

Key Factors Influencing Regional SDI Development and Relevance to Global and other Levels

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The 6th Global Spatial Data Infrastructure Conference (GSDI6)
16 -19 September 2002, Budapest, Hungary

Keywords: Spatial Data Infrastructure (SDI), SDI Hierarchy, Cultural and Social Factors

Abstract

The challenge of designing, building, implementing, and maintaining an SDI draws on many different disciplines and requires examination of a large number of factors and issues. It is essential that SDI practitioners understand the significance of human and societal issues as much as technical issues, all of which contribute to the success of SDI developments. Key issues include sustaining a culture of sharing, establishing a common language, and maintaining reliable financial support.

This paper presents and discusses major classes of factors which influence, or contribute to the development of a Regional SDI initiative together with recommendations to facilitate the development of Regional SDI initiatives. It is argued that the adoption and implementation of these recommendations can assist Regional SDI coordinating agencies to receive more support and speed up their progress in the development of SDI initiatives.

This paper draws on research conducted by the authors in Asia and the Pacific region, based on the theory of innovation diffusion which provides the research framework. The results and lessons learned from this research can also be used and applied in other regions, and potentially other jurisdictional levels such as local, state, national and global.

Introduction

Spatial Data Infrastructure is fundamentally a concept about facilitation and coordination of the exchange and sharing of spatial data between stakeholders from different jurisdictional levels in the spatial data community. The concept is well explained as an integrated, multi-levelled hierarchy of interconnected SDIs based on partnerships at corporate, local, state/provincial, national, regional (multi-national) and global (GSDI) levels. Therefore, it is essential that SDI practitioners understand the

significance of human and community issues, as much as technical issues, as they determine the long running success of an SDI development. Having said that, SDI, therefore can no longer be regarded, or taught, primarily as just a technical matter. Developing a successful SDI initiative depends at least as much upon issues such as political support, clarifying the business objectives which the SDI is expected to achieve, sustaining a culture of sharing, maintaining reliable financial support and enlisting the cooperation of all members of the community, as upon technical issues relating to spatial data access, networking, and standards. Therefore, the argument is that developing a successful SDI within a jurisdictional level must be seen as a socio-technical, rather than a purely technical, exercise; the communities concerned are expecting to reap benefits from their investment in SDI in terms of improved corporate performances and cooperation.

However, current research shows that despite considerable interest and activities, the development of an effective and comprehensive SDI is hampered in most cases by a lack of support from members, which results in this initiative remaining an innovative concept. With this in mind, this paper aims to address the minimisation of this problem based on the results of a case study and survey research on Regional SDI development in the Asia-Pacific region. It is proposed that this problem can be minimised by increasing the level of awareness about the nature and value of SDIs; understanding the dynamic partnerships which are necessary to support a culture for sharing; improving the SDI conceptual model to better meet the needs of communities; and by identifying key factors that facilitate development by better understanding the complexity of the interaction between social, economic and political issues.

To achieve this aim, the paper first discusses human and community issues as well as culture for sharing information which are important in long running success of an SDI initiative. The paper then reviews current Regional SDI activities in Asia and the Pacific region, follows by presenting and discussing three major classes of factors which are the outcomes of research in this region. The paper then argues that these classes of factors are influencing the development of SDIs, and together they may effect the participation rate of members.

Human and Community Issues

Community issues determine the long running success of an SDI development. In the mainstream Information Systems industry, it has long been recognised (as noted by Petch and Reeve 1999) that systems fail as much for human as for technical reasons and this reality is increasingly being recognised within the GIS community. Based on Campbell and Masser (1995), 27.2% of the significant problems that they had experienced were organisationally based, mentioning most frequently poor GIS management structures, staff limitations and lack of support from senior staff.

Therefore, if the success rate of SDI initiatives is to be improved it is clear that attention needs to be paid to understanding the community and organisational issues within

which SDI is supposed to be developed. The SDI initiative has evolved from information systems and technology. With this in mind, as Campbell and Masser (1995) noted that the technological imperative leads us to believe that the adoption of new technology is inevitable and the sooner we adopt the new products the greater will be our advantage. Thus, like any new technology, any community which adopts SDI sooner, will experience greater advantages.

For many years, however, some computer professionals have concluded that the major reasons for the lack of success of their systems lie not so much in any technical limitations, but rather in their neglect of the human and community aspects of technology (Budic and Godschalk 1996). In short, information systems have been driven by technology-push rather than by demand-pull, (Petch and Reeve 1999). Coleman and McLaughlin (1998) have made the same criticism of the development of SDI initiatives.

In response to the recognition of these problems, Petch and Reeve (1999) believe a socio-technical viewpoint has increasingly been adopted with the definition of an information system being expanded to include not only the hardware and software, but also the people involved. This viewpoint is as relevant to the development of SDI initiatives and suggests the need to include people, alongside technical and institutional components, in the definition of SDI initiatives throughout the spatial data community.

Having said that, a socio-technical conception of SDI therefore, should emerge in which it is recognised that even if it is assumed that SDI succeeds on a technical level, its adoption still will ultimately depend on how well implementation strategies address the respective community barriers. Recognising that societal issues can be critical factors in determining the success of SDIs, has meant that the SDI's coordinating agency has had to develop a much richer conception of who its community are, how they behave, and particularly how they are likely to respond to the introduction of such a new spatial infrastructure initiative.

Culture for Sharing Information

SDI is fundamentally about facilitation and coordination of the exchange and sharing of spatial data. However, much of the potential for the use of data and information lies in the ways by which knowledge may be shared. This heavily depends upon the culture of a society. All communities and societies have a culture – a system of shared meaning (Langdon and Marshall 1998). Similarly, any initiative or function, including the sharing of information, also has a specific culture which needs to be promoted to prepare the environment for developing/pursuing the specific activity. Whether that culture is weak or strong is important to both a coordinating agency and individual parties. Therefore, sharing knowledge and information requires a specific culture – a culture for sharing.

Culture is the integrated system of learned patterns of behaviour, ideas, and products characteristic of a society. It is also the ideas people have about their world. In this

sense, culture is our mental map of our world and it is also a map for determining action and it becomes a guide for behaviour and decision-making. Langdon and Marshall (1998) view the organisational culture as a shared system of beliefs and values, as evident in rituals, stories, myths and often a specialised language, that fosters a feeling of belonging. They believe an organisation's culture is made up of two elements:

- The organisation's system of shared meaning – shared beliefs and values; and
- The organisation's behavioural norms – how we do things here.

Cultural differences have also persisted between countries at similar stages in industrialisation, and it has been suggested that national culture had a pervasive influence even upon institutional, productive and managerial structures that had formerly been cited as instrumental in international organisational convergence (Neal 1998).

The debate about the nature of culture has a long history and has been at the heart of sociological, historical and anthropological debates about the relationship between individual action and the nature of society.

Neal (1998) believes, one common lesson propounded by all the researchers is that the relationship between culture and economy is an inter-dependent: a particular form of economy can only persist if it is sustained by a validating culture(s); on the other hand, a particular form of culture can only persist if its ideological and institutional needs are met by a particular form of economy.

Further he reported that, managers find that they are unable to isolate the cultural factors in the diffusion of a new technology and therefore have real problems in trying to manage it (Neal 1998). This is not surprising for in targeting national cultural orders, the complex social factors that are collapsed into the notion of national culture go unaddressed. Cultural problems are the result of complex social dynamics at the interactive and institutional levels. Attempting to manage such problems by targeting transcendent cultural orders overlooks the reasons for these problems.

Many researchers suggest that national cultural differences for example, have an important impact upon the relationship between different countries within a region and their cooperation (Bartlett and Ghoshal 1990, Hennart 1989, Neal 1998).

Asia and the Pacific region and Regional SDI activities: a case study

Asia and the Pacific region is the largest region in the world with some 60 per cent of the world's population and include 55 countries as defined by the United Nations. Asia and the Pacific has emerged as the most dynamic region of the world (Fukasaku 1995). Its rapid and sustained development has created vast trade and investment opportunities, especially for the economies of its individual nations. One of the most significant developments in Asia and the Pacific regional economy has been the rapid growth of regional cooperation. Within a few years, a number of regional initiatives have been

endorsed and various forms of cooperative ventures through the formation of many cooperative organisations have been established.

The Asia and the Pacific regional cooperative organisations are mostly work and cooperate with each other on different areas including development assistance; human resources development; economic development; science technology transfer; political links; institutional linkages; and security issues (Rajabifard *et al.* 2002). These objectives and areas are all related to specific parts or the whole area of the region. To achieve these objectives, all the regional organisations need to access regional spatial data to identify regional spatial features and their characteristics to make informed decisions and to implement resulting regional initiatives. However, in this region, spatial data is traditionally collected and disseminated by a range of mandated national organisations according to a wide variety of national standards.

A major difficulty in relation to the spatial data in this region is a lack of coordination. National administrations do not systematically cooperate with their equivalents elsewhere. Due to this lack of coordination, different data structures, specifications and standards are used by member nations which does not facilitate data exchange. Although networking relationships exist between nations, these are based on individual arrangements and are not reflected in an operational coordination of activities. Where there is metadata at all, different agencies within member nations maintain it using different formats and tools. More generally there is a lack of common elements that could facilitate data exchange such as compatible working scales, compatible GIS software, and the completion of a regional database which could be used for standard basic information layers.

In order to overcome this situation, the Permanent Committee on GIS Infrastructure for Asia and the Pacific (PCGIAP) has been formed in 1995 through the efforts of the United Nation Regional Cartographic Conference for the Asia-Pacific region (UNRCC-AP) and following its 13th Conference in Beijing, May 1994. The aims of this committee are to maximise the economic, social and environmental benefits of geographic information in accordance with Agenda 21 by providing a forum for nations across the region to cooperate in the development of the Asia-Pacific Spatial Data Infrastructure (APSDI) and contribute to the development of the global infrastructure. The PCGIAP's vision for the APSDI is of a network of databases, located throughout the region, that together provide the fundamental data needed to achieve the region's economic, social, human resources development and environmental objectives.

In this regard, the PCGIAP has developed a conceptual model for its SDI initiative that comprises four core components - institutional framework, technical standards, fundamental datasets, and access networks (PCGIAP 1998).

Current Progress of PCGIAP and APSDI development

According to the PCGIAP, this committee achieved some important steps toward the development of the APSDI since its establishment (PCGIAP 2001). For example the

committee successfully implemented a regional precise geodesy network, defined a regional geodesy datum, developed and approved a policy on sharing fundamental data, developed guidelines on custodianship, and in particular, the definition of APSDI. Also, projects are underway for the ultimate goal of APSDI development in the region, among which the Asia-Pacific Regional Geodetic Project (APRGP) is strengthening the regional geodetic network through annual cooperative campaigns by GPS, VLBI and SLR. Surveys among member nations on the status and development needs and on fundamental datasets have also been conducted.

Although these achievements are very important, and provide a valuable contribution and will form the basis for the APSDI development, there are some other issues involved in the progress of PCGIAP which need to be discussed. These issues include the low rate of participation in PCGIAP activities, the organisational structure of PCGIAP, and the APSDI conceptual model.

For example, the current rate of participation in PCGIAP activities, shows that after many years of effort the APSDI initiative still does not receive full support from all member nations and regional organisations (Holland 1998, Mohamed 1999, Rajabifard *et al.* 2000). According to the report of the PCGIAP-Taskforce group, presented at the 15th UNRCC-AP conference, April 2000, Malaysia, the maximum number of countries participating in PCGIAP meetings is less than half of the members. This rate is still the same as it was in year 2000.

This limited number of participants is an important issue which needs to be considered, discussed and resolved, before moving on from any important principle policy such as policy on sharing fundamental data. This is important because these kinds of policies need to be accepted and supported at least by the majority of member nations in the region not the majority of current participating nations.

The problem of participation also can be observed in many National SDI initiatives throughout the world (Masser 1998, Onsrud 1998). Some reasons for the limited support from certain nations, regional organisations and other relevant institutions include:

- the lack of awareness of the value of SDIs;
- defining the SDI;
- the incompatibility of the current conceptual and organisational model with the perceived needs of the member nations; and
- the complexity of different regional issues such as diverse political, cultural and economical positions.

One of the reasons why the PCGIAP can not receive full support from all member nations is related to the PCGIAP organisational structure. Based on its organisational structure, this Committee is comprised of 55 nations in which member nations are represented on the Committee by directorates of national survey and mapping

organisations and equivalent national agencies. This structure causes problems from two different points:

- (a) The PCGIAP members mainly are providers or producers of national spatial datasets and not necessarily the users of such national and regional datasets. But, one of the main promising advantages of SDIs is to facilitate sharing and access to spatial datasets by users. Therefore, it is essential to involve those potential users of regional spatial datasets and those politicians concerned, in development and implementation of the Regional SDI.
- (b) The organisational and political position and responsibilities of each national surveying and mapping organisation (which the members of the PCGIAP come from) are different from the position and responsibilities of a similar organisation in another member nation. In some nations the mapping and spatial data activities are the responsibility of a civilian organisation, but in other member nations the mapping and spatial data activities are the responsibility of a military organisation.

The other issue is the SDI conceptual model. An Spatial Data Infrastructure comprises not only the four core components identified by PCGIAP as institutional framework, technical standards, fundamental datasets, and access networks, but also an important additional component, namely, human resources (people). This component includes the spatial data users and suppliers and any value-adding agents in between, who interact to drive the development of the SDI.

The absence of this important component would cause the problem that the SDI coordinating agency like the PCGIAP just concentrates on four core components and develops their strategies to build the APSDI in such a way that ignores the interests and potential contributions of other stakeholders such as the non-participating members and agencies. To avoid this problem, the current APSDI model and the strategy to its development therefore need to be modified.

Influencing Factors for SDI Development

The challenge of designing, building, implementing, and maintaining an SDI draws on many different disciplines and requires examination of a large number of factors and issues. For example, based on the participation rate in the PCGIAP activities, the development of the APSDI initiative in Asia and the Pacific region remains an innovative concept among its member nations. This is due to the fact that Asia and the Pacific region has a complex social and political environment, typified by competing and often conflicting priorities and motivations. Every case in this region is unique because of its national context, language and characteristics (such as size, population, political systems, varied infrastructures and skills), the national traditional and cultural attitudes, and the people who participate, develop and use SDIs.

Therefore, in order to develop a functioning Regional SDI efficiently in this region, the Regional SDI coordinating agency must manage such diversity to gain the support

necessary to meet their objectives. Identifying critical social factors and processes in the acquisition, implementation, and utilisation of a technology can facilitate the management of such diversity. It is expected that decision-making responses of individual nations, groups, and regional organisations may be predicted and therefore may also be accommodated or redirected through prescriptive strategies.

By identifying key human and technical factors within classes of potential users, SDI coordinating agencies will be able to better define and develop their strategies to achieve their objectives. Having said that, this research has identified three major classes of factors, which are influencing, or contributing to the development of the Asia-Pacific Regional SDI initiative as an example. These classes of factors are Environmental Factors, Capacity Factors, and SDI Organisation Factors, as illustrated in Figure 1. According to this figure, the three classes of factors together effect the participation rate. The next section will elaborate on each of the classes of factors and their influence on SDI development.

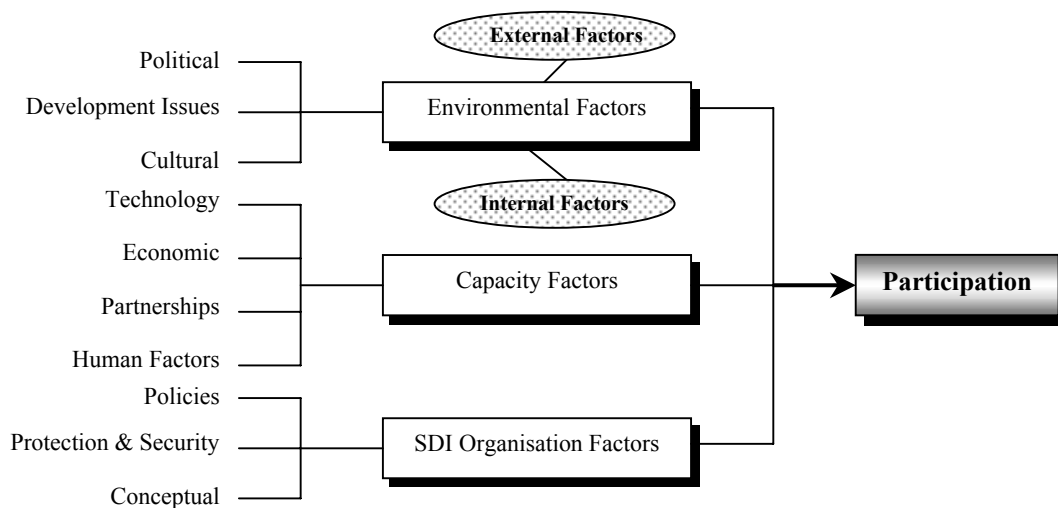


Figure 1: Factors influencing the development of a Regional SDI

A) Environmental Factors

The environment is the overall structure within which the social system operates and is characterised by internal and external factors. Therefore, the different characteristics of social systems, or communities, adopting the SDI concept can be attributed to a number of environmental factors, including the different cultures of the communities, political factors, and development issues. The external factors are those factors outside the border of the social system which affect, or could potentially affect, the performance of an organisation. These factors impinge more on management levels. The internal factors are those factors inside the border and affect both management and member levels. Therefore, determining an appropriate social border for study and analysis of a social system is very important.

Some examples of external factors are Globalisation (global market, global economics, other global initiatives); the GSDI initiative; and the global environment. In terms of

internal factors, examples include the political climate; political structure and procedures; relationships with regional organisations; technological pressure; financial stability of each member nation; organisational structure of the coordinating agency (this is one of the most important factors); and the degree of culture of data sharing.

In terms of effectiveness of factors, the effects of cultural factors on Regional SDI development can be extremely high. The social dynamics of national relations can cause enormous effects on cooperation and costs within the business environment and poor decision-making. By examining the social dynamics of cultural difference within jurisdictions, it would be possible to understand why a high proportion of capabilities of member nations is hidden or not functioning. Regional SDI coordinating agencies must therefore assess the impact of cultural factors in SDI development. If the risk of these factors is seen to be too high, then the strategy for development can be redesigned.

Moreover, the cultural factors should no longer be treated as intangible. They can be analysed and they can be incorporated into the study of the social system of a jurisdiction in which an SDI is supposed to be developed. These are factors of enormous significance in determining the level of support and expectation of individual members within a specific jurisdiction. Those who want to increase the level of support should therefore consider these factors carefully. Thus, any SDI coordinating agency must consider cultural factors to gain significant progress in their activities through concerted policies.

B) Capacity Factors

Capacity building as defined by Georgiadou (2001), may refer to improvements in the ability of institutions and (government and non-government) organisations to carry out their functions and achieve desired results over time. It may also refer to the provision of foundation data, metadata standards, clearinghouse functionalities and a facilitating environment for decentralising GIS application in manageable application domains within the SDI concept. Therefore, based on this definition, capacity building for an SDI in a broad sense may refer to improvements in the ability of all involved parties to perform appropriate tasks within the broad set of principles of that particular SDI initiative.

With this in mind, Capacity Factors are those that cover technology, economic factors, partnerships, and human factors and thus encompass technological capacity, human capacity, and financial capacity. Some examples of Capacity Factors are: the level of awareness of values of SDIs; the state of infrastructure and communications; technology pressures; the economic and financial stability of each member nation (including the ability to cover participation expenses); the necessity for long-term investment plans; regional market pressures (the state of regional markets and proximity to other markets); the availability of resources (lack of funding can be a stimulus for building partnerships, however, there should be a stable source of funding); and the continued building of business processes.

C) SDI Organisation Factors

These are factors related to the way that an SDI is defined, designed and implemented. This mainly includes all SDI core components, including technical and institutional issues such as access policies, access networks, technical standards, and the SDI conceptual model. Some examples of SDI Organisation Factors are: the suitability and degree of complexity of the SDI conceptual model; the availability of spatial data and metadata; the integration and inter-flow of datasets from different parties (this has important implications for the ownership and control of information); access networks; and multiple trusted data sources.

Recommendations

There are four recommendations that can be derived from a consideration of the key factors important to the success of an SDI development and its future directions. In light of the findings from this research, these recommendations as illustrated in Figure 2, are proposed as central to the PCGIAP achieving an increased rate of participation from nations for the APSDI development. The adoption and implementation of these recommendations may also assist other Regional SDI coordinating agencies in such a way that they overcome the problem of low participation and speed up the progress in the development of SDI initiatives.

According to the Figure 2, these recommendations are organisational restructure; redesign future strategy based on the study and understanding of the regional social system; modify the current Regional SDI conceptual model; and adoption and utilisation of a process-based model instead of the current product-based model.

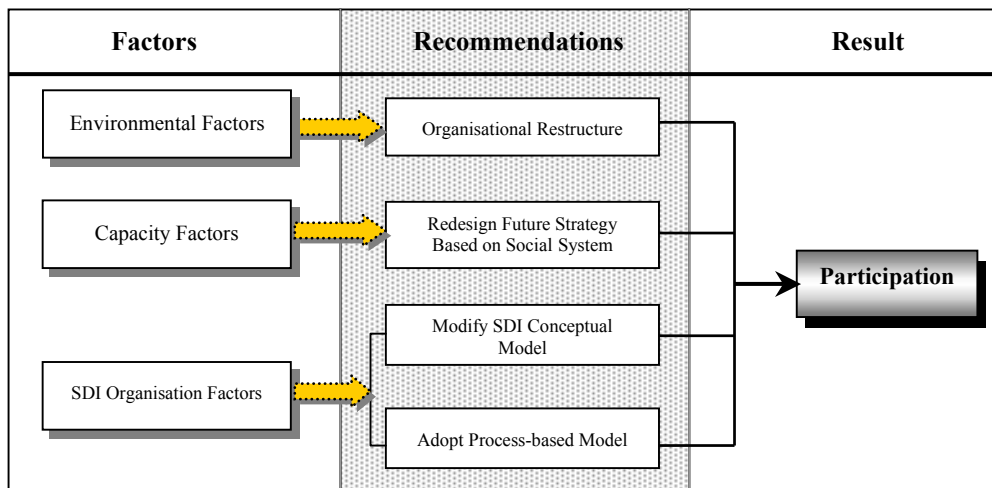


Figure 2: Four recommendations to increase Regional SDI participation rate

Conclusion

The development of a Regional SDI is much more challenging than the development of a National SDI initiative within a nation. This is mainly because of the voluntary nature of cooperation at a multi-national level and participation in a Regional SDI initiative.

This paper presented the key factors influencing the diffusion of a Regional SDI, as an outcome of a case study research. The paper first discussed the importance of identifying such factors. Then it presented three major classes of factors namely Environmental Factors, Capacity Factors, and SDI Organisation Factors, and argued that these classes of factors are influencing the development of a Regional SDI, and together they can effect the participation rate of member nations.

Although this paper focuses on the development of a Regional SDI initiative in the Asia-Pacific region, the results and lessons learned in this research – especially the key factors influencing the diffusion of a Regional SDI - can also be used and applied in other regions, and potentially other jurisdictional levels.

Acknowledgments

The authors would like to acknowledge the support of the University of Melbourne, Land Victoria, Mapping Division, the Geoscience Australia (formerly AUSLIG), the Permanent Committee on GIS Infrastructure for Asia and the Pacific (PCGIAP), and the member of the Centre for Spatial Data Infrastructures and Land Administration at the Department of Geomatics, the University of Melbourne, in the preparation of this paper and the associated research. However, the views expressed in the paper are those of the authors and do not necessarily reflect the views of these groups.

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