Abstract

In the past GIS justifications were concerned with quantifying the cost of GIS as a tool box comprising data, hardware, software and people with GIS expertise, and the benefits as increased revenue and cost saving/avoidance through improved efficiency and effectiveness. Recent GIS research suggests that an organisation-wide GIS is more than a toolbox. It is part of a production infrastructure for meeting the geographic information needs derived from the objectives of an organisation. When justifying GIS nowadays, one should identify the benefits that match the vision and commitment of the administrative level concerned, which should then be balanced against the technological and organisational investment needed in developing the necessary GIS infrastructure.

Introduction

Nowadays, in order to compete with other projects for the limited resources, government departments are using cost-benefit justifications to support their GIS proposals. In Victoria, a major cost-benefit exercise was conducted during a State Government-wide GIS planning study in 1991. It found that total benefits of $312 million can be expected from a $56 million investment in GIS, fully discounted at a rate of 7% over a period of 6 years, giving a cost-benefit ratio of 5.5:1 (Tomlinson Associates Ltd., 1993b) As a strategic initiative, the study convinced the State Government of Victoria to invest in GIS. It also laid the ground work and prescribed a schedule for developing the State Geographic Data Architecture by the Office of Geographic Data Co-ordination.

Despite its positive conclusions, the study registered a caveat in the section of "Requirements for Going Forward" for its cost-benefit justification. This paper will look at the implications of the caveat, and suggest how recent GIS research findings can help improve the justification approach adopted.
A holistic cost-benefit approach to justifying organisation-wide GIS

The 1991 planning study applied a consistent cost-benefit methodology to five key program areas of government. An investigation of the Land Status and Assets Management (LSAM) sector will assist in understanding how the methodology worked. Basically, the staff in each agency identified one or more information products to be generated by GIS. All the potential benefits of the information products, tangible, intangible, and external (outside agencies), were identified and quantified as far as possible. In the resulting cost model, the quantified benefits were compared with the tangible costs of data, technology (hardware and software) and expertise acquisition. This cost is referred to below as the technological cost. Table 1 shows a summary of cost-benefit items identified or used in the GIS planning exercise for the LSAM sector. It is also a good representation of the items considered by other sectors.

Table 1. Cost-Benefit Items for the Land Status and Assets Management Sector (Tomlinson Associates Ltd., 1993a)

<table>
<thead>
<tr>
<th>Cost items</th>
<th>Benefit Items</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Quantified and Compared:</strong></td>
<td><strong>Quantified and Compared:</strong></td>
</tr>
<tr>
<td>Staff:</td>
<td>Improved work efficiency – cost saving:</td>
</tr>
<tr>
<td>additions</td>
<td>– general maintenance</td>
</tr>
<tr>
<td>training</td>
<td>– plan replacement</td>
</tr>
<tr>
<td></td>
<td>– More efficient staff training</td>
</tr>
<tr>
<td>Hardware:</td>
<td>– Better packaging of contracts</td>
</tr>
<tr>
<td>Terminal type</td>
<td>– data maintenance/management</td>
</tr>
<tr>
<td>Input Device</td>
<td>– generate planning certificates</td>
</tr>
<tr>
<td>Output Device</td>
<td>– emergency evacuation routing</td>
</tr>
<tr>
<td>Software</td>
<td>Increased sales/revenues</td>
</tr>
<tr>
<td>Applications</td>
<td>Staff savings/reduction</td>
</tr>
<tr>
<td>Data</td>
<td>Rent reduction/avoidance</td>
</tr>
<tr>
<td>Site Preparation</td>
<td>Reduced litigation/objection cost</td>
</tr>
<tr>
<td></td>
<td>Quantified benefits in $ for improved decision making</td>
</tr>
<tr>
<td><strong>Identified but not quantified:</strong></td>
<td></td>
</tr>
<tr>
<td>Better information, access to...</td>
<td></td>
</tr>
<tr>
<td>information, operations, analyses,</td>
<td></td>
</tr>
<tr>
<td>decisions, &amp; results</td>
<td></td>
</tr>
<tr>
<td>Support process automation</td>
<td></td>
</tr>
<tr>
<td>Better data security, comprehensiveness, &amp; less errors</td>
<td>Eliminate duplication, cost saving, &amp; improved services in external agencies</td>
</tr>
</tbody>
</table>
A holistic cost-benefit approach to justifying organisation-wide GIS

Reduced litigation with more solid evidence
Satisfy statutory obligations, auditable work
More efficient economic environment
Facilitate interagency cooperation
Timeliness of output - handle more work, reduce backlog, increase the appeal of using services provided

Technological and Organisational Costs

Typical of studies with a bias towards the innovation – GIS in this case – a wide variety of benefits were identified in the 1991 study, which were quantified as far as possible, and compared with a limited range of items that make up the technological cost. Knowing that it would take more than just investment in the form of technological cost to gain the benefits predicted, the study registered a caveat which included:

- "Adequate resourcing of geographic data coordination and agency GIS implementation programs."
- "Low-cost availability of government data between government agencies in Victoria."
- "Departments must be allowed to apply GIS technology to increase the effectiveness of program expenditures without immediate concomitant cuts in program budgets or the incentive to introduce GIS technology to gain effectiveness will be strongly inhibited."
- "Senior level (CEO and Ministerial) direction will continue. Cross-portfolio cooperation is crucial..." (Tomlinson Associates Ltd., 1993b)

To the experienced managers, each caveat item translates into additional cost items correspondingly:

- There are costs of coordination and implementation.
- Prior special mechanisms will have to be developed for low-cost data sharing to take place, e.g., standards, administrative and legal framework, institutional goodwill, arrangements acceptable to parties concerned etc.
- Incentives, such as budgetary support, are needed for people to apply the technology to gain benefits.
- Senior level direction and cross-portfolio cooperation will have to be cultivated using various kinds of resource and will not appear out of thin air.

These items can be further translated into strategies needed to support GIS development, which must be funded in one way or another. Unlike technological costs which are usually capital costs incurred up-front to build up the more visible part of GIS (data, software, hardware, and people with GIS expertise), these items constitute a new category of cost. This category of cost is the general recurrent management cost incurred by the whole organisation in the form of time, money, policies and effort by managers and leaders with good management and socio-political skills, to build up an environment for the GIS to function. As it is concerned with management of people, and intra- and inter-organisational relationships, we can call it human-organisational cost, or simply, organisational cost.

The 1991 study was only required to include technological costs in its cost-benefit justification. The approach is valid probably for a project-oriented GIS which will provide specific services to be used by a small team of specialists or highly motivated participants, to achieve the common goals of a well defined project within agreed/ allocated project time and funds. The benefits are clear-cut, being the completion of the project in time and within budget, or achieving well-
A holistic cost-benefit approach to justifying organisation-wide GIS

defined efficiency or effectiveness gains. In this case, GIS introduction can be regarded as a
technical process of building up the GIS toolbox of data, technology, and expertise to provide
the required services. Minimum coordination and administrative input will be required to ensure
that GIS is used to achieve the common goals. The same may also apply to a self-contained
independent management unit with well-defined goal/s and geographic information
requirements in an organisation.

For an organisation with a departmental hierarchical administrative structure like that of the
State Government of Victoria, a GIS that can meet the requirements of all the administrative
units is far more complex to design and implement than a project-oriented GIS. We can called
this particular type of GIS organisation-wide GIS, the introduction of which involves more than
just acquiring a toolbox of GIS data, technology, and expertise. In the next section, the
components of an organisation-wide GIS and its process of introduction are described.

A Broader Concept for GIS and Its Introduction

The uniqueness of GIS as a management information system has been discussed by (Huxhold &
Levinsohn, 1995 p.7; Obermeyer & Pinto, 1994 p.70) Chan & Williamson 1996b) summarise the
three skills and knowledge needed for GIS to be successful. They are:

1. proficiency in the substantive application areas such as mapping, asset management, or
environment planning etc.,
2. GIS skills, and
3. GIS paradigm, or simply the principles of the GIS way of operation.

These principles are no stranger to professionals such as surveyors, planners, or natural
resources scientists etc., but often are unfamiliar to personnel providing information technology
services (ITS) to an organisation. This is why GIS often starts off as a local project within a
certain business function of an organisation, pioneered and developed by professionals other
than the ITS staff. This local project often has the characteristics of a project-oriented GIS. The
purpose of the GIS is highly focussed and pre-defined, the participants are motivated, and the
costs and benefits are well defined. Once top management provides the necessary funding, the
main issue is to put together the necessary hardware and software, to build up the data and
expertise for the project team, and to achieve the target within the deadline. This often gives a
false impression of simplicity to managers implementing such a GIS.

Should top management decide to expand the GIS to serve the entire organisation, the original
managers may be tempted to apply their rather restricted implementation experience,
irrespective of the scale of the new GIS. Almost inevitably, they will encounter problems, both
technical and organisational, of a totally different scale and nature. A sample of the issues are:

- Which standards should be adopted for hardware, software and data for the organisation,
and how can these standards tie in with the infrastructure already put in place by the
information technology services people?
- Who’s interest will be affected by the introduction of the organisational GIS? What would
be their reactions, and to what extent will these reactions affect the success of the GIS?
- What is the best way to persuade the various interest groups in the organisation to accept
GIS?
- What kinds of policy are needed to establish the legitimacy of the GIS and to encourage
people to use the GIS in their routine operations to gain the benefits predicted?
- Are the existing operations amenable to improvements expected by the introduction of
GIS? If not, what impact will changes to these operations have on the people?
- Are the unions likely to accept GIS?
- To what extent is top management prepared and able to back up the project financially
and politically in time of difficulties or conflicts?

The list of issues above is not exhaustive. They arise because GIS benefits will only be realised
A holistic cost-benefit approach to justifying organisation-wide GIS

if management units in an organisation accept the GIS paradigm, and the GIS introduced is used by people, operating within both the formal and informal settings of the organisation (Chan & Williamson, 1996b) The formal setting is the organisational objectives, and the official administrative hierarchy, policies, management and operational procedures established to produce the goods and services to achieve the objectives. The informal setting represents an organisation’s values, norms and culture in general, and the socio-political relationships among the people and interest groups. Often the informal setting, acting within the framework laid down by the formal setting, fine-tunes or even determines the outcomes of implementation of the organisation-wide GIS.

Recognising that successful GIS introduction into an organisation is more than just adopting the technology, and that organisational political behaviours can be commonplace during GIS introduction (Pinto & Azad, 1994) Campbell and Masser 1995) expand the concept of GIS diffusion – the study of GIS development – to an umbrella concept, encapsulating awareness raising, adoption, implementation, routinization and utilisation of GIS and an assessment of the consequences of the entire exercise for the individuals and organisations concerned. In practice, along the same line of understanding, for long the Federal Geographic Data Committee Undated) of USA has defined its National Spatial Data Infrastructure (NSDI) as the technology, policies, standards, and human resources necessary to acquire, process, store, distribute, and generally improve the use of geospatial data through promoting their sharing throughout all levels of government, the private and no-profit sectors, and academia. Echoing the concept of an infrastructure for the national spatial data of USA, Chan and Williamson (1996b) suggest that GIS plays the role of an integral part of the organisation’s production infrastructure, complementing the information technology infrastructure Chan & Williamson, 1996a) already in place to support the business processes.

With these in mind, it is timely to consider what actually constitutes a GIS, or more specifically, an organisation-wide GIS. There are many definitions of GIS in the literature Maguire, 1991) but they are more suited to project-oriented GIS. When planning for the introduction of an organisation-wide GIS, relative to the technical issue of developing the GIS toolbox, issues concerning standards, policies, institutional arrangements, users requirements, and the general formal and socio-political environment of an organisation loom large in the agenda of the planner. The infrastructure nature of an organisation-wide GIS implies that its development is more than just building up the GIS toolbox. It involves establishing:

- a community of users and supporters who accept the GIS paradigm, i.e., believe in the value of the GIS way of conducting business,
- the GIS toolbox and the associated organisational setting that is conducive for these users to apply the technology to gain the predicted benefits, i.e., the technological and organisational GIS infrastructure.

In short, organisation-wide GIS is an integral part of the organisation’s production infrastructure, both technological and organisational. It comprises data, information technology, standards, people with GIS paradigm and expertise, and the organisational setting. Its introduction will require careful planing and the injection of funds, both capital and maintenance, like the introduction of other public infrastructure such as a road network or an education system.

**Justification for GIS – From Vision to Cost**

Recently, concepts from diffusion and organisational analysis leads to the identification of the driving force behind GIS diffusion in an organisation. It is the cumulative active acceptance of the GIS paradigm into the visions of decision makers Chan & Williamson, 1996b) irrespective of which administrative level they are in. The most important driving force comes from top management with a GIS aligned vision as they are the ones who make the policies and mobilise the resources. Therefore, when planning for the development of GIS, in order to gain top
management’s sustained support, Chan and Williamson 1996b) stress the importance of aligning GIS with their vision regarding the organisational business goals and the associated IT strategy.

Based on the vision and with the help of GIS planners, top management will have to decide the role of GIS in achieving the organisational business goals, and to specify the target scope of development of GIS in the organisation. From a useful model by Keen 1991) Chan & Williamson 1996a) have identified two criteria, namely, reach and range for such a purpose. Reach is the locations GIS is capable of linking. Range refers to the degree to which geographic information can be directly and automatically shared across systems and services. The more advanced the development based on these two criteria, the better established the GIS is in the organisation and the more benefit can be expected from GIS. Based on the reach and range framework, we also can identify different contingencies of GIS development as illustrated in the matrix in Figure 1.

In this matrix, there are two scenarios of range along the x-axis – discrete and integrated, and two scenarios of reach along the y-axis – local and corporate. Four contingencies of GIS development can be identified:

- local discrete – GIS exists as stand-alone systems in one or a couple of business units;
- corporate discrete – GIS exists as stand-alone systems in many business units corporate-wide;
- local integrated – GIS exists as a system integrated with the local IT system of a business unit;
- corporate integrated – GIS exists as a system fully integrated with the corporate IT, infrastructure and business process.

The matrix can be a useful planning tool. Once the target scope of GIS development is decided, it allows an organisation to map the target state of GIS development and view it in relation to the current and possible intermediate states of GIS development. Based on the overview and the working experience of the planner, it is possible to plan the path to bring GIS from its current state of development to the target state (see Figure 1) according to top management’s
A holistic cost-benefit approach to justifying organisation-wide GIS strategic goals, taking into consideration other organisational constraints.

Even with the targets defined, researchers stress the need to involve the users/people (Campbell, 1990) in working out ways best to achieve the milestones as defined by the two criteria prior to the actual implementation of the GIS plan. Though it is crucial to have top management with a GIS-aligned vision, it is as important to get the GIS paradigm accepted into the visions of decision-makers or opinion leaders in other levels to gain sufficient momentum to overcome resistance to the diffusion of GIS. Recent findings by Pinto & Onsrud (1993) confirm that there are two most significant and dominant groupings of factors affecting perceived utilization success in local governments, namely, benefits to extended users: and utility. The former refers to generating benefits to meet both internal and external needs, while the latter refers to the utilitarian value of GIS to improve internal tasks. Other important groupings of factors are history of success & failure, cost, and communication channels

Although these factors only accounts for part of the causes of successful adoption of GIS in local government, they serve as a good starting point to develop strategies to persuade decision-makers and opinion leaders in the organisations to adopt GIS. Based on Chan and Williamson’s GIS decision model (1996b) the acceptance of the GIS paradigm into the visions of decision makers will be more likely affected by benefits to extended users and utility. The other factors will probably constitute a set of constraints affecting the actual decision to adopt GIS. Based on this distinction, good examples of strategies that can facilitate acceptance of the GIS paradigm by decision makers are setting up demonstration GIS, talks with vendors and users, in-house pilot projects, setting up interest groups, and helping potential users to solve problems using GIS etc.

With the ultimate and intermediate targets of GIS development well defined, and by gaining acceptance of the GIS paradigm by a wider spectrum of users, it will be easier to assess the GIS benefits and the strategies needed to build up the technological and organisational infrastructure to achieve the targets. Based on the strategies, the associated resources requirement can be identified, and as a result, a better cost of GIS introduction can be estimated. Together, the resulting costs and benefits present a more realistic economic picture of GIS implementation for top management. Based on this economic picture and with guidance from top management, the GIS planner, in consultation with the stakeholders can refine the targets, expectations and the associated strategies of implementation to suit the needs of the organisation and make the process of GIS introduction less traumatic to all.

Even when the GIS planner has no direct access to top management to get direction and feedback, it is still worthy of the planner’s effort to take a wider perspective of the potential role of GIS in achieving the organisational business goals and to match it with the vision of top management as far as possible. Then, by treating the organisation-wide GIS as an infrastructure rather than a toolbox, and by maintaining communication with other decision makers, opinion leaders and stakeholders, more realistic benefits and strategies of introduction can be derived and cost. This approach of justification is more holistic and will not only generate a more pragmatic cost model of GIS introduction, but also a set of implementation strategies that underpins the model.

**Conclusion**

The paper has identified two types of GIS: project-oriented and organisation-wide. The approach to cost-benefit justification for each type of GIS is based on technological cost alone and both technological and organisational costs respectively. Organisation-wide GIS is actually an integral part of the organisation’s production infrastructure, comprising data, information technology, standards, people with GIS paradigm and expertise, and the organisational setting. Its introduction will require careful planning and injection of both capital and maintenance funding to build up the technological and organisational GIS infrastructure for its sustained development.
When planning for an organisation-wide GIS, it is necessary to match its development with the vision of top management in the context of the business goals of the organisation and associated IT strategy. The planning exercise can be carried out within a matrix of reach and range. This matrix provides a means of charting the course of GIS development aiming at maximisation of returns. It would set the scene for the systematic identification of the geographic information needs, the associated scope of GIS services needed and potential benefits. From that, based on the empirical experience of the GIS planner, the implementation strategies needed to achieve the target GIS can be derived, underpinning the estimation of the associated cost. Not only will the resulting GIS cost-benefit justification be more realistic, the overall planning will also become more holistic.

Acknowledgment

The authors would like to acknowledge the Office of Geographic Data Co-ordination (OGDC) of the Victorian Government for its assistance in the preparation of this paper and the associated research. The views expressed in the paper are those of the authors and do not necessarily reflect the views of OGDC.

References


A holistic cost-benefit approach to justifying organisation-wide GIS


Author/s: 
Chan, Tai On; WILLIAMSON, IAN

Title: 
A holistic cost-benefit approach to justifying organisation-wide GIS

Date: 
1996

Citation: 

Publication Status: 
Published

Persistent Link: 
http://hdl.handle.net/11343/33936

File Description: 
A holistic cost-benefit approach to justifying organisation-wide GIS