – is important for successfully supporting adoption and use of PSS technology through data development and software access. 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 GIS, and ICT in general, is often a lynch pin for more sophisticated SDI maintenance and PSS use.

Finally, the significant involvement of external consultants in three of the four cases supports the proposition 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).

Empirical Insights on Validation of Existing Information System Theory

Responding to past and current calls for more theory-building case studies on PSS use (Harris and Batty 1993; Geertman 2006), the case study analyses empirically validate aspects of the PSS Adoption Framework presented by Vonk et al. (2005). 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 previously discussed, 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 departments which, in comparison to urban planning offices, are typically supported by smaller-sized and less specialized staff as well less complex 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. Initial conclusions recommend a reconsideration of including this final factor in the adoption framework.

Ongoing Research 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. 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 PSS use by planners, and increase the effectiveness of the technology in both specialized and routine planning workflows.

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 (e.g., the use of PSS applica-

tions in a selection of regional Metropolitan Planning Organizations (MPOs) and Councils of Government (COGs). Examining cases in such contexts could also provide an opportunity to evaluate the transferability of this study's methods and conclusions to urban planning environments. Finally, 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.

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