GIS Implementation in Local Government: A Financial and Management Case Study Analysis

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Abstract

This case study analyzed GIS (geographic information systems) implementation strategies for a fictional city attempting to understand the short term and long term costs and benefits of installing a GIS system to manage land information records. As local government assistance and tax revenue fall, local governments need to have a clear understanding of how funds are allocated and the return GIS investments can provide in order to create the maximum benefit for taxpayers. The purpose of this research was to use financial and management analysis tools to better understand GIS system implementation with the aim of creating a framework that organizations considering GIS implementation could utilize during the project planning phase. Using industry data and project estimates, the costs and benefits, return on investment, net present value, and cost of outsourcing the project for this GIS implementation project were calculated. The results showed a GIS project of this nature had a high up-front cost; the viability of the project from a financial perspective lay in the amount of revenue that could be generated from the sale of GIS data as this revenue represents an immediate return to offset implementation costs.

Introduction

The intangible benefits such as increased information sharing GIS can provide many organizations are well known. In recent years, the cost of computers has decreased and the quality and accessibility of data has risen making GIS a more appealing investment for many organizations (Obermeyer and Pinto, 2008). As a result of this trend, the need to quantify the tangible costs and benefits of GIS, which are much less well understood by academia than the intangible costs and benefits, has become increasingly important (Obermeyer and Pinto, 2008; Huxhold, 1991).

According to the Center on Budget Policy and Priorities, since 2008 46 states have made significant cuts to state services (Johnson, Oliff, and Williams, 2011). This fact has increased the need for local governments to quantify how public dollars are spent and what return it will provide taxpayers. With high up-front costs for GIS systems implementation and sometimes difficult to quantify benefits, GIS can be an easy target when budgets need to be cut.

The basis for this paper arrives from of the need for independent cost-benefit analysis of GIS implementation within local government. The most effective way to model cost-benefit analysis of GIS systems integration is within a case study analysis that is governed as closely as possible by real world parameters.

This paper examines the costs and benefits of integrating a GIS system within a

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medium size city to manage 10,000 parcels of land records information that will be served to the public via a web application.

This analysis considers hardware, software, and personnel costs necessary for GIS and the financial tools that a government organization can use to measure the returns on an investment, namely the return on investment (ROI), net present value (NPV), cost avoidance projections, and revenue generation projections. The purpose of this paper is not to examine which series of implementation decisions is optimal, but rather illustrate the possible options for quantifying GIS projects and deploy them within the confines of a realistic case study.

As with any case study there are certain projections that need to be made to complete the study and allow for accurate analysis. Time spent on each piece of a project, the wage figures for each employee working on a project, and the hardware and software costs of a GIS system are all areas where some level of projection occurs. The data underlying certain projections are described within the context of the case study's methodology and the justification for each projection is provided.

It is important to note that every GIS implementation has different parameters governing its feasibility, including internal support from management for the project to fiscal limitations that do not allow for significant resources to be devoted to GIS implementation. This paper does not pretend to ignore the importance of these factors in analyzing GIS implementation but rather to consider GIS implementation under the assumption that there is organizational support for a feasibility study. This paper intends to bring quantitative financial analysis tools to a GIS implementation study in the hopes of providing a baseline set of analytical tools with which future GIS implementations can be assessed.

Methods

The first step in the methodology was to identify the conditions that would govern the case study. The decision was made to model the study within the context of a small to medium size city of approximately 50,000 people. This fictional city had 10,000 land records that were recorded on paper land plat maps. City officials decided to investigate the possibility of converting these records into digital parcel records, attributed, stored within a server based database, and served to the public via a web application. They commissioned a study to better understand the costs, benefits, and return on investment that the city would receive by implementing a GIS internally or by outsourcing the project work to a consulting organization. That study is this report.

Software costs were calculated using two types of software: open source "freeware" and licensed proprietary software. "Desktop GIS software prices typically range from $1000- $20000 per user" (Eldrandaly, 2007). Furthermore, "The cost of server GIS products varies from around $5000-25000, for small to medium-sized systems, to well beyond for large multifunction, multi user systems" (Eldrandaly, 2007). Due to the large number of variables that make up the final price for a GIS system, the ranges stated above were used as guides to inform cost projections.

Cost projections for the licensed software were on the low-middle part of the ranges. $7,000 per user was set for the GIS server software and $6,000 per user was assigned for the desktop GIS software price. For two desktop licenses and one server license, the project lifecycle cost for three years was $19,000. These values were selected because this was a rather small GIS implementation and would not require the greater capabilities or capacity that higher priced software would provide.

The way software is packaged and sold differs between GIS software companies, however the "cost per user" is a tool that can be applied to the cost of any company's product which is why it was selected for this study (Eldrandaly, 2007). It is beyond the scope of this study to select a single software licensed GIS software product for analysis or server management services due to the breadth of GIS software available, the numerous packages each company offers, and the inability to access proprietary pricing metrics which contribute to the overall licensed software cost.

Many open source GIS software packages exist. From a financial perspective, choosing a particular package was not as important as the fact that this type of software comes with no up-front cost. In conducting a financial cost-benefit analysis, open source software was considered as a single entity and not assessed by software provider.

The hardware costs were determined by reviewing the baseline hardware requirements for high performance computers. Once these were determined, various computer hardware websites were searched to find an approximate price for a computer (CPU) that met these requirements. After examining market prices for computers that met these specifications, the price for the CPU was determined to be approximately $350 per computer (Hewlett-Packard, 2012a). In addition to a CPU, two monitors were needed at a cost of $110 per monitor (Hewlett-Packard, 2012b). A server to hold the information cost $300 (Hewlett-Packard, 2012c).

The labor costs for the project were divided into eight steps that comprised the GIS implementation, data creation, and data maintenance process: software installation/setup, meeting/training, parcel digitization, quality control (QC) of parcel digitization, parcel attribution, QC of parcel attribution, server database development, web application development, and on-going maintenance to the web application and server parcel database. These were the required steps to convert land records from paper copies into a digital land records information system that could be accessed by the public via a web application.

For a land records project of this scale, if the project were done internally, one GIS Analyst and one GIS Technician would be required. The wage costs per hour were obtained from the Bureau of Labor Statistics (BLS) May 2010 National Occupational Employment and Wage Estimates report. The BLS uses generalized occupational categories; for example, the closest category to a GIS Technician was a "Surveying/Mapping Technician" and this category was used to document the wages for the GIS Technician position (BLS, 2010). According to the BLS, the mean wage per hour for the "Surveying/Mapping Technician" position within local government was $21.35 (BLS, 2010). The BLS occupational categories did not include a GIS Analyst so the wage figure for a "Computer Systems Analyst" within state government/ local government was used (BLS, 2010). The BLS mean wage per hour for a "Computer Systems Analyst" was $32.53 (BLS, 2010).

These two occupational categories were chosen because the duties detailed in each position most closely matched those the GIS Technician and GIS Analyst would perform. For each of these positions, the mean wage was used because this study was not specific to a particular geographic region.

The BLS was used as the source of wage data because it represented one of the few credible sources of wage data publicly available. While there were many companies or individuals that provided wage information for the GIS industry, the methods by which many of them collected their data were unknown or the data provided were determined from small sample sizes.

Within the confines of this case study, both the GIS Technician and GIS Analyst worked in a contract position that lasted for the duration of the project. The GIS Analyst was contracted to assist in overseeing the work of the GIS Technician and performing system administration and maintenance tasks. The GIS Technician was hired to create and attribute the parcels for the project. Each employee was paid on an hourly basis and the wage figures reflected employee benefits. The division of duties between the GIS Technician and GIS Analyst was based on the author's own experience on professional GIS projects and consultation with industry professionals.

In some cases, the creation of a GIS system is outsourced to a private company or larger governmental organization. Outsourcing is a viable alternative to undertaking a GIS implementation and therefore worthy of consideration within this case study. Winona County in Minnesota, which has approximately the same population as the city modeled in this case study, charges a flat fee of $60 per hour for "implementing and development of GIS applications" (Winona County, 2011). This flat rate of $60 was multiplied by the total number of hours required if the project were done internally minus the 120 hours for setup/installation of software.

The setup and training process was not necessary for outside consultants. If the project was outsourced, it would also not be necessary to purchase software or hardware for servicing or maintaining the GIS application since this cost would be borne by the consulting organization.

One quantifiable benefit was the labor costs savings that would occur from not having to assign city staff to handle land information records requests from citizens. The time saved from these tasks could be used to perform other duties that benefit the city or reduce the overall staffing need. According to the BLS, the mean hourly wage for a local government 'Information and Records Clerk' is $15.29 (BLS, 2010). Assuming it takes an average of 10 minutes, $1/6^{th}$ of an hour or 15 minutes, $1/4^{th}$ of an hour, to research and answer a citizen's question regarding their land information records, the number of requests for this information per year was used to extract the dollar figure that represents yearly cost-avoidance from using GIS.

Cost Avoidance Value (1) per request (CAV) = Info. Clerk Wage * .16667(equivalent to $1/6^{th}$ of an hour)

Cost Avoidance Value (2) per request (CAV) = Info. Clerk Wage * .25(equivalent to 1/4th of an hour)

CAV * number of requests = yearly cost avoidance

Essentially, this figure represents the money not spent on the clerk's wage because the GIS performed a task that previously had been done by the clerk. This figure should be assessed with the understanding that a GIS system will not completely eliminate the need for land records personnel but rather the system will reduce the in-person or phone inquiries they receive regarding land records.

The second type of benefit was derived from revenue generated by the sale of GIS data or paper map products to private companies or individuals. In order to model realistic conditions within this case study, the 2011 GIS data fee schedule for Winona

County Minnesota was used as a template (Winona County, 2011). The 2011 rates for GIS parcel data from Winona County were: $75.00 per request for data plus $.0.07 for parcels 1-5000, $0.05 for parcel 5000-15,000, and $0.04 for parcel above 15,000. Revenue generation projections at each of the digital parcel price points were calculated to show revenue generated from the sale of 100, 1000, 5000, and 10,000 parcel segments.

Winona County also sells printed maps at $3.00 per page for an 8.5x11 map and $5.00 per page for an 11x17 map. According to a local municipal GIS official, the demand for printed map products in Winona County is greater than the demand for digital data products (Zielsdorf, 2012). To account for this fact, the sale of printed maps was modeled at 8.5x11 and 11x17 rates.

Furthermore, the demand for complete parcel datasets, either as digital data or printed maps, is lower than the demand for smaller portions of the dataset, such as a section of the county (Zielsdorf, 2012). This phenomenon is modeled by a greater number of small datasets projected to be sold.

The total revenue figure is a summation of the sale of digital data and printed map products for a single year. Total revenue is represented as a percentage of the maximum projected revenue, from the sale of printed maps and digital data, in increments of 25% from 25%-125%. This was done to better contextualize how much revenue could be generated if a certain percentage of projected revenue was realized.

For all financial calculations 100% of the projected revenues in addition to the maximum cost-avoidance value were used to represent expected benefits.

The municipality of the official interviewed generated $2400 in revenue last year; this figure was used as a baseline comparison to ensure revenue projections were realistic (Zielsdorf, 2012).

Advanced Fiscal Metrics Methodology

The return on the initial investment was calculated using this formula:

%ROI = (Total Net Benefits/Total Costs) x 100 (Maguire, Kouyoumijan, and Smith, 2008).

This formula for calculating ROI was selected because it provides a quantifiable value for what the city would receive monetarily for each dollar it invested in GIS.

It is acknowledged there are benefits to a GIS implementation within this scenario that could not be measured. However, these calculations represented an attempt to quantify everything that would be involved in the GIS implementation process while keeping in mind the decision making process would be undertaken with more than just quantifiable measures in mind.

The Net Present Value (NPV) formula was used to project the overall value of GIS implementation in present-day dollars (Pick, 2005). NPV typically is used to analyze future returns three years into the project from the start date. The discount rates modeled within this case study were 5%, 8%, and 10%. These values were selected by the author. In many cases, the variables that enter into the selection process of the discount rate are numerous and discussion of these is beyond the scope of this paper (Obermeyer and Pinto, 2008). Three different rates were modeled in order to provide context for the returns each rate would provide. NPV calculations were run using Money Zine's NPV calculator (Money Zine, 2012).

The initial startup investment used in the NPV formula includes all the hardware, software, and labor necessary to initiate the project. This value does not include the yearly maintenance labor costs. Likewise, there is no return for the initial "Year 0" investment. The return is only seen in years 1 through 3 (Money Zine, 2012).

Results

Labor costs were calculated using the wages cited in the methods section multiplied by the number of hours necessary to complete each task (Table 1). The total startup labor expenses if the project was carried out internally for the first year were $54,487.14. $5,205 was also accrued as a yearly maintenance cost that was expensed on a yearly basis in years 1-3. In these projections, 638 hours were budgeted for the work of the GIS Analyst and 1,580 hours were budgeted for the work of the GIS Technician. The work of the GIS Analyst consumed 33% of the budgeted time and the work of the GIS Technician consumed the remaining 66%.

Due to the wage differences, the GIS Analyst earned 44% of the labor costs while the GIS Technician earned 56%. The GIS Analyst worked approximately one half of the hours of the GIS Technician and was focused on higher level activities such as database and web application creation and maintenance in addition to performing quality control checks on the work of the GIS Technician. All cost and time estimates displayed in Table 1 were based on the budgeted time for each task and the employees responsible for the task. Table 2 displays the startup and yearly maintenance costs if the project were outsourced.

Software costs were considered as a one-time investment for each user. $6000 was assigned for each of the two users of the desktop software for a total of $12,000. Due to the fact that the GIS Analyst would be solely responsible for managing the spatial data on the server, $7,000 was projected in order to represent the costs for this software.

Table 1.Overall startup labor costs if the project were done internally.

Task	Employee	Hours	Cost
Setup	Analyst	120	$ 3,903.60
Setup	Technician	80	$ 1,708.00
Meetings	Analyst	50	$ 1,626.50
Meetings	Technician	50	$ 1,067.50
Digitization	Technician	450	$ 9,607.50
QC of Digitization	Analyst	68	$ 2,212.00
Attribution	Technician	1000	$21,350.00
QC of Attribution	Analyst	150	$ 4,879.50
Server Database Development	Analyst	150	$ 4,879.50
Web Application Development	Analyst	100	$ 3,253.00
Startup Total		2218	$54,487.10

Table 2. Labor costs of the project if outsourced.

Task	Hours Required	Cost/Hour	Cost
Startup Costs	2018	$60	$121,080
Yearly Maintenance	160	$60	$9,600

These costs (Table 3) were included within the startup costs, not the yearly costs. The costs in years 1-3 consist solely of labor costs for maintenance which is estimated at $5,205. This value was determined by multiplying the hours projected for maintenance times the hourly rate of the GIS Analyst.

Table 3. License costs for each required software component at startup.

Software	Cost Per User
Desktop (Two Users)	$ 6,000
Server	$ 7,000
Total	$ 19,000

If the implementation was outsourced, there would be no software costs; those would be incurred by the consulting organization.

The hardware costs in doing the project internally came from the purchase of two computers, a server, and two monitors. The cost for these items was estimated to be $1270.

If the implementation was outsourced, there would be no hardware costs; those would be incurred by the consulting organization.

Figure 1 displays the total startup cost for the project and the yearly maintenance and software expenses (for the licensed software). The startup costs include the necessary hardware and labor (including yearly maintenance and is accounted for in years 1 through 3) to execute the project over its first three years.

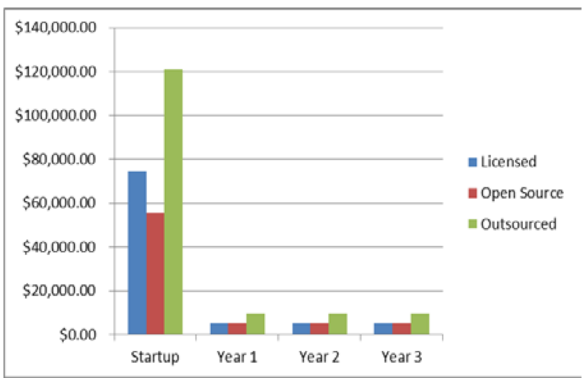

Figure 1. Total costs of the project using licensed software, open source software, and an outsourced project implementation in startup and years 1 through 3.

The benefits of a GIS were first considered from the perspective of labor cost-avoidance. The saved labor costs were calculated twice: 1) assuming that each citizen request required 1/6th of an hour to complete, and 2) assuming each request required 1/4th of an hour (Tables 4-5). The cost avoidance per request is the mean hourly wage for this position divided by six and four, respectively. The 'Requests' field represents the number of citizen requests per year. The 'Savings' field is a product of the 'Request' field multiplied by the cost avoidance.

Tables 4 and 5 display the cost savings derived from not having to pay an information clerk to handle these requests. If the average request required an average of 10 minutes to complete, that equates to 1/6 of an hour.

If 250 requests for land information were serviced via a GIS instead of by city staff, $637.5 in wage costs would be avoided because these services were provided by the GIS system. Likewise, if the same number of requests took 15 minutes (1/4th of an hour) each, those same requests would save the city $955.50.

Table 4. Cost avoidance at 1/6th of an hour per request.

Requests	Savings(1/6th hour)	Savings(1/6th hour)
50	$2.55	$127.5
150	$2.55	$382.5
250	$2.55	$637.5

Table 5. Cost avoidance at 1/4th of an hour per request.

Requests	Savings(1/4th hour)	Savings(1/4th hour)
50	$3.82	$191.0
150	$3.82	$573.0
250	$3.82	$955.0

Detailed in Tables 6 and 7 are the results from the revenue generation projections from the sale of parcel datasets and printed map products. The price per parcel was assessed using the Winona County fee schedule.

The revenue figure was derived by multiplying the price per polygon by the number of parcels and by the '# of data sets' field. The 10,000 parcel figure is a complete parcel dataset within this case study.

Table 6. Revenue projections for sale of digital data.

Price Per Parcel	Number of Datasets	Revenue	Parcels Per Dataset
$0.07	7	$ 574.00	100
$0.07	5	$ 725.00	1000
$0.07	3	$1,275.00	5000
$0.05	1	$ 575.00	10000
	Total	$3,149.00	

Table 7. Revenue projections for the sale of printed map products.

Map Size	Number of Pages Sold Per Year	Cost Per Page	Revenue
8.5x11	50	$3.00	$ 150.00
8.5x11	100	$3.00	$ 300.00
8.5x11	200	$3.00	$ 600.00
11x17	50	$5.00	$ 250.00
11x17	100	$5.00	$ 500.00
11x17	200	$5.00	$1,000.00

Table 8 displays the total yearly revenue projected to be generated from the sale of printed and digital GIS data. The '100% of Projected Revenue Realized' value originates from the summation of the revenue projections for the sale of digital data and $600 per year worth of paper map products being sold. The figure used for the sale of paper map products does not imply that only 8.5x11 maps will be sold at the quantity indicated in the table, but rather the total sales of both sizes of maps will equal $600.

This value was selected because it is near the median in the range of projections. The sale of paper map products was projected to be lower than the sale of digital map products because the revenue realized per unit through the sale of a paper map is far less than the sale of digital data. While the quantity of digital data sets sold is projected to be smaller, the revenue on each dataset is larger and thus contributes more heavily to the overall total revenue projections being realized.

Table 9 presents the net present value (NPV) calculations if the licensed software was selected and the maximum calculated benefit was obtained for years 1 through 3.

Table 8. Total yearly revenue projections for the sale of printed and digital data.

Percent of Projected Revenue Realized	Total Revenue(Printed + Digital)
25%	$ 937.25
50%	$1,874.50
75%	$2,811.75
100%	$3,749.00
125%	$4,686.25

The NPV has been calculated at 10%, 8%, and 5% discount rates. The 'Cash Flow In' column represents the projected revenue plus the costs avoided per year. 'Cash Flow Out' refers to the yearly maintenance costs detailed earlier in this paper (Money Zine, 2012). The startup costs are also used in the NPV formula and can be found in Figure 1.

Table 9. NPV using licensed software.

Startup	$74,757.1		
Dis. Rate	Yearly Cash Flow In	Yearly Cash Flow Out	NPV
10%	$4,704.5	-$5,205.0	-$76,001.8
8%	$4,704.5	-$5,205.0	-$76,047.0
5%	$4,704.5	-$5,205.0	-$76,120.1

Within this case study, the decision to use open source software was also considered. While open source software lowered the initial cost it did not change the benefits conferred from the system. Table 10 contains the NPV of a GIS system using open source software with a 10%, 8%, and 5% discount rate and the maximum benefit being realized in years 1-3.

The NPV of the project if it were outsourced was also measured in Table 11.

Table 10. NPV using open source software.

Startup	$55,757.1		
Dis. Rate	Yearly Cash Flow In	Yearly Cash Flow Out	NPV
10%	$4,704.5	-$5,205.0	-$57,001.8
8%	$4,704.5	-$5,205.0	-$57,046.9
5%	$4,704.5	-$5,205.0	-$57,120.1

Table 11. NPV if the project was outsourced.

Startup	$121,080		
Dis. Rate	Yearly Cash Flow In	Yearly Cash Flow Out	NPV
10%	$4,704.5	-$9,600.0	-$133,254.4
8%	$4,704.5	-$9,600.0	-$133,696.2
5%	$4,704.5	-$9,600.0	-$134,411.7

ROI

Table 12 displays the ROI for the three GIS implementation options. The 'Costs' column holds the sum of the startup and maintenance costs for the initial three years of the project. The 'Benefits' column displays the three year sum of the total benefits obtained. The negative ROI value (expressed as a percentage of the total project life cycle investment) is indicative of a project that will not return a positive investment for each dollar invested over the project's first three years.

Table 12. ROI of the implementation options.

Method	Benefits	Startup & Yrs. 1-3 Costs	ROI Perc.
Outsource	$14,113.5	$149,880	-90.6
Open Source	$14,113.5	$71,372.1	-80.2
Licensed	$14,113.5	$90,372.1	-84.4

There were many potential benefits such as increased convenience for citizens and greater efficiencies throughout the organization that could theoretically be realized by expanding the GIS systems into other parts of the city's operation. For the purposes of this project, only the implementation costs and benefits that could be readily quantified were considered.

Discussion

From a financial perspective, the viability of a GIS system is largely dependent upon the ability of a GIS system to produce revenue by selling data. Some states allow cities to sell their GIS data. However, the direct revenue generation opportunities via the sale of GIS data is limited in many states. This is due to this information being public information and thus being freely available (Croswell and Wernher, 2004). According to a survey published by the Urban and Regional Information Systems Association (URISA), in 1998, "Only about 10 percent of the agencies actively advertise data for sale or distribution in catalogs, clearinghouses, or other approaches" (Croswell and Wernher, 2004). Between 1998 and 2003, when a second survey of local government was published, 85% of respondents in the survey were selling some GIS data (Croswell and Wernher, 2004). The survey goes on to indicate that 82% of organizations provided data to "Other Public Agencies", 74% provided data to "Private Companies", 50% provided data to "Not for Profit Organizations", and 63% provided data to "Individuals/Citizens" (Croswell and Wernher, 2004).

While these surveys indicated a stronger willingness to sell GIS data, in the long-term it is highly unlikely the cost of the GIS implementation could be fully paid for by the sale of GIS data. However, the sale of data could be used to provide a tangible benefit to offset implementation costs and augment cost savings and non-tangible benefits derived from the GIS system. The decision making process in GIS implementation should be driven by a desire to improve process efficiency, information management systems, public accessibility to information, and data sharing between departments, not a desire to generate revenue, because the demand for GIS data can be hard to predict before a system is in place.

In making projections regarding revenue generation, an organization would want to gauge the interest from companies and individuals in the community in purchasing GIS data before making these calculations. Implementing a GIS without having a firm understanding of the realistic returns that could be expected would be short sighted and could lead to unrealized expectations.

While the purpose of a GIS is not necessarily as a revenue generator, the high up-front costs associated with putting it in place could make the system a financial burden for any city if the benefits were miscalculated.

The NPV and ROI figures (Tables 9-12) indicate there is little financial return on a GIS system. These numbers represent only projections of future returns; however, in projecting increased revenue or cost avoidance over the life of the project to cover startup and maintenance costs would be an unjustifiable error. GIS data cannot be sufficiently monetized and costs cannot be reasonably quantified well enough in the early stages of a project to indicate any kind of positive future financial return. The impetus for putting a GIS system in place must come from a strong desire to reap the strong unquantifiable benefits a GIS can provide, such as increased public information sharing.

If the project were conducted internally, the decision on which software to use was the only area of cost flexibility. There are many options for open source GIS software available to GIS users and organizations. These software packages are sometimes created for a specific purpose rather than trying to be a complete software solution as the licensed proprietary software packages attempt to be. In many cases, these software packages require extensive programming to customize them for project needs, which can increase project preparation time. The other major issue with open source software is the lack of designated software support. Many of these software packages are developed by online or academic user/developer communities and are the result of collaborative efforts. These groups can provide support if other users have questions but there is no certainty that the users will get the answers they seek or that the software will be updated in a timely fashion. For professional users who seek to create a stable, reliable web application and GIS system, open source software does not offer the software support of licensed proprietary software. As an addendum, while the software itself is free to use, some software packages will charge users for customizations to the software package that are specifically requested by the user. These types of costs represent hidden potential costs that are part of using open source software.

Licensed proprietary software provides considerable benefits to professional GIS users but these benefits are balanced by considerable costs. Licensed software is developed in commercial software engineering environments that go through methodical testing before software is sent to market. For professional GIS users, these software packages may provide greater software stability and software support via regular updates and patches. In many cases licensed software attempts to provide a wide palate of tools to meet any needs a of GIS user. Typically, while programming, scripting, and customization are certainly integrated into these software packages, unlike open source software, the licensed software packages are created to be “out of the box” GIS solutions that allow users to jump into analysis immediately without much configuration needed. Licensed software also has designated software support representatives in place within their organization to answer questions of users. There are also well established user communities that are similar to those that surround the open source software and they can provide additional assistance to users. Licensed GIS software is typically broken into tiers; each tier provides certain capabilities and has an associated cost. As the capabilities increase, so does the cost. Sometimes these capabilities are packaged as extensions that can be purchased individually or as packages. The costs escalate sharply upwards as a user purchases more extensions. Therefore it is imperative GIS professionals and project managers identify exactly what the workflow will be for their GIS projects and what tools they will need. A failure to do so could cause project managers to invest in unnecessary extensions and add unnecessary costs to any project budget.

Outsourcing a GIS implementation can also create unrealized expectations or unexpected costs. Communication between the consultant and municipality regarding the functionality and structure of a GIS system is vital in order to ensure that the deliverable ordered is the one that is received. Even if solid communication is maintained and a well-defined project framework is in place, outsourcing can lead to quality issues in the final product due to a host’s diminished ability to oversee the daily work on a project. The decision to cede creation of an important system to an outside consultant must be given much consideration.

Conclusions

Conducting a case study such as the analysis of a GIS implementation required a series of projections and assumptions to be made. All these projections represented sources of potential error, but overall the financial tools such as NPV, ROI, and revenue generation models proved suitable for modeling a GIS implementation scenario. Case studies such as this report are important because they provide a model for how to quantify the GIS implementation process. Future research could focus on applying different financial tools to a GIS implementation scenario or attempting to reconstruct a cost-benefit analysis from a GIS system that has already been established.

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