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Research Article

The different identities of GIS and GIS diffusion

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Abstract. GIS managers traditionally consider three perspectives of the nature of GIS when introducing GIS into an organization. When the GIS is developed to address focused and well defined problems of the organization, these perspectives adequately describe the changing identities of GIS in the study of its diffusion. However when the GIS is developed to address strategic, but vaguely defined problems, as typically is the case of a corporate GIS, these perspectives are inadequate for describing it. Therefore a new perspective is developed for the corporate GIS and the significance of the new perspective on GIS diffusion research is discussed.

1. Introduction

In recent years the Geographic Information Systems (GIS) community has adopted the diffusion paradigm in the study of the implementation and development of GIS (Chan and Williamson 1996, Masser and Campbell 1996, Masser and Onsrud 1993, Onsrud and Pinto 1991). This paradigm centres on the definition of diffusion as being 'the process by which an innovation is communicated through certain channels over time among the members of a social system' (Rogers 1995: 5).

Campbell (1996b: 40) recognises that GIS diffusion is affected by the nature of GIS, the structure of an organization, and the interplay of the two, and identifies the need for 'An analysis of perspectives on the nature of GIS technology with particular emphasis on the extent to which each organization reinvents a particular form of technology'. The need can be addressed initially by examining existing definitions of GIS.

This paper first establishes the significance of definitions of GIS in diffusion studies. With Rogers' organizational innovation process as a model for GIS diffusion in an organization, two main scenarios of GIS diffusion are described, based on the nature of problems to be addressed by the GIS in the organization. One scenario is called the *focused* scenario and the other the *dispersed* scenario. These scenarios are illustrated in the paper by the experience of GIS development in the State Government of Victoria, Australia.

The paper then reviews past definitions of GIS, using the implicit organizational framework developed by Maguire (1991). The paper finds that these definitions

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comprise one or more of three perspectives on the nature of GIS technology. These perspectives are identified and described in detail.

This paper contends that existing perspectives on the nature of GIS are considered adequate to describe GIS in a *focused* scenario of diffusion. However this is not the case for GIS in a *dispersed* scenario. A corporate GIS is a typical example of GIS in this latter case. This paper then develops a model of a corporate GIS by examining the roles played by GIS in an organization. This model identifies a new perspective of GIS, which has important consequences for GIS diffusion research.

2. Significance of definitions of GIS in GIS diffusion studies

2.1. *The diffusion paradigm*

According to the discussion on the diffusion paradigm by Rogers (1995), innovation diffusion among individuals is modelled by the innovation-decision process (figure 1). The process is affected by the perceived characteristics of the innovation and characteristics of the individuals involved in the decision (Rogers 1995). These findings have been found to be applicable to GIS by Budic (1993) and Onsrud and Pinto (1993).

The situation is different and more complicated for innovation diffusion in an organization (as distinct from an individual), which is modelled by the organizational innovation process. Rogers' model of the process (figure 2) is comprehensive, well known, and has a strong theoretical base. It also takes into account the issue of *re-invention* in which the identity of the innovation changes in the course of diffusion (Rogers 1995). This issue has often been overlooked by researchers in the past although its existence in GIS diffusion has been confirmed by Campbell (1996a).

In recent years two theoretical models for GIS development/diffusion have been described. Azad's (1993) model is still at the early stage of development with little detail on the whole process in general and re-invention in particular. The model by Anderson (1996) is well developed with extensive detail, and provides for re-invention to take place. However, the model fails to account for why GIS is considered for adoption by the organization in the first place and when development/diffusion of

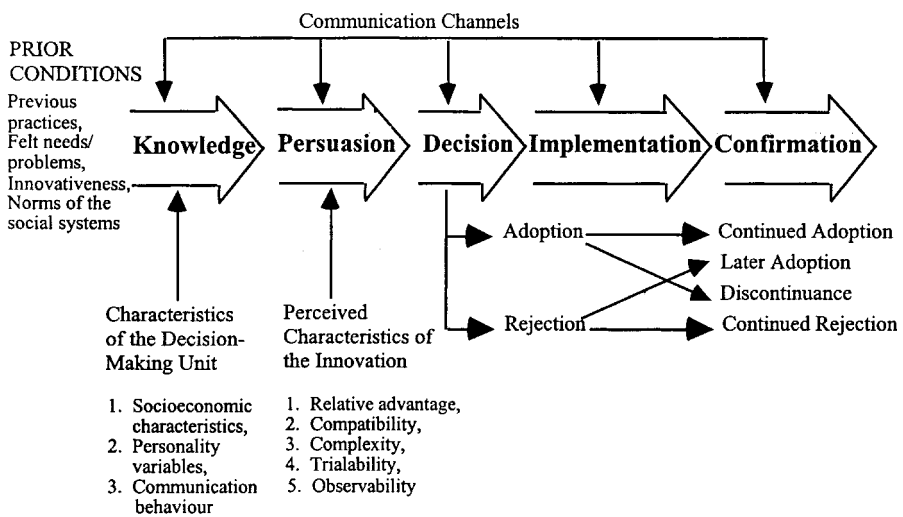

Figure 1. The innovation-decision process (adapted from Rogers (1995: 163)).

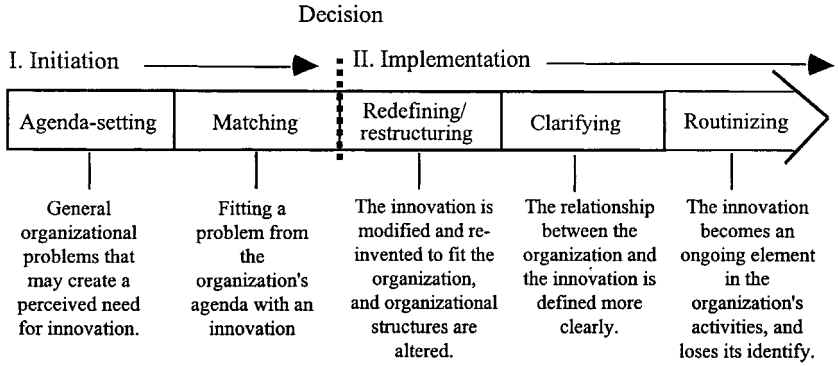

Figure 2. The organizational innovation process (adapted from Rogers (1995: 392)).

GIS is considered complete. Therefore, this paper adopts Rogers' model as a more suitable framework for a general discussion of GIS diffusion.

Figure 2 describes Rogers' model (1995: 392) in which there are two stages in the organizational innovation process, namely *initiation* and *implementation*. *Initiation* has two sequential substages called *agenda-setting* and *matching*. *Implementation* has three: *redefining/restructuring, clarifying* and *routinizing*. The two stages are separated by a decision to adopt an innovation.

2.2. *Significance of definitions of GIS*

Managers undertake significant planning and justification when trying to introduce GIS into an organization (Aronoff 1989, Onsrud and Pinto 1993, Somers 1996). This starts in the *initiation* stage in which managers inform senior managers and other stakeholders about the concepts and benefits of GIS, and try to persuade them the technology is needed. Since many stakeholders are not experts in GIS, their perceptions of GIS are often based on their interpretation of the managers' definition of GIS. These perceptions of the characteristics of GIS will later affect the stakeholders' decisions regarding GIS adoption as shown in figure 1 and by Onsrud and Pinto (1993).

During the *implementation* stage, managers implement strategies to develop a GIS that is broadly in line with their definition of GIS (Tomlinson Associates Ltd. 1993). The characteristics of GIS as perceived by the stakeholders, which may be different to those of the GIS managers, can lead the stakeholders' to oppose GIS implementation strategies (Campbell 1996a, Goodman 1993). Since both strategies of managers and characteristics of GIS as perceived by stakeholders originate from a definition of GIS, definitions play a fundamental role in GIS diffusion in any organization. A holistic understanding of GIS diffusion therefore requires understanding of how both managers and other stakeholders view GIS. The paper explores this understanding from the point of view of GIS managers.

2.3. *Conditions governing identity of GIS in diffusion*

Based on Rogers' organizational innovation process, two theories that underpin GIS diffusion in organizations deserve attention. First is the *performance gap* theory which requires that GIS, as an innovation, addresses a performance gap which is identified in the organization in the form of actual problems or potential areas of improvement. The gap may be identified prior to or after the organization becomes

aware of GIS. Second is the *re-invention* theory which suggests that in the process of being accepted, the identity of GIS changes together with the organization during the *redefining/restructuring* substage of implementation. These two theories (Rogers 1995) establish some boundary conditions regarding the identity or definition of GIS and are critical to GIS diffusion research.

By requiring GIS to address a set of problems identified during the *initiation* stage in diffusion, a specific identity is given to the GIS. The stakeholders of the GIS project are also broadly defined by virtue of their relationship with the problems. The different interests that these stakeholders represent underpin their interaction, which in turn drives the diffusion (Goodman 1993). Though GIS undergoes re-invention in the *redefining/restructuring* substage, on completion of its diffusion, it should still address the same set of pre-defined problems established during the *initiation* stage. In the process of re-invention, any excessive change to the problems being addressed will alter the identity of GIS and the combination of stakeholders. The resulting change in the dynamics of interaction between the stakeholders suggests that the initial set of assumptions adopted when designing the diffusion study may no longer be valid. This necessitates a re-design of the study. Otherwise, many causal relationships of diffusion, which are predicted or identified on the basis of the initial assumptions, will be open to challenge.

2.4. *Scenarios for GIS diffusion*

Apart from laying down conditions for GIS diffusion research, the *performance gap* theory also provides the theoretical base to identify scenarios of GIS diffusion according to the nature of problems being addressed. The scenarios describe homogeneous diffusion environments that facilitate prediction and interpretation of the outcomes of GIS diffusion research. Two contrasting scenarios are described below, based on the experience of GIS development in the State Government of Victoria in Australia.

The first scenario is called a *focused* scenario in which a GIS is developed to address a set of highly focused problems. The problems are so well defined that operationally the composition and technical capabilities of the technology can be specified early on. A School Assets Management System that was developed in the early nineties in the Department of Education in Victoria is a good example (Ward undated). It was an independent GIS in the Directorate of Schools developed to facilitate management of state schools in areas such as assets and security management, and management of cleaning contracts.

The second scenario is called a *dispersed* scenario in which the problems addressed are often strategic in nature and have wide implications. A *corporate/enterprise* GIS is a typical example of GIS in this scenario. Common problems addressed by a corporate GIS include elimination of duplication, acceleration of development and promotion of data sharing (Levinsohn 1997). These problems have such general and wide impact, and the resource implication is often so great that there is significant uncertainty about the long term composition and technical capabilities of the required GIS.

An example of the corporate GIS in a *dispersed* scenario is the GIS proposed for the State government of Victoria in 1993. The key problems addressed in a strategy developed by a group of consultants for the government (Tomlinson Associates Ltd. 1993) were data sharing and cost reduction (Williamson, *et al.* 1998). This strategy was meant for the whole of government, yet it covered only those sectors of government that already had an interest in GIS. Even the departments in these targeted

sectors had different needs for GIS, and varied experiences of GIS utilisation. The scale and complexity of the issues involved were great, and the resources implied were significant. This resulted in great uncertainty in the final identity and capabilities of the required GIS.

Instead of describing an independent government wide system, the strategy identified the GIS as a collection of 61 information products and associated datasets for the departments studied. It identified a list of strategic elements to support development of the information products. Success was conditional upon a list of 'Requirements for Going Forward' that specified the organizational setting required (Tomlinson Associates Ltd. 1993: 5) as well as many other technical and institutional issues. The uncertainty of implementation was so great that the GIS was disaggregated into two main parts. The State GIS coordinating agency concentrated on developing a core set of shared spatial digital data called the State Digital Map Base. The departments involved were left to develop their individual GIS under the loose coordination of the agency.

While this section sets the scene for GIS diffusion research, the next section reviews the different perspectives on the nature of GIS as described by managers in the literature. These perspectives underpin the different identities of GIS portrayed by managers when they try to introduce GIS into an organization over time and under different conditions.

3. Definitions of GIS

Maguire (1991) reviews the definitions of geographic information systems used by managers (or their collaborators). In the process he also identifies the unique characteristics of GIS. He concludes that a composite approach in which all the ideas about GIS are summarised in a series of views is the only satisfactory way to define GIS. Maguire has actually described three perspectives on the nature of GIS that underpin various definitions of GIS, namely, *identificational*, *technological*, and *organizational* perspectives.

3.1. *Identificational perspective of GIS*

The *identificational* perspective describes the unique features of GIS that distinguish GIS from other types of information systems. This perspective gives GIS its special identity to justify separate attention needed from people during GIS implementation. The characteristics of GIS are 'the general focus on spatial entities and relationships, together with specific attention to spatial analytical and modelling operations' (Maguire 1991: 17). These characteristics are echoed by Obermeyer and Pinto (1994) who specify spatial referencing as an organising framework for the data. Huxhold and Levinsohn (1995) expand the framework to include geo-coding, geo-referencing and topology. In short, the unique features of GIS are:

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

Here spatial analyses include operations that range from simple querying functions that return data to answer simple locational and conditional questions, to complex modelling processes (Rhind 1990 quoted in (Maguire 1991)). With data about entities and their relationships managed within a spatial framework, any computerised system that provides an answer to a simple question of 'what is at location X?' is a GIS.

3.2. *Technological perspective of GIS*

Maguire (1991) broadly identifies two perspectives on the nature of GIS, namely, the *technological* and *organizational* perspectives. Cowen's (1988) four approaches of defining GIS are good illustrations of the *technological* perspective. The first approach is a process-oriented approach which emphasises the capabilities of GIS to handle information (e.g. storage, retrieval, manipulation, and display of geographic data). The second is an application approach which groups information systems according to the problems they seek to address (e.g. soil, land, and planning information system). The third is a toolbox approach which emphasises the generic aspects of GIS as a toolbox to manipulate spatial data. The fourth is a database approach which regards GIS as a database system.

Within this perspective, Maguire (1991) identifies three views of GIS with each view focusing on one functional aspect of GIS. The *map* view provides inventory function such as data querying. The *database* view is concerned with simple analysis, such as overlaying, buffering. The *spatial analysis* view focuses on more complex analytical functions such as modelling and decision making.

Embracing all the above views and approaches, the *technological* perspective describes GIS as a certain form of technology (database, application, or toolbox) that provides specific functional capabilities (map, database, and spatial analysis). While the *identificational* perspective deals with specialised concepts such as geo-referencing and topology, the *technological* perspective portrays GIS as a tangible operational system that people can related to from their daily experiences.

3.3. *Organizational perspective of GIS*

Carter (1989: 3) defines GIS as 'an institutional entity, reflecting an organizational structure that integrates technology with a database, expertise and continuing financial support over time'. Maguire (1991) regards Carter's definition as being representative of the *organizational* perspective but does not elaborate on its meaning.

By examining Carter's definition, two characteristics of the *organizational* perspective can be identified. First, GIS is described in terms of its generic elements, or building blocks—an approach also used by other researchers (Dangermond 1988, Dickinson and Calkins 1988). What distinguishes Carter's perspective from these researchers' is the second characteristic: inclusion of the organizational or institutional implementation environment in the definition.

Following the recognition of the importance of a National Spatial Data Infrastructure (NSDI) by the Government of United States of America (Executive Order of the White House 1994), the *organizational* perspective has gained popularity (Chan and Williamson 1995, Huxhold and Levinsohn 1995), particularly in describing NSDI (ANZLIC 1996, Federal Geographic Data Committee Undated).

The five elements of *organizational* perspective suggested by Chan and Williamson (1995) include *data, information technology, standards, people with GIS expertise* and *organizational setting*. The scope of these elements as detailed in table 1, covers most of the elements suggested by other researchers and is a useful illustration of the organizational perspective of GIS.

3.4. *Summary*

Three perspectives on the nature of GIS that underpin existing definitions of GIS have been identified in the literature. The *identificational* perspective establishes the uniqueness of GIS. The *technological* perspective describes GIS as a tangible

Table 1. Elements of a GIS (Source: Chan and Williamson (1995)).

Elements of a GIS	Scope of each element
Data	all accessible data, both geographical and attribute, required to meet the geographical information needs, identified or latent.
Information technology	all computer hardware, software (including applications) and the associated communication technology required to meet the geographical information needs, identified or latent.
Standards	all agreed practices required to facilitate the sharing of the other four components of a GIS.
People with GIS expertise	all knowledge, skills, procedures, and systems, technical or otherwise, acquired by people involved, for the smooth functioning of the GIS.
Organizational setting	all the operating environments, technical, political, or financial, created by the interaction among stakeholders, in which the GIS is to function.

operational system providing specific functional capabilities. The *organizational* perspective highlights the multi-element nature of GIS, emphasising the organizational environment as an integral element. The relation between these three perspectives and GIS diffusion in organization is explored in the next section.

4. Perspectives on the nature of GIS and GIS diffusion

4.1. *In the initiation stage*

In either one of the two scenarios of GIS diffusion described in subsection 2.4., the *identificational* perspective is most important in the *agenda-setting* substage of the *initiation* stage of diffusion. In this substage, the general organizational problems that may create a need for innovation are identified. The primary function of the *identificational* perspective in this case is to raise the general awareness of GIS and succinctly inform people, especially senior management, what GIS is about. It distinguishes GIS from other information systems or technologies which are competing to be the innovative solution. It also underpins other perspectives of describing GIS.

Next in the *initiation* stage is the *matching* substage in which GIS as an innovation will have to be fit with a set of problems. It is at this stage that the technology is packaged into a certain configuration (Goodman 1993) and marketed to the stakeholders. Without such a configuration as a basis for interaction among stakeholders, like embarking on a marketing campaign without a product in mind, there will be no diffusion in the organization. The *identificational* perspective, while describing the uniqueness of GIS, fails to portray such a working GIS configuration.

In a *focused* scenario, the problems to be addressed are focused and well defined, allowing specification of the composition and functionalities of the GIS. In this scenario, the problems may concern improvement of specific business functions in the organization for example. In this case, the *technological* perspective which describes GIS as a certain form of computerised information system that provides specific spatial data handling and analytical capabilities to address the problems, provides a good working configuration. In another case, the problems may concern the development of a multi-participant GIS such as a set of shared GIS capabilities for departments within a local authority. In such circumstances, the *organizational*

perspective which describes the GIS elements to be shared, offers an alternative working configuration for the participants.

However in a *dispersed* scenario, the problems are so broad and vaguely defined that there is uncertainty regarding the final composition and functionalities of the GIS. As both the *technological* perspective and *organizational* perspective portray a definite target configuration for the GIS, they are not compatible with the uncertainty in the identity of GIS in this scenario.

4.2. *In the implementation stage*

In the *implementation* stage of diffusion (figure 2), it has been argued that the pre-defined problems must be addressed on completion of diffusion (subsection 2.3). If the problems addressed are substantially changed during the *redefining/restructuring* substage, the GIS diffusion study should be refocussed or even started again to take into consideration the changes that have taken place. In a *focused* scenario, as in the case of the School Assets Management System, the *technological* perspective is a useful yardstick to assess the change. This perspective identifies the GIS as an information system that supports assets and security management. Subsequent to re-invention, the scope of applications may change; the final configuration of data, hardware, and software may be different from that originally conceived. On condition that after passing the *routinization* substage of implementation, the GIS is used by the Directorate of Schools to manage assets and security issues, its diffusion is considered complete. If there was pressure for the GIS to be modified to additionally manage pupil intake for example, the stakeholders involved would be changed and the identity of the GIS would also be substantially changed. Study of the GIS diffusion in this case should be re-designed or even started afresh to account for the changes.

The *technological* perspective only allows changes to or re-invention of the GIS to be monitored in terms of its technical capabilities. As such, it is not sensitive enough to track the change of detailed composition in the re-invention of GIS. In this respect, the *organizational* perspective is more versatile. On the one hand, by monitoring the extent of development of the elements, it can show progress of development of shared GIS capabilities, such as spatial data infrastructures. On the other hand, by monitoring incremental changes to the elements over time, re-invention of a GIS can be monitored. Therefore, the *technological* and *organizational* perspectives complement each other in monitoring progress of diffusion in the *implementation* stage in a *focused* scenario. This is in line with the use of both perspectives together to give a composite definition of GIS by Burrough (1986) and Maguire (1991).

In a dispersed scenario, the position is more complicated. The case of the whole-of-government GIS intended for the State Government of Victoria serves as a good illustration of the issues involved. The Victorian system was originally visualised as a government wide system. The scope of the project was very wide and the issues involved were complicated. Despite having spent about US$ 0.8 million in GIS planning, the government wide GIS had to be disaggregated into separate departmental initiatives and a statewide spatial data infrastructure development programme.

In this circumstance, while the vision may be a corporate GIS which is typical of a *dispersed* scenario, it will be quite misleading to treat the GIS in its diffusion as a single inseparable entity. The development of that single entity may take years, if

not decades. The combination of stakeholders and the problems that the GIS set out to address may change drastically during development and implementation (Juhl 1997). In this case the *technological* perspective which specifically relates technical capabilities of the GIS to the pre-defined problems of the organization will be unsuitable.

In the course of developing a corporate GIS, some initiatives will be successful and some will fail. New initiatives may be added while old ones may be discontinued as the organization is restructured to meet changing needs of government and society. In these circumstances, the *organizational* perspective which views GIS in terms of its integral elements, will not be able to distinguish one initiative from another, or to keep track of the changing combination of initiatives. There is no way for this perspective to monitor the progress of diffusion of the individual initiatives of the corporate GIS; to indicate when diffusion has been completed or when diffusion study should be re-designed or terminated.

Instead of being homogeneous, the corporate GIS is an evolving heterogeneous entity that tries to address different problems of the organization at different points in time. It is argued above that neither the *technological* perspective nor the *organizational* perspective is suitable to describe the corporate GIS and to monitor the progress of its diffusion. A new perspective to describe GIS, and a corporate GIS in particular, is needed to overcome the difficulties in studying diffusion of GIS in a *dispersed* scenario.

5. A new perspective on the nature of GIS

5.1. *GIS in an organization*

To describe a corporate GIS, it is necessary to understand the relation between GIS and an organization. Chan and Williamson (1996) view GIS as part of the organizational capabilities (renamed in the 1996 paper as production infrastructure), which are used in a production process to generate the product mix required of the organization. Figure 3 describes such an organization in terms of a mechanism of

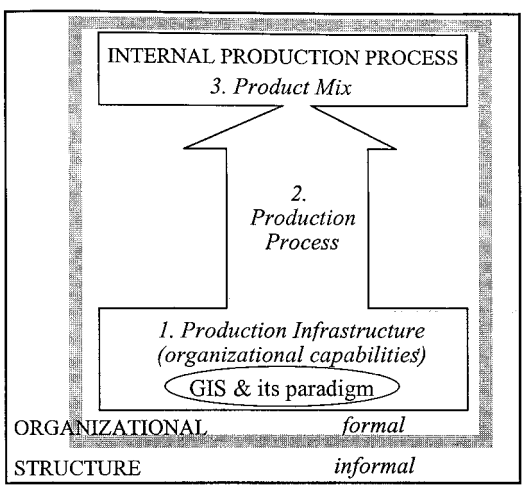

Figure 3. Relation between GIS and the organization (adapted from Chan and Williamson (1997)).

production, which is made up of both a formal and an informal structure, and shows the role of GIS in such a context.

According to (Broom, *et al.* 1981), an hierarchical structure and the division of labour are the key elements in a formal structure of an organization. Among the five main types of organizational structures identified by Mintzberg (1979), a basic combination of hierarchical structure and division of labour can be identified. This basic combination separates an organization into central administration and the different business functions. Applying this primary level of division of labour and hierarchy of authority to the model in figure 3, a new relation between GIS and the organization is derived.

Figure 4 describes the new relation in which the formal structure of an organization is divided into two functional parts. The first is the *Business* component which includes all the business functions directly involved in the production of the product mix required of the organization. The second is the *Administration* component which includes the central administration and the staff departments which provide coordination and support functions to the *Business* component. The formal structure includes people and associated rules, regulations, procedures, power/authority, and communication channels that allow organizational functions to be carried out and changes to be made. Each formal structure achieves its functions by making use of organizational capabilities, which include GIS. Associated with each functional component is the informal structure of organization (Handy 1993) which dictates the norms and values that have not been decreed.

5.2. *The two roles of GIS in an organization*

Based on the corresponding concepts developed for information technology (Weill, *et al.* 1996), Chan and Williamson (1995) suggest that there are two types of GIS. The first one is a *business process GIS* which is an integral part of each organizational business process that is directly involved in producing the product mix. The other one is an *infrastructure GIS* which supports existing *business process GIS* or facilitates the development of new ones.

A model of corporate GIS is developed by replacing 'GIS' in figure 4 with *business process GIS* and *infrastructure GIS*. Figure 5 describes the model in which each functional component of an organization is a potential location for GIS that in turn

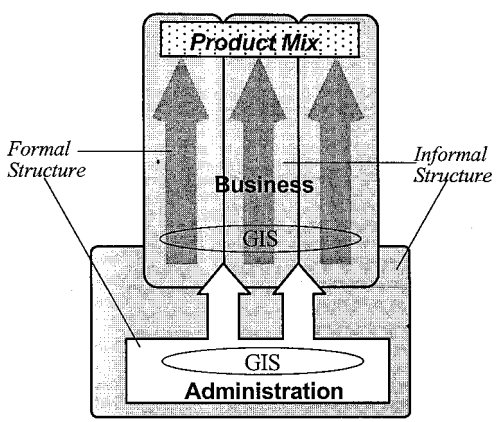

Figure 4. GIS in an organization.

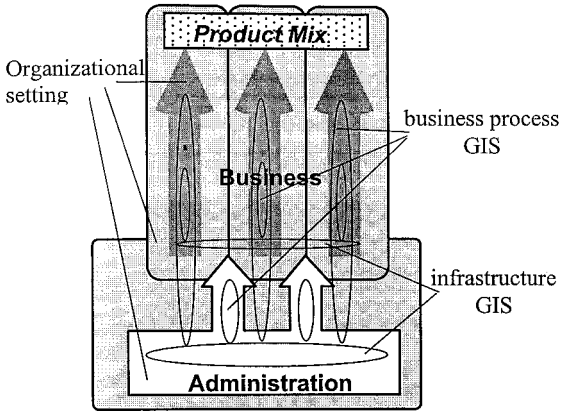

Figure 5. GIS in an organization—the corporate GIS.

can assume any combination of the two roles of infrastructure and business process. Therefore it is possible to identify four basic modules of a corporate GIS: *infrastructure* and *business process GIS* in *Administration*, and *infrastructure* and *business process GIS* in *Business*. There can be a *business process GIS* for each of the business functions and staff departments, all of which are supported by *infrastructure GIS* of the respective functional component. It should be noted that owing to the coordinating and supportive role of *Administration*, its *infrastructure GIS* also supports *business process GIS* in *Business*.

The model forms the basis of the *productional* perspective which describes a corporate GIS as an integral part of the wider internal capabilities that support the organization's effort to produce a set of products (or services) required by external stakeholders. The corporate GIS is seen as a dynamic heterogeneous collection of individual GIS modules in the organization. Each module assumes the role of either an infrastructure or a business process in its particular functional component. The collection of modules is dynamic because as the formal structure of the organization evolves, so do the collection of GIS modules. Defunct modules can be taken out of the organization, new modules can be added, and existing modules may be modified.

However, the corporate GIS is more than just a collection of modules of GIS. By definition, each *infrastructure GIS* will eventually support all the *business process GIS* in each functional part of the organization. Although the necessity of implementation or convenience may initially lead to the independent development of the two types of GIS, theoretically, they will be linked in due course. This relationship that links all the modules together in an organization, identifies the corporate GIS as an independent entity worthy of being studied separately.

By referring back to the organizational innovation process in figure 2, figure 6 describes the role played by the four perspectives on the nature of GIS in the diffusion study of a corporate GIS. Instead of a unidirectional process as implied in the organizational innovation process, the diffusion of a corporate GIS is portrayed as a cyclical process in a *dispersed* scenario.

In the *agenda-setting* substage, the *identificational* perspective is still crucial to help justify GIS against other technologies. In the *matching* substage, the *productional* perspective portrays a high level identity of the corporate GIS showing inter-related modules of GIS playing the roles of an infrastructure or a business process. At this

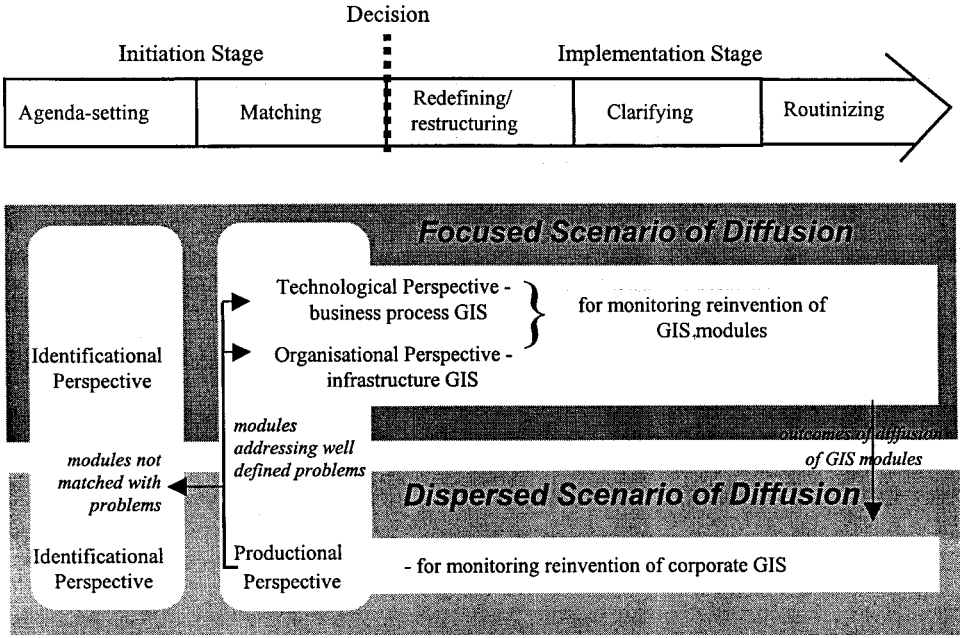

Figure 6. Roles of the four perspectives on the nature of GIS in describing a corporate GIS in the study of its diffusion.

point, the corporate GIS can be disaggregated and have the diffusion of its integral modules separately studied. Some modules, both *infrastructure* and *business process GIS*, may be conceived to address problems that are focused and clearly defined. Instead of remaining in a *dispersed* scenario like the corporate GIS, these modules can now progress to the next stage of diffusion in a *focused* scenario. Previous discussion in the paper suggests that in such a scenario, the progress of diffusion of *infrastructure* and *business process GIS* can be tracked by the *organizational* and *technological* perspectives respectively. The *organizational* perspective can also help monitor re-invention of each module in terms of its composition during implementation. For ease of discussion, this group of modules, the diffusion of which can be examined separately from the corporate GIS, is referred to as *focused* modules.

Coexisting with the *focused* modules are the remaining modules of the corporate GIS which are conceived to address problems that have not yet been clearly defined by the stakeholders, or even problems that may only be identified in the future. This latter group of modules remains in a *dispersed* scenario of diffusion. Instead of proceeding into the more advance stage of diffusion with the other modules, these modules will return to the *agenda-setting* substage pending clarification of the problems they intend to address. These modules are called *dispersed* modules. When the *dispersed* modules and the problems they address become better configured for one another, they become *focused* modules and can progress to the next stage of diffusion in a *focused* scenario like their earlier counterparts.

The perspective also provides a framework (figure 5) that organises the individual modules into a corporate GIS which as an independent entity remains in the *dispersed* scenario. The progress of diffusion of the corporate GIS can be measured within the framework of the perspective by the number of *focused* modules that have completed

diffusion. By using the same framework to monitor the status and number of the *dispersed* modules and the progress of diffusion of the *focused* modules, re-invention of the corporate GIS can be tracked. In addition, viewing the corporate GIS as an independent entity, the framework also serves as a tool to examine inter-relationships of the modules, and the impact that one GIS module has on the diffusion of other modules.

On the one hand, the *productional* perspective helps disaggregating the corporate GIS into its integral modules in terms of their roles and the scenario of diffusion. As a result, the environment of diffusion of each module is made more homogeneous. This facilitates the tracking of identity of each GIS module in a diffusion study, and makes the prediction and interpretation of the outcomes easier and more meaningful. On the other hand, this perspective provides a framework that organises the individual modules into a holistic one.

6. Conclusions

GIS diffusion in an organization is affected by the nature of GIS. In the literature, three perspectives on the nature of GIS have been identified, namely, *identificational, technological* and *organizational*. The *identificational* perspective describes the uniqueness of GIS. The *technological* perspective describes the tangible form and functional capabilities of GIS. The *organizational* perspective emphasises the multi-element nature of GIS, bringing to the fore the organizational environment that affects the introduction of the technology.

Individual perspectives on the nature of GIS, when used alone or together, form different definitions of GIS which are used by GIS managers to give GIS an identity when introducing the technology into an organization. As diffusion progresses, the identity of GIS also changes. The paper argues that excessive change to the identity may affect prediction or interpretation of outcomes of a diffusion study. Therefore, it is important to be able to track the changing identity of GIS.

However the environment of diffusion is not homogeneous. Based on Rogers' organizational innovation process and depending on the nature of the pre-defined problems in the organization that GIS is to address, two contrasting scenarios of diffusion can be identified. The problems in a *focused* scenario are focused and well defined while those in a *dispersed* scenario are broad and strategic in nature with potentially great impact and resource requirement.

The paper has reviewed the ways that the changing identity of GIS in the two scenarios of diffusion can be tracked and described. It concludes that while current perspectives on the nature of GIS adequately describe the changing identity of GIS in a *focused* scenario of diffusion, they do not allow satisfactory monitoring of diffusion of a corporate GIS, which is a typically found in a *dispersed* scenario.

As a result, the *productional* perspective is developed. It views a corporate GIS as made up of modules that play the roles of either an infrastructure or a business process. Depending on the nature of the problems these modules are designed to address within the respective diffusion scenarios, the corporate GIS can be disaggregated into *focused* and *dispersed* modules. This helps to overcome the problem of studying the diffusion of a complex heterogeneous corporate GIS. At the same time, the perspective also provides a framework that allows the diffusion of the corporate GIS to be studied and monitored holistically.

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