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CHAMPIONS OF GIS: MUNICIPAL IMPLEMENTATION AND ORGANIZATIONAL DIFFUSION OF GIS IN PENNSYLVANIA LOCAL GOVERMENTS

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***ABSTRACT**: This study investigates the use of geographic information systems (GIS) technologies within local governments in the Philadelphia region. Local municipalities are often the primary decision makers when it comes to land use and development planning and for the provision of local public services. GIS is a valuable tool for municipalities to manage these functions, but many local governments have been slow to adopt and implement the technology. This study investigates the status of GIS use in local governments and identifies factors related to its adoption and internal organizational diffusion. Based on a survey of local governments in Chester and Montgomery counties in Pennsylvania and two local government case studies, this study investigates the role and importance of an organizational "champion" of the technology. Findings reveal that the existence of a champion within the municipal organization is strongly related to the successful implementation and perceived effectiveness of GIS technologies.*

***Keywords**: Geographic Information Systems, Diffusion, Local government, Planning*

INTRODUCTION

Over the past two decades, geographic information systems (GIS) have moved into the heart of mainstream planning practice. While the efficacy of GIS has been well established (Ventura, 1995), GIS technologies have not been universally adopted at all levels of government. State, regional, county, township and city governments have incorporated GIS technologies into multiple organizational levels, but there is still resistance in smaller, local municipalities in suburban and rural areas. GIS provides spatial analysis and information management capabilities that align closely with the needs of local governments. Local municipalities have to make countless decisions regarding the use of land. In Pennsylvania, they are the primary decision makers when it comes to development planning, zoning, open space programs, public services, and public works programs. Somers (1987) indicated that as much as 70-80% percent of local government functions can be spatially organized. The outcomes of local government decisions impact the entire region. With increasing pressure to improve government performance, GIS technologies can help governments enhance the efficiency of their operations.

The purpose of this study is to investigate GIS use in local suburban governments in order to determine what factors influence the adoption, implementation and perceived effectiveness of GIS technologies. Technical demands to utilize GIS such as installing hardware and software, training and related costs are often considered obstacles to its use, however research in larger government settings has indicated that organizational, political and human factors such as staff resistance and organizational inertia are more significant in determining whether the technologies are employed (Budic, 1993). The central proposition of this research is that human and organizational factors within a municipality influence acquisition and implementation. The perceived effectiveness of GIS technologies is impacted by the way it is introduced and the organizational support provided to integrate the technology into municipal operations. Based on a survey of local municipalities in the Philadelphia region and two case studies of local municipal users, this study explores the extent to which local governments use GIS technologies in municipal planning activities and the perceived effectiveness of the technology for decision making. These research findings have important implications in developing strategies to expand the use of GIS technologies in municipalities that have not yet utilized them and in understanding the perceived limitations of their use.

GIS IMPLEMENTATION & DIFFUSION

A growing body of theoretical and empirical literature investigates the use of GIS technologies for governmental administration. Emerging from the fields of public administration, planning, and geography, the literature explores factors that influence local government decisions to adopt GIS and the variables that influence the diffusion of GIS within an organization. Factors that explain local governments' decisions to adopt GIS technologies include organizational structure, the function of the agency, decision-making procedures, and personality variables (Chan and Williamson, 1999; French and Wiggins, 1990). Large jurisdictions with higher growth rates, larger staffs and more funding have been found to be early adopters of GIS technologies while smaller jurisdictions who lack organizational resources such as funding and staff lag behind (Budic, 1993). The performance of GIS in practice, like any technology-led innovation, will only "work" if the proper organizational and management support, budget resources, infrastructure and culture exist (Campbell and Masser, 1995). Technical constraints such as system components and technical expertise are typically less of an impediment to GIS use than organizational, institutional and other human factors of implementation such as how well staff understand the technology and its role (Innes & Simpson, 1993; Budic, 1993). Obstacles to GIS implementation also lie in the organizational shortcomings of local government, particularly communication between departments (Ventura, 1995).

Simply acquiring a GIS system does not automatically guarantee its successful implementation throughout an organization (Onsrud, and Pinto, 1993). Diffusion is a complex process by which an innovation is communicated through a number of channels at multiple levels of governmental organization. Organizational and management factors are important in the internal diffusion process. Budic and Godshalk (1996) used a multi-case study to track the diffusion of GIS within four departments of a North Carolina county government. With surveys and interviews they investigated how perceptions, experience, attitudes and communication behavior of a local government affect the adoption of GIS technology as an organizational innovation. Three factors were found to be significantly related to an individual's decision to use GIS: perceived relative advantage, compatibility with computer experience, and exposure to GIS technology.

Building on this literature, this research investigates GIS use in smaller municipalities and organizational and management factors that impact its implementation and perceived effectiveness.

STUDY AREA

The study area consists of all municipalities within Chester and Montgomery counties; two suburban counties in the greater Philadelphia region (see Figure 1). Together, the two counties contain 135 municipalities with 62 in Montgomery County and 73 in Chester County. The municipalities range from high density urban areas with established commercial and industrial districts in the east to low density agricultural communities to the north, south and west. These locations were selected because they have been facing suburbanization pressures over the past 30 years. U.S. Census data indicate that, from 1990 to 2000, population grew by 10.6% and 15.2% respectively in Montgomery County and Chester County. In contrast, nearby Delaware County grew by 0.59% while Philadelphia County lost 4.3% of its population. Presumably the growth pressures would cause the local governments to consider new technologies to help in managing their growth and development. Pennsylvania is a particularly instructive area in which to study the use of GIS technologies for decision making since most land use control is vested in local municipalities. Municipalities individually decide what technologies to employ to manage their land use.

Two municipalities, known users of GIS, were selected for case studies. The townships were selected for case studies because they are generally representative of the larger, more developed townships in the study area. Since the main focus of the research is to examine factors that supported GIS use, known users of GIS were selected. Both townships faced considerable growth pressures over the previous 20 years as development continued to push north and west in the region. Lower Providence is located in south central Montgomery County, Pennsylvania (Figure 1). Encompassing 15.35 square miles, the Township is located approximately 17 miles to the east of Philadelphia. In 2000, 22,390 people (7,446 households) resided in the township. The population density was 1,458 people per square mile (U.S. Census). The Township is governed by a five-member Board of Supervisors who appoints the Township Manager to execute their policies. GIS was first installed in Lower Providence Township in 2004 by a private GIS consultant. West Goshen Township is located in central Chester County (Figure 1). In 2000, the Township housed 20,495 people (7,554

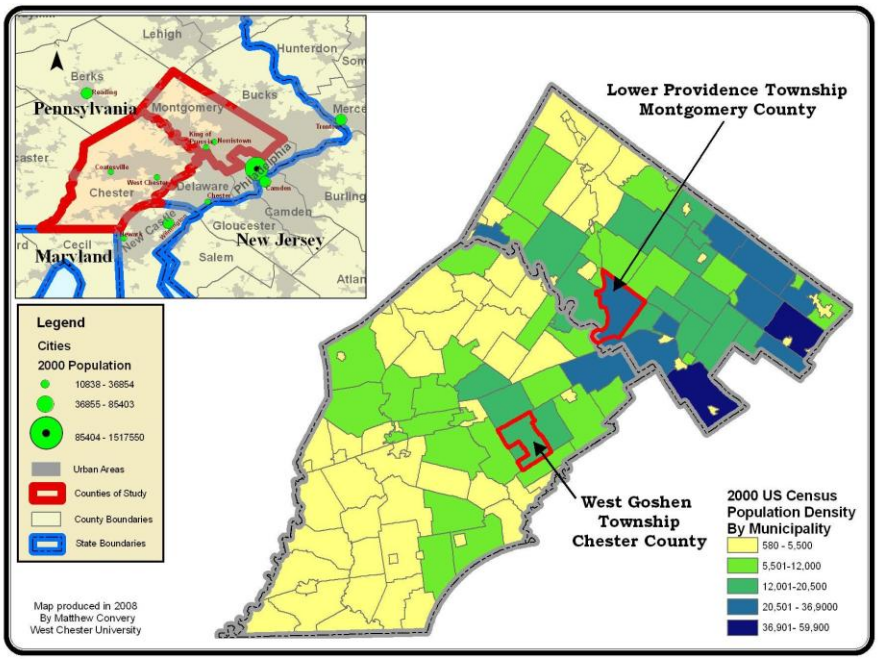

Figure1. Study area map.

households) with a population density of 1,720 people per square mile. Installation of a GIS was proposed by the Township Manager and approved by the five-member Board of Supervisors in 1998.

METHODOLOGY

A survey and case studies were used for this research. In September 2007, a questionnaire, developed by the researchers, was sent to each of the 135 municipalities in Chester and Montgomery counties. The survey considered the influence of the following factors of GIS in municipal operations: nature of use, budgetary and personnel resources, and perceived effectiveness. Questions were designed to isolate organizational and human factors that influence GIS adoption and use and its perceived effectiveness. The questionnaire consisted of 12 questions permitting responses on both standardized Lickert scales and more generalized replies where respondents could choose one of a number of answers (see Table 1).

The prevalence of GIS use was measured as a dichotomous variable where respondents reported yes or no as to whether or not they utilize GIS technologies for any municipal purposes. Those respondents who indicated that they do not utilize GIS technologies were asked a follow-up question to indicate one or more reasons for the lack of use. The questionnaire provided a list of possible choices and an "other" option where responders could identify alternative reasons for lack of use. Respondents who indicated they use GIS technologies were asked to respond to nine additional questions.

Respondents were asked to indicate how GIS is used, and by whom. Categorical scales were developed for each of these questions and respondents had the ability to identify more than one task and/or user. Another set of questions asked respondents to identify the frequency of use of GIS technologies, the frequency that data is updated, the amount of money budgeted to GIS and the nature of GIS personnel. An ordinal scale was developed for each of these questions. Finally, respondents were asked to rate their level of satisfaction with the effectiveness of GIS technologies. Level of satisfaction was assessed by a 5-point Lickert scale ranging from extremely satisfied to extremely dissatisfied.

The survey data were analyzed using descriptive and inferential statistics. Frequencies and percentages summarized the prevalence and patterns of GIS use, reasons for lack of use, nature of use, costs and perceived effectiveness. To test the hypotheses of the study, chi-square tests were used to compare differences between certain factors of use and perceived satisfaction. Significance was assessed by a p value < 0.05. Chi-square is a non-parametric test of statistical significance for crossbreaks (or bi-variate tabular analysis). A chi-square statistic asks whether two variables are independent. The value of the chi-square compares the frequencies of various categories of items in a random sample to the

frequencies that are expected from the data as hypothesized.

The formula for the chi square is as follows:

$$X^2 = \frac{\Sigma[(f_o - f_e)^2]}{f_e}$$

Where f_o = observed frequencies; f_e = expected frequencies (McGrew & Monroe, 1993).

SUMMARY OF SURVEY RESPONSES

Responses were received from 67 of the 135 municipalities, resulting in a response rate of 50%. Forty eight respondents (67%) indicated that they utilized GIS technologies, while nineteen (28.4%) indicated that they did not. Over 50% of non-users noted that a lack of funds to implement a system was the major factor prohibiting its use. This is consistent with previous research which found that lack of funding is commonly cited as an obstacle to GIS implementation (Croswell, 1991). Three respondents (15.8%) reported that a lack of experience or exposure to GIS was the major factor that prohibited its use and two respondents (10.5%) indicated that they did not see the effectiveness of GIS capabilities.

Users were asked to indicate the length of time that GIS has been utilized in the municipality. A number of local municipalities in the study area have been rather slow to adopt the technology. Three of the respondents (6.8%) have utilized GIS for less than a year; eight (18.2%) have utilized the technology for 1-2 years, and 17 (38.6%) have utilized GIS for 3-5 years. Only 16 (36.3%) have utilized GIS for five years or more. Northrop, et. al. (1990) investigated the use of computer technologies in general and found that benefits from technology accrue slowly as it takes a period of time to incorporate the technology into general decision making. It is likely that it will be a period of time

Table 1. Survey Questions

1. Do you have GIS software in house or provided by a consultant? Yes or No
2. If you do not have or use a GIS, what is the major factor prohibiting its use? a. Do not see the value or effectiveness b. A lack of experience or exposure c. Lack of funds to implement a GIS d. Other, Please indicate
3. How long have you utilized GIS information or a system? a. Less than a year b. 1-2 years c. 3-5 years d. 5-10 years e. 10 years or longer
4. Who proposed or championed the idea of a GIS System in your Municipality? a. Manager b. Board of supervisors c. Municipal engineer d. Planning commission e. Zoning hearing board f. Other advisory board g. Other
5. How often is your GIS system referred to? a. Daily b. Weekly c. Monthly d. Multiple times a year e. Seldom
6. How is the data and analysis most often used? (circle all that apply) a. To produce maps and exhibits b.To perform geospatial analysis such as calculating buffers, distances, slopes c. For planning purposes such as producing models or forecasts d. Management tool for organizing existing property data and infrastructure or to maintain property records e. Other
7. Who uses GIS in the township? (circle all that apply) a. Administration, Manager, treasurer, admin staff b. Zoning Department- Engineers, Zoning Officer c. Public Works d. Water/Sewer Authority e. Other
8. How often is the data updated? a. Daily b. Weekly c Monthly d. Semiannually e. Annually f. Less often
9. Do you have dedicated GIS personnel? a.Yes, Full Time b.Yes, Part time-in addition to a staff members normal duties c.Yes, Part time- consultant d..No
10. How much money is budgeted per year for GIS personnel, maintenance, hardware and software? a. No annual budget b. Less than $1,000 c. $1,000-$5,000 d. $5,000- $10,000 e. $10,000-$25,000 f. $25,000-$50,000 g. $50,000 and greater
11. How effective do you find the GIS system or data you use? a. Extremely effective, could not operate the township without the system. b. Very effective, used on an almost daily basis. c. Effective, performs the tasks when needed d. Somewhat effective, used for limited functions e. Not effective, waste of time and money
12. Optional Question – Add any comments you wish about the use of GIS in the municipality such as frustrations, unique uses found, resident feedback, etc.

before many municipalities realize the full benefits of GIS technologies.

Respondents were asked to identify who in the municipality was responsible for initiating the implementation of GIS. Initiating parties were classified into "champions" and "non-champions." The internal leaders of the municipal governments, namely, the Township Manager and the Township Engineer, were considered champions. The elected governing body, members of advisory boards and "other" were considered non-champions. Presented in Table 2, the majority of respondents (67.5%) noted that the municipal manager and/or the municipal engineer initiated the implementation of GIS technologies. A relatively small number (9.3%) indicated that GIS technologies were initiated by the elected body and an even smaller number (4.7%) indicated that a member of an advisory board was responsible for initiating the implementation.

Respondents were asked how GIS technologies are being used in the municipality. Responses were summarized into four categories as presented in Table 3. The categories fall into two general functions: information generation and management. The most common applications were to produce maps and exhibits and to manage property records (65.9% and 63.6% respectively). Budic (1993) found that agencies used GIS for mapping applications and rarely used the technology to its full potential. The underutilization is likely a result of lack of experience with the system since the majority has utilized GIS for less than five years.

Respondents were asked to indicate the amount of money budgeted annually to support GIS. Findings (summarized in Table 4) indicate that the amount of money committed for GIS is relatively low. Over 50% reported budgeting between $1,000 and $10,000. Fourteen municipalities (32.4%) indicated that they did not budget anything for GIS.

Using a five-point Lickert scale, respondents were asked about the perceived effectiveness of GIS technologies (see Table 5). The largest proportion of respondents (46.7%) rate GIS technologies as very effective. Only one municipality reported that they found GIS technologies to not be effective.

Chi-square Statistical Significance Test

The central thesis of this research is that human and organizational variables influence the use and perceived effectiveness of GIS technologies in local governments. Theoretical propositions and testable hypotheses were developed from this general thesis. Chi-square was used to test the significance of organizational variables as they relate to perceived effectiveness of GIS technologies in municipal operations. To test the proposition that the existence of a champion enhances the perceived effectiveness of GIS, the following hypothesis was proposed:

Hypothesis 1: There is not a significant relationship between perceived effectiveness of a GIS system and the presence of a GIS champion within the organization (Table 6).

The calculated chi-square value is 4.01 (significant at p=0.045).There are four cells and one

Table 2. Party Initiating Implementation of GIS (n = 43)*

Survey Question #4	CHAMPION		NON-CHAMPION		
	Manager	Municipal Engineer	Board of Supervisors	Advisory Board	Other
No. of Municipalities	19 (44.2%)	10 (23.3%)	4 (9.3%)	2 (4.7%)	8 (18.6%)

*Five respondents did not answer the question.

Table 3. Local Government GIS Uses (n = 44)*

Survey Question #6	Governments	
	Number	Percent
INFORMATION GENERATION		
Produce Maps & Exhibits	29	65.9%
Perform Geospatial Analysis	17	38.6%
MANAGEMENT		
Planning Purposes	11	25.0%
Manage Property Records	28	63.6%

*Four respondents did not answer the question.

degree of freedom. Since the level of significance of the calculated chi-square is less than 0.05, the hypothesis can be rejected and the alternative hypothesis, that there is a relationship between the party who initiated the implementation of the GIS technologies and its perceived effectiveness can be accepted. To test the proposition that organizational support enhances the perceived effectiveness of GIS, the following hypothesis was proposed:

Hypothesis 2: There is not a significant relationship between perceived effectiveness of a GIS system and organizational support for its use (funding) (Table 7).

The calculated chi-square value is 3.78 (significant at p=0.05). There are four cells and one degree of freedom. Since the statistical test is significant at p=0.05, the hypothesis can be rejected and an alternative hypothesis accepted that there is a relationship between perceived effectiveness and the amount of money budgeted to GIS.

Analysis of the survey data reveals the major factors that impact the decision to implement a GIS in local municipality and perceived effectiveness of its use. The presence of a champion and adequate funding resources are two key factors that emerge from the analysis. As in every survey approach, the findings are limited by the nature of the questions, the understanding of the questions by the respondents and the response rate. To supplement the findings of the survey, and to develop a richer understanding of the role of the champion and the internal diffusion of GIS technologies in local governments, two case studies of known users of GIS were developed.

Table 4. Money Budgeted for GIS (n = 43*)

Survey Question #10	$0	<$1,000	$1,000 - $5,000	$5,000 - $10,000	$10,000 - $25,000	$25,000 - $50,000
No. of Municipalities	14 (32.4%)	2 (4.7%)	3 (7.0%)	19 (44.2%)	2 (4.7%)	3 (7.0%)

*Five respondents did not answer the question.

Table 5. Perceived Effectiveness of GIS Technologies (n=45*)

Survey Question #11	Highly Effective	Very Effective	Effective	Somewhat Effective	Not Effective
No. of Municipalities	4 (8.9%)	21 (46.7%)	12 (26.7%)	7 (15.6%)	1 (2.2%)

*Three respondents did not answer the question.

Table 6. Summary of Responses (Frequencies) (n = 43*)

		PERCEIVED EFFECTIVENESS		
		Effective	Not Effective	Total
INITIATING PARTY	Champion	26	3	29
	Non-Champion	9	5	14
	Total	35	8	43

*Only 43 of 48 total GIS users answered both questions.

Table 7. Summary of Responses (Frequencies) (n = 43*)

		PERCEIVED EFFECTIVENESS		
		Effective	Not Effective	Total
BUDGET	Under $5,000	13	6	19
	Above $5,000	22	2	24
	Total	35	8	43

*Only 43 of 48 total GIS users answered this particular question.

CASE STUDIES

Information was collected from written reports and in-person interviews were conducted with municipal leaders from both townships between January and March 2008. West Goshen Township and Lower Providence Township both utilize a fully functioning GIS that has been implemented with base parcel mapping, aerial orthophotography, and operate over multiple township infrastructures. Both townships integrate their parcel records with permitting and document management as well as public works and utility management features. Both allow horizontal GIS access between departments and vertical access to the GIS between township staff and administration. The purpose of the interviews was to determine what variables and factors led to implementation of a municipal GIS and to test the general thesis of this research that human and organizational factors influence the implementation and use GIS technologies. Also tested were the specific propositions that it takes an individual within a municipality to champion the initiative and push the adoption and implementation of a GIS.

Case study methodology has been recognized as an effective approach to investigate the nature of the use of the technology and its diffusion (Craig 1989; Onsrod and Pinto, 1992). However, case studies are not without shortcomings. With poor sampling control and lack of generalizability to the larger population, case study analysis lacks scientific rigor. To build a larger body of meaningful results from case study research, more attention needs to be paid to scientific method. Onsrud and Pinto (1992) suggest a process of theory testing to enhance the scientific rigor of case study analysis. Their methodology was employed in analyzing the case studies presented here. Prior to the interviews, two theoretical propositions, developed from the general thesis, were selected as necessary factors to affirm the role of a champion and for evaluating successful GIS implementation. For each proposition, predictions of the outcome if the theory is true are stated. Conclusions about falsification or corroboration of each proposition were reached through qualitative analysis of the case study findings.

Proposition 1: There is a champion with a vision of the perceived advantages of a GIS and s/he can sell that vision to generate organizational support. The champion's vision becomes the organization's vision to ensure GIS implementation will continue beyond any individual's tenure in the organization (Campbell and Masser, 1995; Chan and Williamson, 1999).

Predicted Outcome: A champion is the force that drives adoption and implementation of GIS.

Proposition 2: For successful GIS diffusion, two phases must be completed – initiation and implementation. Initiation involves recognizing the advantages of GIS and adopting the technology. Implementation means developing a plan and taking steps to ensure that the GIS can be integrated into existing and developing township operations by consulting users and staff about GIS attitudes on an individual and organizational level. (Onsrud and Pinto, 1993)

Predicted Outcome: The initiation and implementation will take into consideration all aspects of the township's staff and duties for the most successful implementation of a GIS.

Case Study Results: Champion's Vision

The case studies support the hypothesis that an internal champion (in both cases the Township Manager) was vital to the approval, adoption and implementation of effective GIS programs. The West Goshen Township Manager was approached by an outside engineering company about purchasing GIS software in 1998. The Manager saw two benefits: first, GIS could provide better customer service to residents by providing property information and maps in a timely fashion; second, GIS would improve staff efficiency in handling information requests from residents, by reducing time and duplication of efforts. The Manager had only limited GIS experience but was familiar with its capabilities. After securing approval from the Board of Supervisors, the Manager hired an engineer who, among other responsibilities, would serve as the GIS Manager in charge of implementing and managing the township GIS. Implementation began in 2000 and took several years. The township's computers and server needed to be upgraded to handle the GIS software. It took four years of coordination between the GIS Manager and the GIS vendor to have the system running to pre-implementation expectations. The majority of that time was spent populating the system with GIS data of the township's infrastructure, permitting and property information databases. The hiring of a GIS Manager to oversee and manage the GIS ensured that the use of GIS within the organization was formalized and permanent.

The Lower Providence Township Manager had previously worked in another township that had implemented GIS and wanted to bring those benefits to Lower Providence. The Manager actively pursued getting approval and staff to implement the GIS. The Manager's initial justifications to the Board of

Supervisors were cost savings in expediting information requests for the residents and map production. The framework of a municipal GIS makes this task much more efficient for the township staff. The Township Manager hired a GIS Manager in 2003 and began to implement the hardware and software in 2004. GIS then expanded throughout the organization in terms of employee use and general functionality.

These observations corroborate the proposition of a champion's vision becoming the organization's vision. In each case, the Manager immediately saw the value of a GIS and the impact it would have on the organization. Each Manager was instrumental in securing the budget for the hardware and software as well as hiring GIS personnel to oversee and push implementation between the staff and the GIS vendors. In West Goshen and Lower Providence, GIS has expanded throughout the organization.

Case Study Results: Clear Diffusion Plan

In both Townships, adoption of GIS, including purchasing the software and hardware and hiring new GIS staff was accomplished quickly. The implementation phase of the diffusion plan requires the township to go through multiple steps to ensure that the GIS can be successfully adopted and infused into the existing work flow and operations of the township. This phase includes identifying factors that may inhibit the successful adoption of the technology. Factors that are usually taken into consideration would be individuals (end users and staff) that perceive the innovation as complex and may be resistant to change in their tasks and how they are performed (Budic and Goldshalk, 1996).

In neither case did the Township Manager consider the implementation plan before pursuing the initiation phase of the GIS. Neither Manager consulted the municipal staff for input on how the GIS would be implemented and used. Staff needs were assessed by the Township Manager, but their opinions and ideas on implementing a GIS were not sought prior to adopting the technology or initiating its implementation. Once the implementation had begun, the GIS Manager had to handle staff that had misgivings about the effectiveness of the GIS. The objection to its implementation was based on a resistance to change and a general lack of confidence in computer literacy rather than to any specific fear or concern over the capabilities of a GIS. With additional training and time spent reassuring these individuals, the GIS was implemented into the existing operations of the township.

There was a mixed result for testing this theoretical proposition. The initiation phase went smoothly but the implementation plan did not unfold as expected. The decision to implement a GIS was made by the Manager without input from the staff about their ideas, concerns or opinions about GIS. The technology was adopted based on the champion's vision, without the input of staff who would ultimately be the end users. This top-down approach to implementation was in part ineffective as staff resistance proved to be an impediment in the smooth implementation of the technology. Perhaps with some earlier input from staff, a quicker and less costly diffusion of the technology into the organization could be achieved, although if there is too much resistance, early input might be counterproductive.

The case studies reveal parallels of implementation in both Lower Providence Township and West Goshen Township. The decision to implement GIS was carried out as an executive decision within each organization. Both champions pressed their views with the governing body to gain funding and support and then pursued a top-down approach in implementing the technology into municipal operations. Both case studies affirm that there were organizational limitations to the implementation of GIS, as the staffs in the townships were not particularly computer savvy. There was some resistance from the staff as they had the perception that GIS was complicated software to learn. With more effort to educate and engage the staff in the process, implementation could be smoother.

CONCLUSIONS AND RECOMMENDATIONS

GIS is an important information technology that can improve decision-making at all levels of government. In Pennsylvania where local municipalities have significant influence over land use and development decisions, it is important that local municipalities have information resources to support good decision making. GIS is largely underutilized by local governments in suburban Philadelphia. Municipalities have been slow to adopt the technology and are not using it to its full potential. There are a number of factors that could explain the lack of GIS use, including technical demands, training, cost, as well as organizational, human and political resistance. A greater understanding of the human and organizational factors that influence the implementation and utilization of GIS technologies can help

municipalities to implement and better utilize GIS technologies. This research specifically tested for the role of a champion and cost factors. Ultimately the decision to incorporate a new technology is made by one or a few individuals in an organization. The findings of the survey and case studies support the central thesis that an internal 'champion' within the organization is instrumental to the implementation and perceived effectiveness of GIS systems. The survey findings indicate that there is a significant relationship between the party who initiates GIS use and its perceived effectiveness. The survey also reveals that GIS adoption is largely an executive task, typically by a Township Manager of Township Engineer. The case studies corroborate the significance of a champion in initiating a GIS. Political support by the elected body is important to ensure funding, but the decision to incorporate the technology happens internally. While the cost of GIS software has dropped, the case studies affirm that adequate funding is essential to the full implementation of a GIS system. Funding is necessary to provide for staff training and to install or upgrade hardware to support the software. Smaller townships do not have the budget to absorb the associated costs of GIS for hardware upgrades, staff training and education, and data generation. Future research, perhaps utilizing case studies of municipalities that have not yet adopted GIS, could investigate other factors that limit GIS adoption such as political and organizational resistance.

The conclusions of this study help to frame three recommendations for townships looking to adopt and implement a GIS in the future. First, identifying a "champion" within organization is the most significant step a local government can take to implement an effective GIS. The champion needs political support for the GIS to be funded and to be able to exert executive control over the organization to ensure the most effective implementation and diffusion throughout the organization. If an organization does not have someone internally to fill the role of a champion they should consider hiring someone who will champion GIS adoption and implementation. Second, education is vital to the successful implementation of a GIS. The more educated a potential champion, staff members and elected officials are about the nature and advantages of GIS, the more effective a champion can be in getting political approval and facilitating implementation throughout the organization. Education on the benefits, applications, implementation procedures and costs of GIS can be obtained by the township through third party consultants, GIS software vendors, and other government agencies. Third, adequate funding is important to the implementation of a GIS. The price of GIS software is within reach of most local governments; however, the major cost obstacles revolve around training personnel, upgrading the computer hardware/networks and data acquisition. Federal, state and county grants for GIS are available under certain situations.

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