A Model of the Decision Process for GIS Adoption and Diffusion in a Government Environment

Tai On Chan and Ian P. Williamson

Abstract: *The way a government organization conducts its business can be viewed as a public management system, consisting of a 'public production process' in an organizational setting. In this system, many factors interact with one another to make it operate. Accordingly, the decision for the adoption and diffusion of geographic information systems (GIS) in such a system also will be subject to the influence of these factors. Based on the experience of GIS adoption and utilization observed in several Australian State government agencies in 1995 and 1997, six such factors are identified, namely, GIS aligned dominant vision of decision makers, production infrastructure, production process, product mix, organizational setting, and the external environment of the stakeholders. Their relationships are described in a model that confirms the need for alignment between GIS and these factors in a government organization.*

Introduction

A government organization functions in the context of two elements: the unique way government conducts its business and the organizational setting. The government business delivery process, also called 'public production process' by Alford (1993), comprises the use of the production infrastructure of a government, by means of a process of production, to generate a product mix to satisfy the needs of the stakeholders and to gain a continual provision of resources. The organizational setting is the formal and informal management environment developed over the years of existence of the organization. Any introduction of change in a government environment must be studied in the context of these two elements. This paper will examine how these two elements interact in general, and provide a framework to describe the decision process for adoption and diffusion of GIS in a government environment. The paper starts by examining what constitutes the government business delivery process.

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Government Business Delivery Process

Disturbed by the success of business management principles in gaining support of government administrators, Moe and Gilmour (1995) reiterate the importance of law-based principles of public administration in protecting the citizenry from an overbearing, arbitrary, and capricious use of government power. They stress that private and public sectors are inherently different and the entrepreneurial management model is not and cannot be a substitute for political and legal accountability. They call for the recognition of the strengths and responsibilities of each sector. Moe and Gilmour's view echoes the debate about 'managerialism' in the Australian public sector in the late 80s as noted by Alford (1993). This debate centered on whether or not public sector activity should be managed as a productive process just like the private business sector. After reviewing the argument, he concludes that neither party give a proper account of the task and context of public sector management, and puts forward a public management model called 'Public Production Process'.

Alford regards public sector activity as a production process made up of four main components: *organizational capabilities*, *production*, *value*, and *environment*. Organizational capabilities refer to the productive capabilities of the organization such as staff, equipment, buildings etc. Production is the procedures whereby the organizational capabilities and other resources are converted to something of value. Value refers to something of value produced, such as goods, services, market failure remedies, and equity etc. Environment is the citizens and stakeholders for whom the value is produced; and from whom authority and funds (taxes) to conduct the business are received. The public produc-

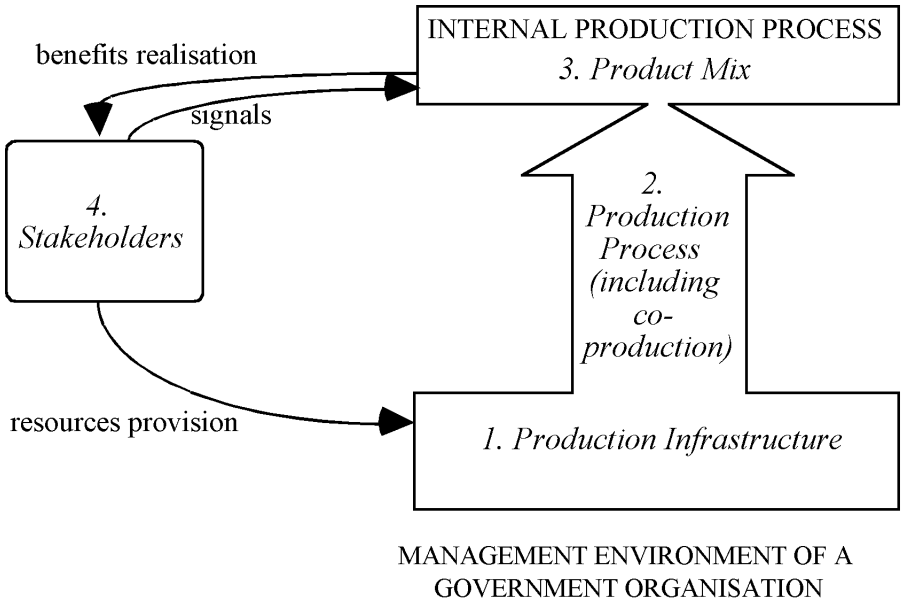

Figure 1.
The Public Management System of a Government Organisation (adapted from Alford, 1993).

tion process is distinct from the private one in four ways. Very briefly, first, public sector managers produce non-market values (also referred by some researchers as public value) in addition to market values. Second, the range of actors in the *environment* is more complex involving stakeholders other than clients and taxpayers. Third, public sector managers use public power, including persuasion, convenience and power itself, in addition to public money as a resource to carry out their tasks. Four, they make use of public power to tap production capabilities from other external organizations through a process called co-production. To portray a clear and coherent set of meanings and to facilitate the following discussions, the four elements are renamed from environment to *stakeholders,* organizational capabilities to *production infrastructure*, production (including co-production) to *production process* and value to *product mix*. For a government organization, the stakeholders will form its external environment while the remaining three elements will constitute the internal production process within its management environment. Together, they make up the *public management system* of that organization (Figure 1)

GIS Diffusion in a Government Organization

In this section, we shall try to identify the relationships between GIS and the public management system of a government organization, and establish what GIS diffusion in this environment entails. There are many definitions of GIS (Maguire 1991). In a recent review of the identities of GIS, Chan and Williamson (1999a) summarize four perspectives on the nature of GIS: *identificational, technological, organisatioal* and *productional*. In a diffusion study the *identificational* perspective describes the unique features of GIS and distinguishes GIS from other types of information systems that may or have been adopted by an organization. These unique features include:

- Data of entities and relationships managed within a spatial framework; and
- Ability to perform spatial analyses.

Rogers (1993) defines diffusion as the process by which an innovation is communicated through certain channels over time among members of a social system. GIS adoption is typically a contingent innovation-decision (Rogers 1983, p.347) as its adoption decision by an organization normally proceeds that of the individuals owing to the high capital outlay required. As Campbell and Masser (1995, p.5) point out, this type of decision by an organization involves interaction between complex sets of personal, organizational and cultural interests. Further, adoption does not necessarily lead to successful utilization resulting in benefits. They suggest that diffusion should be an umbrella concept encompassing the processes of awareness raising, adoption, implementation, routinization and utilization and an evaluation of the outcomes. The ultimate achievement of GIS diffusion is the embodiment of the technology into the organization's business processes (Zwart 1993). Therefore the study of GIS diffusion within an organization will involve study of not just the adoption decision, but a process comprising a whole host of GIS deci-

sions involving adoption, implementation, utilization, and routinization in order to achieve the required outcomes.

An organization is a stable system of individuals who work together to achieve common goals through a hierarchy of ranks and a division of labor (Rogers and Agarwala-Rogers 1976, p.26). Stability is achieved by a high degree of structure imposed on communication patterns through creation of the formal and informal organizational settings. The formal setting which is defined by predetermined goals, prescribed roles, authority structure, and rules and regulations (Rogers 1983), also broadly define how the internal production process is structured to achieve the organizational goals. Before any major change can be formally adopted and accepted, it must first gain official recognition through the formal setting, e.g., by means of proper justification or feasibility study etc. through prescribed channels.

The informal setting refers to the various kinds of informal practices, norms and social relationships among the members of the organization (Rogers 1983). These members, like all other communities of people, have different opinions and values, conflicting priorities and goals. As a result, they compete amongst themselves for power and resources (Handy 1993, p. 291). This competition gives rise to organizational political behaviors, which are displayed to attain a goal by "*informal*, rather than formal means of *influence* in the face of potential *conflict*." (Pinto and Azad 1994). These behaviors manifest the presence of the informal setting. While the formal setting broadly defines the internal production process, the informal setting decides how and what are actually produced. As a result, any major change will ultimately have to pass the scrutiny of the informal setting in addition before it is fully accepted by the organization. Likewise, before the bolts and nuts of a GIS can be introduced into a government organization, in one way or another, the importance of the unique features of GIS based on the *identificational* perspective of GIS in the internal production process must be established in both the formal and informal organizational settings first.

Traditionally, recognition by the formal setting is achieved through justification exercises or feasibility studies. If successful, this is often followed by purchasing and installation of the hardware and software. At this stage, GIS enters into the internal production process as an entity in the production infrastructure. Through a process of data conversion, applications development, and training, GIS may be used to varying degrees to produce the product mix required of the organization. Often problems arise at this stage in the diffusion process. Though the unique abilities of GIS may have been accepted in the formal setting, it has not gained the recognition of the informal setting. Unless it has, it will be difficult for GIS to be integrated into the internal production process. As a result, the progress of diffusion may be delayed or even stopped.

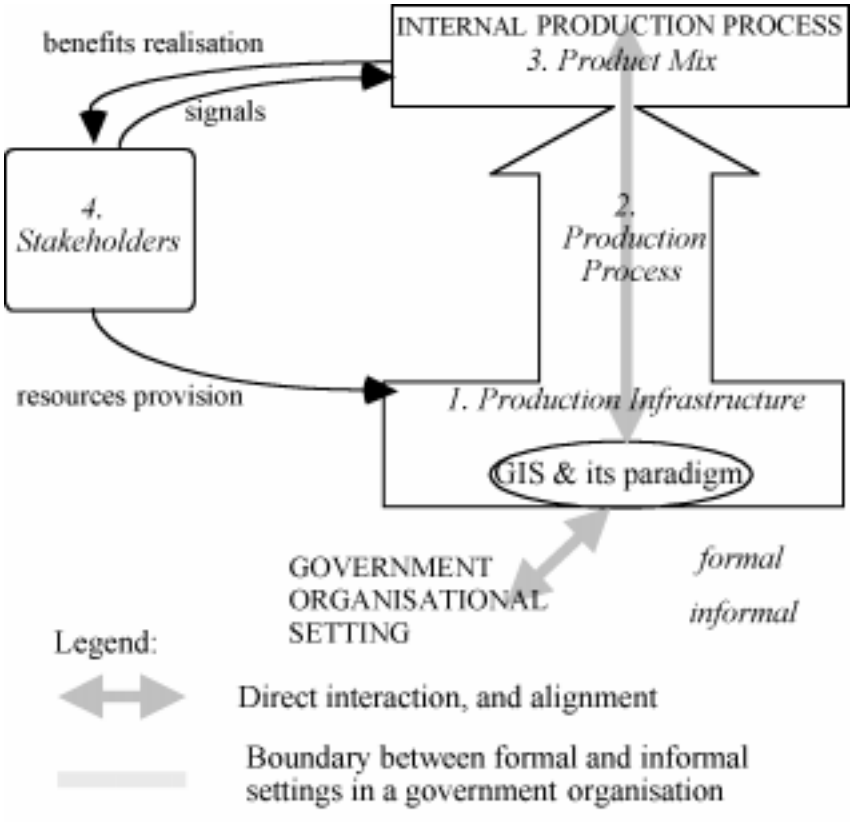

Figure 2. Interactions of Factors in a Public Management System during GIS Diffusion.

In an ideal situation when the unique abilities of GIS has been recognized by both the formal and informal settings, the technology will gradually become an integral part of the production infrastructure and production process (Chan and Williamson 1995), converting resources to the prescribed product mix. In the diffusion process, the production process may have to be modified, or re-engineered, to make full use of the potential offered by the technology. When users become more proficient with the technology, they can identify more efficient ways of production, or new products that may be more effective in meeting the needs of the stakeholders. This achievement is important as by reducing cost and satisfying the stakeholders, resources will be more likely available to support the business of the organization. Over time, GIS will diffuse throughout the organization, becoming more integrated into the internal production process and more transparent to the users. Based on the above discussions, the way factors in the public management system of a government organization interact during diffusion of GIS can be summarized in Figure 2.

In the model in Figure 2, the public management system comprises the external environment formed by the stakeholders, and three elements of the internal production process (production infrastructure and process, and product mix) which resides in the government organizational setting. The organizational setting is make up of its formal and informal components for which there may be no clear-cut boundary. The entry point for GIS and its paradigm is the production infrastructure. For it to progress to more advanced diffusion stages, it will have to establish itself as an integral part of the internal production process by creating an alignment with the process and with the formal and informal settings through interaction. This alignment is a reciprocal exercise with each party adjusting to the needs of others to achieve the best outcome. GIS diffusion in a government environment is also indirectly affected by the stakeholders' satisfaction towards the product mix and their willingness to support the production process.

Vision and The GIS Decision Model

As pointed out in the last section, the formal and informal settings of an organization give it not only stability but also significant resistance to change. Under these circumstances, Rogers (1983, p. 349) still observes that innovation is going on all the time in an organization. What is the driving force behind these innovations? The answer may lie in the difference among people in an organization as observed by Handy (1993). People tend to have different personalities, experience, education, needs, and values. These qualities, subject to the influence of the organizational settings, will congeal into their visions, which can be defined as a '*sense of purpose and direction*' (Dunford 1992) or a '*mental journey from the known to the unknown, creating the future from a montage of current facts, hopes, dreams and dangers and opportunities*' (Hickman and Silva 1984). Like people, visions of people in an organization differ. These visions will drive them, actively or passively, reasonably or maliciously, to attaining goals which range from gaining resources or power on purely a self-serving basis to that of furthering the organizational goals (Pinto and Azad 1994).

A vision can play an important role in the decision process for GIS diffusion. According to Rogers' (1983, p. 165) innovation-decision process model, an innovation decision is preceded by knowledge and persuasion. Knowledge of the innovation, GIS in this case, is affected by prior conditions such as previous practice, felt needs/problems, innovativeness and norm of the social system. It is also affected by the characteristics of the decision-making unit comprising social-economic characteristics, personality variables and communication behavior. These prior conditions and characteristics of a decision-making unit correspond to its vision developed within the organizational settings, as described in the previous paragraph.

A vision, on taking into consideration the unique features of GIS, completes the knowledge stage in Rogers' model. The stage of persuasion is completed when the perceived abilities of GIS, such as, access to learning, ease and effects of use, cost, utility etc., are thoroughly evaluated against the vision (Pinto and Azad 1994). This is followed by the decision stage, the outcome of which may be acceptance or rejection. On accepting GIS, a person develops a GIS vision. The higher up the person is within the hierarchy of an organization, the more dominant will be his/her vision, the greater will be the impact of the resulting decisions, and often, the greater will be the resistance encountered. However, it is a person with a GIS vision who is the driving force behind diffusion of GIS within an organization. In the literature, an individual in high position who has a strong GIS vision often is referred as the champion.

As pointed out by Campbell and Masser (1995, p. 159), a champion in an organization may come and go. Under these circumstances, a champion has two important roles to play. First is to get the tangible part of GIS, e.g., data, hardware and software etc. in place. Second is to nurture the development of aligned GIS visions in decision-making units in the organization. On the premature departure of the champion, those with the nurtured GIS vision can develop a new driving force, building on what has been achieved by the champion. Over time, it is the combined drive of those with an aligned GIS vision, which sustains the momentum of GIS diffusion in an organization.

To sum up, the decision for GIS diffusion is a continuous process of decision-making through interaction with the internal production process, the organizational setting, and the external environment of the stakeholders. The whole process starts with the development of a GIS vision in one or more decision making units in an organization, particularly that of the champion. Through the effort of the champion to educate the users and to lobby for support, other decision-making units also develop similar visions that together form a GIS aligned vision. Gradually senior managers may also recognize the value of GIS. Some may decide that the future of the organization lies with GIS and adopt the GIS aligned vi-

sion as the dominant vision of the organization. Other may decide that GIS is an important tool to realize the organizational goals and choose to align the GIS vision with existing dominant vision of the organization. In either case, the outcome is a GIS aligned dominant vision.

Based on the two roles identified for a champion, for GIS diffusion to advance, the GIS aligned dominant vision will have to generate two types of decisions. First are the GIS decisions that directly affect the physical growth of GIS in an organization. It is this type of decisions that dominated the literature in the past. Second are the ancillary decisions that are made to change the production infrastructure, the production process, the product mix, the organizational setting, and the views of the stakeholders to complement the GIS decisions. This is to ensure that the development of GIS and the way the public management system functions align with each other to achieve the organizational goals efficiently and effectively. An important side effect of aligning GIS with the public management system is to make the latter more receptive to the GIS. As a result, ancillary decisions help to nurture GIS aligned visions among other decision-making units in the organization, which in turn will maintain the momentum for GIS diffusion.

These decisions have to be made through interactions with the rest of the public management system, providing valuable feedback towards the state of GIS diffusion in the organization. The outcome is the continual flow of resources from the stakeholders in return for the production of the appropriate product mix demanded in an effective and efficient way. This decision process takes time that is an important factor for successful GIS diffusion. The complete decision process of GIS diffusion in a government environment is illustrated in Figure 3.

An opportunity to match the theoretical model described above with actual practice in a government environment arose during a recent visit to several State Government agencies in Australia to study their GIS development. Three cases are documented in the next section. This is followed by a section discussing how the actual experience can illustrate the concepts described; i.e.,

1) A GIS vision is the driving force behind the decision for GIS diffusion,
2) The need for a GIS aligned dominant vision to sustain the momentum for GIS diffusion. This is achieved by either nurturing minor visions that align with the dominant GIS vision, or aligning the GIS vision with the dominant vision of the organization.
3) The need for alignment between GIS decisions and ancillary decisions.

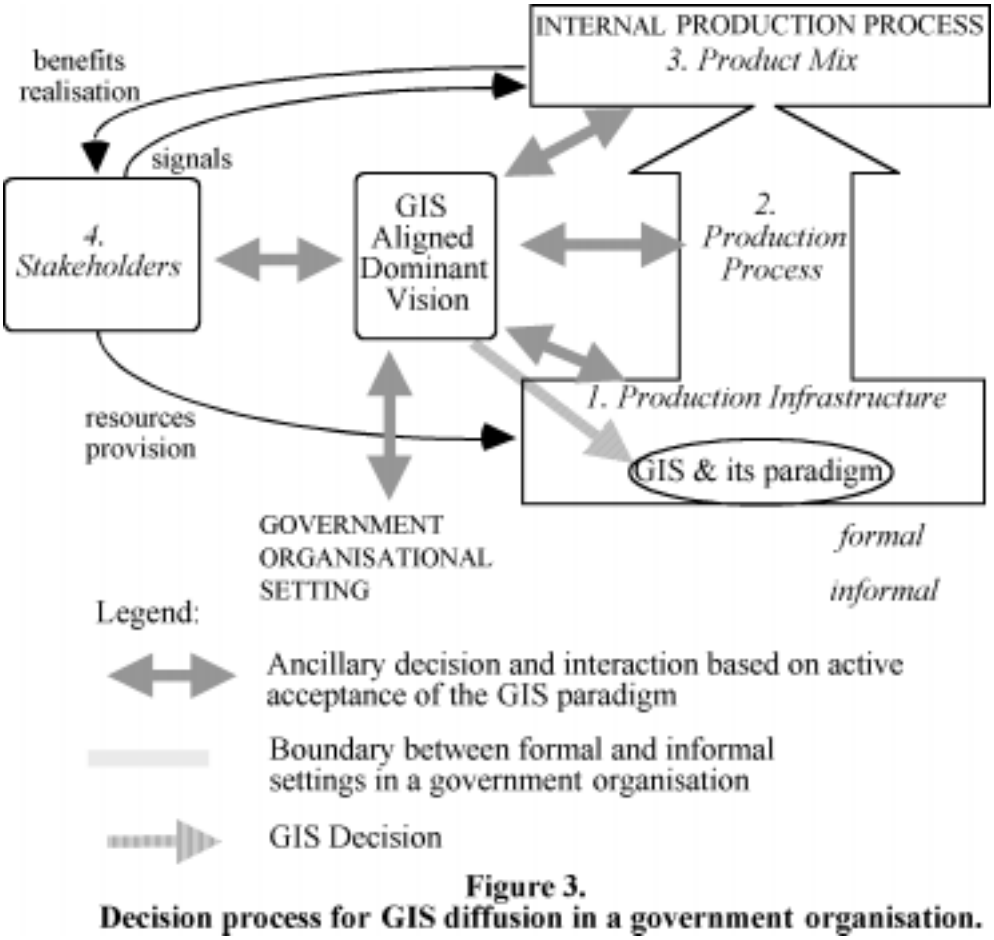

Figure 3.
Decision process for GIS diffusion in a government organisation.

To avoid possible embarrassment to the agencies and the staff concerned, the agencies are identified by a codename respectively: Xcase, Ycase, Zcase. Other than that, as far as the authors can ascertain, the information provided reflects the actual situation.

Cases of GIS Development

Xcase

The first agency is Xcase, which is responsible for the supply of mapping data, both paper-based and digital. It has a total staff size of about 400 and a recurrent annual budget of over A$21 million (1992/93). Though staff was already experimenting with digital facilities in 1974, the organization was not committed to a digital environment and as a result, not much progress was made. In 1985, the present agency was officially established by an amalgamation of two existing Offices, and later was headed by the present Director in 1987.

Since 1980/81, there was a continuous scaling down of the budget and staff size of both the present agency and its parent Offices. The agency was located away from the State capital that bred a feeling of isolation. By 1987, the morale of the staff was low and many were disillusioned about their future with the completion of the statewide cadastral (parcel-based) patterns developed from orthophotographs. The new Director, who was conscious of the needs of the agency and its staff, and had experience with GIS, decided to adopt the technology as part of the long-term strategy of the agency. At first, there was limited support for the new vision. Many staff, apart from the GIS pioneers, was not familiar with use of computers and could even be considered techno-phobic. Use of information technology in the agency was limited.

With the appointment of a supportive business manager, a systematic effort was made to better align the views of managers and staff with the help of GIS pioneers. The effort involved promotion by merit, training staff in the new technologies, and encouraging staff to interact with clients to find out their needs. More significantly, with the help of cost-benefit justifications, politicians were convinced to inject A$30 million for the development of the statewide digital cadastral database (DCDB). Staff could then see the benefits of change, particularly the adoption of GIS, and so, a vision driven, customer oriented GIS embracing culture was developed. The GIS is currently providing both infrastructure and business process services to the various business units of the agency.

Ycase

The second agency is Ycase, which is responsible for land administration, land registration, and general supply of land ownership data, both paper-based and digital, for about three million legal parcels. It supports the operation of the land market in the State. It has a total staff size of about 700 and a recurrent annual budget of about A$30 million (1994/95). It started examining the use of information technology in the early 1970s and a working Management Information System (MIS) was introduced in 1983.

All along, both previous and present Directors of the agency recognize that the system they are running is essentially a GIS, involving both geographic and attribute data albeit the geographic component comprises paper-based maps. In 1988, the Charting Branch received funding to start a pilot GIS project to investigate if providing a computer cadastral map index to the land ownership data was feasible. However, before a full GIS for business application could be developed, the agency needed a Statewide DCDB at graphic accuracy.

In the mid-80s, with an interagency agreement, the development of such a database was to be coordinated by a separate body. In the mean time, apart from supporting the development of the DCDB, resources of Ycase were heavily committed to continually introducing new MIS and the associated changes in business processes needed to reduce reliance on manual labor - to reduce backlog of data up-dates, and generally to improve services to the public. Therefore, the pilot GIS project progressed slowly over the years.

This does not pose any adverse effect on the project that has been kept as an on-going core agency project since 1988. This has been possible because top management are convinced that conceptually, the system being run by the agency is essentially a GIS and in the long term, requires an accurate DCDB for both charting and searching of all ownership data and for checking cadastral survey plans. Further, over these years, the agency gained significant management experience and expertise in the introduction of information technology into the agency. A more change-conducive organizational culture had been built up. With the completion of the DCDB by a separate state agency in 1974-5, an arrangement is in place for the two agencies to work together to develop a GIS that serves their needs. In future, when the GIS is mature enough for agency-wide introduction, the achievement of total computerization and automation of the business delivery process of the agency for both textual and graphical data will be possible.

Zcase

The third agency is Zcase, which is responsible for managing 16,900 km of road and the associated traffic systems in the State, with emphasis on road safety and transport efficiency. It has a total staff size of over 8000 and a recurrent annual budget of over A$706 million (1992/93).

In the late 1980s, middle and lower management of different business units were increasingly aware of GIS, and their demand to use GIS to provide a graphical interface to query the large management databases grew significantly. In response, the general manager of Information Technology Services justified a case for a corporate license of a proprietary GIS software with associated training for a small number of people. At that time, the immature technology and difficult commands resulted in great user resistance. A few took on the challenge and became the GIS core group.

Three years on, managers separately responsible for assets management and maintenance, route and network planning, road

safety and road use, road performance measurement, road funding allocation and environmental management etc. acquired other PC-based GIS products. Though GIS matched the corporate business information needs, there was no consensus on a standard GIS within the agency. In 1991, a management consultant was unable to overcome the problem.

Simultaneously, Zcase's Information Technology policy was being restructured. The officer-in-charge of the exercise saw the value of GIS and fought the case for an integrated GIS at CEO level. Ultimately, an internal cost-benefit justification helped gain approval to set up a team to implement GIS across Zcase. In 1994, a four-member GIS management implementation team was created under the Information Technology Services group to oversee implementation of the selected system corporate-wide. To overcome staff resistance in the process, a value management study was conducted with the help of experts to ensure that all necessary functions are provided to meet end user needs. It gained over 90% support and was found to be a valuable tool to facilitate change.

In early 1995, on the recommendation of one of the directors, the project team was placed under a different section in the agency, within a common geomatic environment of surveying, mapping, and property management. Later, the Chief Executive commissioned a third party evaluation of the implementation of the corporate GIS project, which was found to be a success. The project delivered GIS software, hardware, geographic data, training and applications to users throughout Zcase. Based on the recommendations in the report, the implementation team was given two years to get GIS fully operational and decentralized to regions. It was also required to operate on a self-sufficient basis through provision of services to regions and other clients.

In the mean time, senior management was keen to encourage business units to get quality accredited to ensure that Zcase got value for money from its investment in management and technology. Special badge presentation gatherings were organized to recognize openly the achievement of those who got the status. Senior management was keen to improve the productivity of the agency through conscientious cultural change. It is expected the GIS groups in headquarters and in regions be accredited in time.

Discussion

A GIS vision as the Driving Force

Both Directors of Xcase and Ycase believed that GIS was the technology for the two agencies in future. Their GIS visions had sustained the development of the technology in their organizations. In the case of Zcase, GIS diffusion was a result of two GIS visions. In response to the vision of business managers to use GIS to query the corporate management databases, GIS was introduced in the late 1980s. Uncontrolled introduction of the technology resulted in a proliferation of incompatible systems in Zcase. This led to the development of a vision for an integrated GIS to serve Zcase as a whole. This vision aligned with the dominant vision of the agency and gained senior management support. This brought GIS diffusion in Zcase to a new dimension. Irrespective of the context, decisions in support of GIS diffusion in all three agencies were driven by GIS visions in one form or another.

From a different perspective, the importance of a GIS vision in GIS diffusion is confirmed by a recent study into the study of the long term development of corporate GIS in the Department of Natural Resources and Environment of the State Government of Victoria in Australia. In their study Chan and Williamson (1999b) highlighted the experience of the National Parks Services of the Department, in which GIS diffusion was delayed for ten years or more because of the reluctance of the Director of National Parks Services to invest in information technology, including GIS. This took place despite GIS had become quite common in the Department and a demonstrated need for GIS generated products, such as, maps and plans in the Services. Other managers simply complied with the particular vision of the Director. This confirms that GIS diffusion cannot progress without a GIS vision.

GIS Aligned Dominant Vision to Sustain GIS Diffusion

In Xcase, the Director's belief in GIS as a means to modernize the agency was the GIS aligned dominant vision, and the constant driving force behind development of the corporate GIS. It took him almost a decade to build an integrated GIS to conduct the agency's core business and became a leader in its field. In the process, being aware of the reluctance of the agency to change, an effort was made to better align the visions of the managers and staff with his dominant vision. It involved promotion by merit, training staff in the new technologies, and encouraging staff to interact with clients to find out their needs. At the time of the study, all managers interviewed were perceived to share a common GIS vision.

In Ycase, owing to data and other administrative and business constraints, GIS using digital spatial data has stayed in the pilot stage since 1988. However, unlike similar project in the private sector that would have been abandoned, the project remained as an on-going core agency project. This was largely due to the support of the present and previous Directors who were convinced that the system the agency used to deliver its products was essentially a GIS, albeit a GIS using a paper-based map base. It was their intention to eventually introduce a modern fully computer-based GIS. This was the GIS aligned dominant vision keeping GIS alive in Ycase.

Currently, those responsible for the GIS pilot project have been working on a demonstration to show staff and clients how GIS using digital base map can make the business delivery process more effective and efficient. Over the years, Ycase has successfully introduced new information technology to streamline the old paper-based operations for textual data. The management expertise developed and the resulting change-conducive organizational setting have prepared the agency for the transition to a GIS-based production process. Capitalizing on this achievement

and with the support of top management, it is expected that the demonstration can help nurture a strategic GIS aligned vision rapidly to aid smooth diffusion of GIS in the agency.

In Zcase, top management originally had minimal knowledge of and commitment to GIS. Their vision was to boost productivity and to improve product quality. In the course of realizing the vision, Information Technology strategy (incorporating GIS) was restructured and a Total Quality Management policy was adopted. Once they were convinced by the GIS advocates that an integrated GIS was essential to core business, and was in-line with their strategic intent, they had provided the financial backing and used various means to ensure the successful introduction of a coordinated corporate GIS. Unlike Xcase and Ycase, GIS aligned vision is not the dominant vision in Zcase. However, it aligned successfully with the current dominant vision, generating a GIS aligned dominant vision, and achieving more advanced GIS diffusion.

Since the introduction of the first proprietary GIS into the agency, the GIS vision had spread. More sections in the agency have developed their own GIS based on different PC-based software. This created conflicts when effort was made to introduce agency-wide GIS software under a new vision for an integrated corporate GIS. However, as the new GIS vision had aligned with the dominant vision of the organization, the support of senior management was forthcoming. The different GIS visions of the business units were ultimately aligned through a value management study.

In 1996, GIS hardware and software had also been introduced into the regional offices and staff was encouraged to use the technology with the help of key local advocates. These were also measures to nurture the development of GIS visions by the regional staff through hands-on experience. In due course, it was expected that an aligned GIS vision would be developed throughout the agency to support the coordinated application of GIS to core business.

The experience of the three state government agencies in New South Wales described above suggests that a GIS aligned dominant vision is important to sustain and ensure advance in GIS diffusion in a government organization. However based on their in-depth study of GIS diffusion in the State Government of Victoria, Chan and Williamson (1999b) have made observations that throw additional light on the significant of a GIS aligned dominant vision. They point out that while an ideal corporate GIS is fully integrated, not all GIS capabilities that form a corporate GIS are necessarily integrated. They also found that it took at least the concerted effort of middle and junior managers with a common GIS vision to sustain GIS diffusion in an organization.

Depending on the nature of the GIS vision, the managers may develop GIS capabilities that serve specific business units or the wider community in the organization. If it is the former case, the outcome is islands of the GIS technology in the organization—a corporate GIS that is not integrated—as in the early phase of GIS development in Zcase. If it is the latter case, the outcome is a corporate GIS that is integrated to a different extent depending on the nature of support from senior managers.

According to Chan and Williamson, an ideal fully integrated corporate GIS is a product of concerted effort from junior, middle and senior managers all of whom share a common vision, the GIS aligned dominant vision, to achieve a common goal of develop a GIS that serve the entire organization. However this is only true in the short term. Support from senior management may not be sustainable in the long term due to staff movement and changes in organizational priorities, resulting in the GIS vision no longer being the dominant vision. Visionary junior and middles managers are often left with the task of sustaining the momentum of achieving the common goal using whatever resources and support they can scavenge. As a result of the uncertain support from senior management, development of the ideal fully integrated corporate GIS, while still possible theoretically, cannot be guaranteed in the long term.

As a result of the new insight into GIS diffusion introduced by the research of Chan and Williamson, the significance of the GIS aligned dominant vision in sustaining GIS diffusion is still valid, provided that the GIS in question is a fully integrated corporate GIS, as implied in Figure 3. If the GIS in question is just any collection of GIS capabilities anywhere in the organization, then concerted effort of junior and middle managers in any business unit with aligned GIS visions is sufficient to sustain GIS diffusion.

Alignment of GIS and Ancillary Decisions

In Xcase, although there was a GIS vision in 1987, the Director was fully aware that the agency was not yet prepared for the technology. Apart from nurturing the visions of staff and building up the GIS, ancillary decisions were made to equip more staff with the new technology, to change the manual and product-oriented way of business delivery to an automated, customer-oriented way, and in general, changing the internal production process. Most important of all, a decision was made to invest in a consultancy justification for a DCDB and to actively lobby government (the stakeholders in Figure 3) to invest in GIS. The result was the injection of A$30 million for the project, providing a great boost in morale and financial support to achieving the GIS vision, and demonstrating the importance of aligning the GIS and ancillary decisions.

In Ycase, though a decision was made by the government to develop a DCDB in support of a GIS in the mid-1980s, the agency was only given a supporting role. However, it needed an accurate cadastral map to carry out its work. Further, there was a pressing need to automate the internal production process to meet the demand of clients. Confronted with these constraints and despite the Director's GIS aligned dominant vision, the GIS and ancillary decisions made have to compromise and align with each other. The outcome was to press ahead with the automation process, and to develop the necessary GIS skills in the agency through pilot projects while waiting for the DCDB to be completed.

In Zcase, in the early phase of development of the GIS, the GIS and ancillary decisions were not aligned resulting in proliferation of PC-based GIS. To remedy this position, when it was decided to introduce an agency-wide GIS, an ancillary decision was made to use a value management study to align the visions of the user groups. A consensus was reached as a result, clearing the way for the smooth introduction of GIS. On the other hand, as GIS was only a tool to achieve the agency's dominant vision of quality and productivity improvement, the GIS team will have to abide by the resulting ancillary decisions to get quality management accreditation and to be self-sufficient within two years.

The experience of all the three cases emphasizes the fact that GIS is only part of the internal production process that functions in the organizational setting. In order for any GIS decision to have its impact, it must be accompanied by a set of ancillary decisions to make the internal production process and the organizational setting more conducive to bringing out the full benefits of GIS. The example of Zcase in particular illustrates that once a GIS vision is aligned with the dominant vision, GIS managers and senior management must interact to adjust to each other's needs.

Conclusions

A GIS vision is the driving force behind the decision for GIS adoption and diffusion. It also takes at least the concerted effort of junior and middle managers with a common or aligned GIS vision to sustain GIS diffusion. If their vision is to develop independent GIS capabilities for individual business units, senior manager's support is often not necessary and the outcome is islands of independent GIS technology in the organization. However, if the vision is a GIS that serve the entire organization, particularly, a fully integrated corporate GIS, senior management support is essential. To realize the vision, the GIS vision must either be adopted as the dominant vision of senior management or be aligned with the existing dominant vision to create the GIS aligned dominant vision. It is the GIS aligned dominant vision that is sustaining the decisions that drives the diffusion of a fully integrated corporate GIS in an organization.

A government organization is viewed as a public management system comprising an internal production process in an organizational setting, and influenced by the external stakeholders. GIS is part of the internal production process which involves using production infrastructure to generate the product mix required through a set of production processes. For diffusion of GIS to advance, it must establish itself as an integral part of the internal production process in alignment with the organizational goal, by gaining the recognition of both the stakeholders and the organizational setting. The GIS adoption and diffusion decision is not a single decision but a series of decisions made through a process of active interaction with the public management system over time. In the process, two types of decisions are made. First are GIS decisions that concern the physical development of GIS, and second are ancillary decisions that concern the complementary change of the public management system to facilitate acceptance of GIS. To maximize the benefits of GIS, the two types of decisions will have to be aligned.

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