

## BIOGRAPHICAL INFORMATION

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### Specific Responsibilities

Dr. Ottawa joined the University of Idaho faculty in 1985 to instruct GIS application courses in the Department of Landscape Architecture. He has taught numerous GIS courses since his first appointment. Also having served as a co-director of the GIS Laboratory, he was responsible for promulgating early GIS technologies among a number of disciplines represented on campus. Twenty years later, everyone affiliated with the University of Idaho has free educational access to the GIS technologies.

### Past Experience

Dr. Ottawa has taught CAD and GIS-related courses at Ball State University and the University of Idaho for 25 years and has published more than 50 papers, journal articles and technical reports. His forthcoming book entitled *Applied Land Informatics* is based on his inexhaustible motive to help maximize the benefits from GIS in corporate settings by understanding better and sound GIS design that meets organizational missions and goals. He served as a trustee of the International Geographic Information Foundation.

### Educational Information

B.S.L.A. – Landscape Architecture, Tokyo University of Agriculture  
M.L.A. – Regional Planning, University of Massachusetts at Amherst  
Ph.D. – Geographical Sciences and Planning, University of Queensland, Australia

### Professional Memberships

American Society of Landscape Architects (ASLA)  
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BENEFITS AND OBSTACLES OF GIS IMPLEMENTATIONS:  
RECENT PERCEPTUAL SHIFTS AND IMPLICATIONS FOR CITY AND REGIONAL  
PLANNING ORGANIZATIONS

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ABSTRACT

Geospatial information systems (GIS) were widely diffused into various organizations in the 1990's and have become a common tool for many professions. Statewide surveys were conducted to help evaluate their implementations in a *corporate* or organization-wide environment in Queensland, Australia, using a questionnaire as a data collection instrument.

This paper specifically examines survey respondents' perceptions of the benefits and obstacles associated with GIS, and how that perception shifted during the 1990's. The review of GIS literature identified 10 types of benefits and 12 types of obstacles that are associated with GIS implementations. Survey respondents evaluated these factors on the scale of 1 to 4, from least to most important in our two surveys administered during the early and late periods of the 1990's.

The statistical analyses of both survey results reveal that the perceived benefits changed very little in the State during the last decade, contrary to our early hypothesis that both benefit and obstacle factors would shift due to the increased learning curve as the implementation phase progresses. Conversely, the early obstacles may have been overcome or have shifted to different types of obstacles in the late 1990's as our survey results clearly indicate.

INTRODUCTION

GIS has been diffused widely into various organizations responsible for land planning and management in recent years. To help assess the efficacy of GIS implementation, a long-term research project was initiated in the early 1990's. At that time, there was an urgent need for scientifically understanding a better and effective method of diffusing GIS into a corporate setting with particular reference to the city and regional planning and management mandates of local governmental entities. (The term *corporate* refers to a corporate governing body in this paper rather than a private corporate entity as normally used.) An assessment model was conceptualized and applied to local government authorities (LGAs) in the State of Queensland, Australia, as a demonstration site. A questionnaire was designed and used as a data collection instrument, and the assessment data was collected twice during the last decade, first in 1991 and again in 1999. This paper describes and compares several findings from both questionnaire results with particular reference to the research objectives stated below.

RESEARCH OBJECTIVES

Results from several research objectives were published previously (Ottawa and Lyons, 1992; Ottawa, 2002a; Ottawa, 2002b), and therefore not discussed in this paper. The specific objectives

this paper addresses are; (a) to assess how the benefits and obstacles associated with a corporate GIS are perceived by organizational managers and GIS users in physical or spatial planning organizations, (b) to analyze how these perceptions shifted during the last decade, and (c) to examine the implications of such changes over time as the state of implementation progresses in the future.

## ASSESSMENT PROCEDURE

When our research project commenced in the early 1990's, there was an urgent need for understanding a better and effective method of diffusing the GIS technology into spatial planning and management organizations. In response to the urgency, the author conceptualized an assessment model that was applied later to local government authorities (LGAs) in the State of Queensland, Australia. As mentioned, a questionnaire was used as a data collection instrument, and data was collected twice -- first in 1991 and again in 1999 -- from LGAs throughout the State that were chosen at random. The questionnaire consisted of four major parts, Part A through D, where the first three parts aimed at collecting organizational data, for example, the number of employees by each organizational division, the status of GIS within an LGA, and the approach that an LGA took to implement its corporate GIS. The last section of the questionnaire, Part D, consisted of a series of questions to assess the values, beliefs and attitudes of survey participants regarding their corporate GIS. It included 57 parameters that influence the success (or failure) of GIS. Nineteen other factors within this section assessed their preferences for GIS data, attitudes toward data sharing, areas of GIS applications, etc. In addition, Part D of the questionnaire incorporated two questions about the benefits of GIS and obstacles to the implementation of a corporate GIS. This paper provides an in-depth analysis of the answers to these two questions.

Several authorities in organizational behavior and management, and socio-technical studies provided this researcher with a theoretical foundation (Eason, 1988; Emery, ed., 1969; Hirschheim, 1985; Hirschheim, Klein and Lyytinen, 1995; Lawler, Nadler and Cammann, 1985; Pasmore, 1988; Rogers, 1995; and Van De Ven and Andrew, 1980). This foundation is outlined briefly in one of our earlier publications (Ottawa and Lyons, 1992) and in more recent publications (Ottawa, 2002a; Ottawa, 2002b). Success in MIS implementation has been documented already and analyzed extensively (DeLone and McLean, 1992). Some of the recent GIS adoption studies helped further strengthen our assessment (Campbell, 1994; Campbell and Masser, 1995; Nedovic-Budic and Pinto, 1999; Nedovic-Budic, 1999; Onsrud and Rushton, eds., 1995; Onsrud and Pinto, 1991; Pinto and Onsrud, 1993; and Tulloch, 2000).

## PROFILES OF SURVEY PARTICIPANTS

As mentioned, two surveys were conducted during the 1990's, first in 1991 and again in 1999 throughout the State of Queensland. Questionnaires were sent to 50 randomly selected LGAs in both surveys, and 32 of the 50 LGAs returned 94 completed forms. There were 137 LGAs present in 1991 in the State. During the second survey, twenty-two LGAs out of the 50 sent returned 29 completed forms (i.e., 44% organizational return rate). Because of mergers with neighboring LGAs and/or their restructuring initiatives in the State, several LGAs selected in 1991 no longer existed in 1999. In such a case, forms were mailed to the reorganized entity.

The lack of sufficient funding to conduct on-site, follow-up interviews was the primary reason for the low return rate in the second survey.

Additionally, detailed characteristics of the participants including (a) disciplines, (b) position classes and (c) level of experience in GIS are further described (Ottawa, 2002a; Ottawa, 2002b). In brief, many professional backgrounds were represented, and no single discipline was dominant in either survey. Position groups were also diverse including various types of managers, technical support personnel, and GIS users both internal and external to an LGA. The modal class for the level of GIS experience shifted from 2 to 7 years, an excellent indicator that some progress had surely been made in implementation during the 1990's.

### PERCEIVED BENEFITS FROM GIS IN *CORPORATE* SETTINGS

One of the survey questions (i.e., Part D, Question 8) was designed to assess the respondents' perceptions of benefits from a *corporate* GIS. Table 1 lists the question as it appeared in our questionnaire in both surveys.

Table 2 compares the ranking orders of the perceived benefits of GIS from our two surveys. It shows that the perceived benefits have changed very little for the last decade. Respondents thought GIS would bring benefits to our society in three respects:

1. Improved public accountability,
2. Improved decision-making due to better and sound data analysis, and
3. Enhanced communication among involved parties.

It is remarkable to note that the majority of respondents agreed on these three types of benefits in both surveys, although survey participants were completely different in each survey. These benefits are considered as common threads and are in line with some arguments made in the late 1980's (Chrisman, 1987; Clapp et al., 1989). Generally, these trends may be interpreted that GIS, as used at the local government level (with particular reference to Queensland, Australia), is making a *healthy* progress towards achieving the above goals.

### PERCEIVED OBSTACLES IN GIS IMPLEMENTATIONS

A question (i.e., Part D, Question 7) similar to Question 8 in Table 1 asked for the respondents' perceptions of obstacles and is listed below in Table 3. Contrary to the benefit beliefs discussed in the previous section, the perception of obstacles in implementing and operating a *corporate* GIS changed significantly between our two surveys (see Table 4).

The obstacle that has seen the most dramatic change is the factor Q7-(1), i.e., "management has little support, therefore funding level is insufficient." It was ranked seventh in 1991 but was lifted to the obstacle of first importance in 1999. When our project commenced in 1990, GIS was still in infancy as a *corporate* information system. Very few organizations had gained sufficient experience to make GIS fully beneficial and operational, and yet a number of LGAs were interested in moving towards automation with GIS which was slowly gaining popularity at that time. Management was generally in favor of GIS (see Table 4), conceivably due to curiosity

in the relatively new technology, thirst for it, or somewhat inflated expectations often triggered by vendor demonstrations.

Table 1. Question to Assess Perceived Benefits from GIS

<p><b>Q8. What are the major benefits envisaged by you as a result of implementing GIS for your department/organization? Select FOUR important benefits and rank them in the order of importance. (4 = most important, 1 = least important)</b></p> <ul style="list-style-type: none"> <li>▪ Can do my routine job much faster</li> <li>▪ Requires less funding to perform my function</li> <li>▪ Can respond to requests from the public much quicker</li> <li>▪ Can do much detailed analysis of data</li> <li>▪ Can produce prettier maps than hand-drafted ones and other forms of output</li> <li>▪ Managers are quite impressed by what GIS can do</li> <li>▪ Automation is the name of the game and therefore system demands less work from me</li> <li>▪ Will result in savings to the general public since system increases organizational efficiency</li> <li>▪ Enhances communication between other departments and us</li> <li>▪ Increases the chance of citizen participation in planning process</li> <li>▪ Other (Describe: _____ )</li> <li>▪ Other (Describe: _____ )</li> </ul>
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Table 2. Change in Perceived Benefits of GIS between Two Surveys

Overall Rank		Type of Benefit	Rank Sum		Rank Average	
1991	1999		1991	1999	1991	1999*
1	2	Can respond to public inquiries quicker	199	215	2.1	2.3
2	1	Being able to analyze data in detail	191	217	2.0	2.3
3	3	Resulting in savings to public	156	133	1.7	1.4
4	5	Enhanced communication within organization	109	107	1.2	1.1
5	6	Faster daily work with GIS	93	98	1.0	1.0
6	4	Can produce better cartographic products	38	110	0.4	1.2

\*Converted to 1991 scale for comparison purpose.

Many LGAs invested significant amounts of funds in various GIS resources – hardware, software, human resources -- to name a few in the 90's. Now, management demands tangible returns from their investments. Without the tangibles, it is less likely that management continues to support a *corporate* GIS. It is well known from various case studies of management information systems (MIS) that this is the type of hurdle that any information system experiences. Some researchers proposed organization-wide solutions to overcoming hurdles with particular reference to GIS (e.g., Saarinen, 1987). More specific and focused organizational diagnosis will be necessary to examine each case to gain (or re-gain) management support for GIS today.

The obstacle, "Insufficient knowledge and skills to use GIS," has continued to plague LGAs for some time, which is still one of the most critical impediments today. It means that LGAs must strive for continuing education in GIS for their employees to make the installed systems worthwhile. Educating employees will require additional costs to maintain the operation of an existing GIS and may make management more skeptical about it without any tangible results as discussed above.

As in the case of educational needs above, the lack of quality GIS data has hindered many LGAs in the State for some time. The availability of GIS data necessary for projects may have improved a little since our first survey. Enhanced data availability does not necessarily mean that their accuracies have also improved. LGAs constructed many GIS databases when users did not demand their high precision levels or technology did not allow for such accuracies. In addition, many of them may have been outdated because some LGAs could not afford to keep updating their databases. Although it is still an important issue today, the factor "Data conversion issues" eased a little thanks to the knowledge gained from a decade of implementation experiences and improved technologies such as data conversion software.

LGAs' learning in implementing GIS is also evidenced by the factor "Not anticipating potential problems early," which is less critical today than ten years ago. Lastly, the market for the GIS technology has continued to grow, thanks to the accelerated manufacturers' competition, innovations and mass-production. New and improved technologies have become easily available to those who could not afford them ten years ago. The factor "Cost of GIS hardware and software" no longer restrains LGAs from GIS implementations and their sustainable operations.

## CONCLUSIONS

Two statewide surveys were conducted during the last decade to understand scientifically a better and more effective method of diffusing GIS into an organizational setting with particular reference to the land planning and management mandates of local governmental entities in Queensland, Australia. A questionnaire was used to collect perceptual and preference data from local government entities in the State. Of the twenty-five questions included in Part D of the questionnaire, two were designed to assess participants' perceptions on the benefits and obstacles of GIS implemented in an organizational setting. This paper analyzed the perceptual change between the two surveys. The perceptions of benefits shifted very little and may be categorized into three areas: (1) Improved public accountability, (2) Improved decision-making due to better and sound data analysis capabilities, and (3) Enhanced communication among involved parties. In contrast, the perceptions of obstacles in GIS implementations have shifted considerably. Today, "the lack of management support" tops the list of obstacles. Educating and training

employees continues to be a priority item for the participated LGAs. Equally important are the issues that relate to GIS data frequently used by LGAs, including (1) data inaccuracies – both spatial and attribute, (2) data conversion issues, e.g., digitizing and format translations, and simply (3) the lack of data necessary to perform routine job duties.

Table 3. Question to Assess Perceived Obstacles in GIS Implementations

**Q7. If you have any major obstacles you have encountered or anticipate during implementation such as the following, please identify FOUR major ones and rank in the order of importance (4 = most important, 1 = least important)**

- Management has little support, therefore funding level is insufficient
- Not many users with sufficient knowledge and skills to operate GIS
- Data sets in digital form are not easily available or are too expensive to purchase on the market
- System hardware and software are too expensive to purchase at this point in time
- Not recognizing problems when implementation was initiated
- Data conversion issues such as data format incompatibility and the lack of data standards
- Data accuracy is insufficient to perform our job function
- GIS software does not meet our needs and/or standard
- GIS hardware does not meet our needs and/or standard
- Very few are interested in moving towards GIS in our organization
- Will possibly antagonize or have already antagonized other departments
- Political pressure from other departments, internal or external to organization
- Other (Describe: )
- Other (Describe: )

In conclusion, the State of Queensland, Australia can maximize benefits from their existing GIS by focusing on the identified obstacles. By overcoming barriers, their GIS could move to the next stage of implementation. To gain (or re-gain) support from management may not be an easy matter since significant amounts of investments have been made for some time on their GIS resources. However, efforts should be targeted towards removing the identified obstacles, which are usually performed tactically on an incremental basis. Such efforts may require a significant amount of funding; therefore, it is important to focus on what each LGA can do to help solve problems within their limited funding levels, which vary greatly from organization to organization.

Table 4. Comparison of Perceived Obstacles in GIS Implementations between Two Surveys

Overall Rank		Type of Obstacle	Rank Sum		Rank Average	
1991	1999		1991	1999	1991	1999*
1	2	Insufficient knowledge and skills	181	38	1.9	0.4
2	4	Data conversion issues	100	21	1.1	0.2
3	5	Lack / availability of necessary data	84	16	0.9	0.2
4	8	Not anticipating potential problems early	70	9	0.7	0.1
5	3	Inaccuracies of spatial and attribute data	62	23	0.7	0.2
6	10	Cost of GIS hardware and software	47	7	0.5	0.1
7	1	Lack of support by management	43	42	0.5	0.5
8	6	Lack of interest in GIS	35	15	0.4	0.2

\*Converted to 1991 scale for comparison purpose.

In addition, the State should continue to monitor closely the progress of implementation as our project has accomplished to date. With these targeted efforts, many LGAs, particularly in Queensland, Australia, can enhance the rate of success in GIS implementations. Other entities, whether public, private or semi-public, could maximize benefits from GIS in a similar fashion.

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#### REFERENCES

- Campbell, Heather. 1994. "How Effective are GIS in Practice? A Case Study of British Local Government." *International Journal of Geographical Information Systems* 8: 309-325.
- Campbell, Heather and I. Masser. 1995. *GIS and Organizations*. Bristol, Pennsylvania: Taylor and Francis.
- Chrisman Nicholas R. 1987. "Design of Geographic Information Systems Based on Social and Cultural Goals." *Photogrammetric Engineering and Remote Sensing*, v.53, n.10, pp.1367-70.
- Clapp, James L.; McLaughlin, J.D.; Sullivan, J.G.; and Vonderohe, A.P. 1989. "Toward a Method for the Evaluation of Multipurpose Land Information Systems." *Journal of the Urban and Regional Systems Association*, v.1, n.1, pp.39-45.
- DeLone, William H. and E. R. McLean. 1992. "Information Systems Success: The Quest for the Dependent Variable." *Information Systems Research* 3: 60-95.

- Eason, Ken. 1988. *Information Technology and Organisational Change*. London: Taylor and Francis.
- Emery, Frederick E., ed. 1969. *System Thinking -- Socio-technical Systems*. London: Penguin Press.
- Hirschheim, Rudy A. 1985. *Office Automation: A Social and Organizational Perspective*. New York: John Wiley.
- Hirschheim, Rudy, H. K. Klein and K. Lyytinen. 1995. *Information Systems Development and Data Modeling: Conceptual and Philosophical Foundations*. New York: Cambridge University Press.
- Lawler, Edward E., III, D. A. Nadler and C. Cammann. 1985. *Organizational Assessment: Perspectives on the Measurement of Organizational Behavior and the Quality of Work Life*. New York: John Wiley.
- Masser, Ian and H. J. Onsrud. 1993. *Diffusion and Use of Geographic Information Technologies*. Boston: Kluwer Academic.
- Nedovic-Budic, Zorica. 1999. "Evaluating the Effects of GIS Technology: Review of Methods." *Journal of Planning Literature* 13: 284-295.
- Nedovic-Budic, Zorica and J. K. Pinto. 1999. "Interorganizational GIS: Issues and Prospects." *The Annals of Regional Science* 33: 183-195.
- Onsrud, Harlan J., J. K. Pinto. 1991. "Diffusion of Geographic Information Innovations." *International Journal of Geographical Information Systems* 5: 447-467.
- Otawa, Toru. 2002a. "GIS Diffusion in Urban and Regional Planning Organizations: Analysis of Paradigm Shift in the 1990's." *In: Proceedings of the First Hawaii International Conference on Social Sciences*, np.
- Otawa, Toru. 2002b. "Analysis of GIS Diffusion in Digital Government: Application of an Evaluation Model." *In: Proceedings of GIS 2002 held in Toronto, Ontario, Canada*, np.
- Otawa, Toru and K. Lyons. 1992. "Success of GIS Implementation: Perceptual Variations among Local Government Officials in Queensland, Australia." *In: Proceedings of the LIS'92 Symposium held in Vancouver, B.C.*, pp. 1-10.
- Pasmore, William A. 1988. *Designing Effective Organizations: The Sociotechnical Systems Perspective*. New York: John Wiley.
- Pinto, Jeffrey K. and H. J. Onsrud. 1993. "Correlating Adoption Factors and Adopter Characteristics with Successful Use of Geographic Information Systems." *In: Masser, Ian and H. J. Onsrud, eds. Proceedings of the NATO Advanced Research Workshop on Modeling the Diffusion and Use of Geographic Information Technologies*, pp. 165-194.
- Pinto, Jeffrey K. and B. Azad. 1994. "The Role of Organizational Politics in GIS Implementation." *Journal of the Urban and Regional Information Systems Association* 6: 35-61.
- Rogers, Everett M. 1995. *Diffusion of Innovations*. Fourth Ed. New York: The Free Press.
- Saarinen, Allan O. 1987. "Improving Information Systems Development Success under Different Organizational Conditions." *In: Proceedings of the 25th Conference of Urban and Regional Information Systems Association (Vol. II)*, pp.1-12.
- Tulloch, David L. 2000. "Data Shaping the Landscape: GIS and Stewardship." *Landscape Journal* 19: 211-219.
- Van De Ven, Andrew and D. L. Ferry. 1980. *Measuring and Assessing Organizations*. New York: John Wiley.