

Expanding SDI Hierarchy for Countries with Non-federated System: A Case Study of Iran

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Abstract: The need to geo-spatial data in different applications particularly for knowledge-based sustainable development is considerable. However, various problems encountered with production, dissemination and accessing geo-spatial data makes users to face with many difficulties when intending to use them. Spatial Data Infrastructure (SDI) is introduced as a solution to these problems. Success of an SDI strongly depends on partnership among different parties at different administrative levels involved in SDI development, which makes SDI to have a complex nature. The general SDI Hierarchy model tries to simplify the complexity of SDI development. However, it is essential to expand this model in order to be adopted for specific initiatives at the implementation phase. This paper proposes expansion of SDI Hierarchy for Iran as a country with non-federated system. It also describes the concept and importance of Organizational SDI (OSDI) in developing National SDI (NSDI).

Key word: Spatial Data Infrastructure (SDI) . SDI hierarchy . organizational SDI

INTRODUCTION

It has been estimated that over 80% of governmental data has spatial nature, component, location or basin [1-3]. It has been also observed that a large majority of all decisions depend on spatial situation or have spatial effects [4]. The role of spatial information to generate knowledge for achieving decision-making for complex problems has been increasingly recognized. Such situation made emerging Geospatial Information Science as a new field of study in early 1990s that is currently underway [5].

Spatial data is vital for promotion of economic development, improvement of our stewardship of natural resources and protection of the environment [6]. Currently, in most of the developed countries it is widely acknowledged that spatial data is a part of the national infrastructure for which extensive efforts are made [7]. Today, more and more people are gaining access to spatial data and using it in business processes and systems to assist decision-making within and between many organizations [8]. However, with such a role of spatial data in everyday business and decisions, there are substantial problems with collection, dissemination, access and usage of these data. Duplication of efforts in spatial data collection, unawareness of data availability, institutional and military-type security barriers for dissemination or exchange of data and heterogeneity of systems can be named as some of the general problems with spatial

data. Spatial Data Infrastructure (SDI) is an initiative intends to resolve these problems by creating an appropriate partnership environment for data collection, dissemination, access and usage.

With this in mind, during the last decade different nations have had extensive efforts on developing their own SDIs (particularly at the national level) as part of their infrastructural activities. However, none of these initiatives has reported complete implementation of an SDI. It is actually due to complex nature of SDI and different problems associated with SDI implementation. As a result, in the context of different research activities and based on different SDIs experiences, it has been tried to identify the problems with SDI development and then to develop different models for resolving them.

In this paper, the general SDI model and the SDI Hierarchy model will be reviewed. Then, based on a case study in Iran, the SDI Hierarchy model will be expanded. It will be depicted that the expanded model can better clarify required basic arrangements at each level of hierarchy and their relationships for developing SDIs.

MATERIALS AND METHODS

SDI components and nature: SDI can be defined as initiative intent to create an environment in which all stakeholders can cooperate with each other and interact with technology to better achieve their objectives at

different political/administrative levels [9]. SDI is fundamentally about facilitation and coordination of the exchange and sharing of spatial data between stakeholders in the spatial data community. It constitutes dynamic partnership between inter- and intra- jurisdictional stakeholders [10]. SDI initiatives have evolved in response to the need for cooperation between users and producers of spatial data to nurture the means and environment for spatial data sharing and development [11].

Experiences of various SDI initiatives highlight that development of SDI is matter of different technical and non-technical challenges [12, 13]. Technical merging at multiple resolutions, non uniformity of data densities, positional accuracy issues and data standards are some examples of technical obstacles [14]. Lack of awareness on concept and applications of SDI, privacy issues, entrenched bureaucratic practices, cultural issues for data sharing, costs/lack of financial incentive, lack of suitable agreements/ contracts, custodianship issues, inappropriate political environment, lack of the application of metadata standards and data pricing can be named as some of the non-technical issues [12]. Rajabifard and Williamson [10] and Mansourian *et al.* [15, 16] also introduced a number of important socio-technical factors and issues relating to SDI development from conceptual, technical, political, institutional and financial perspectives. In this respect Rajabifard and Williamson [10] highlighted that three categories of factors namely environmental factors, capacity factors and SDI organization factors strongly affect partnership in development of SDI.

Different initiatives have considered different components for SDIs in order to be used for SDIs implementation. These components are interconnected and aim to create an environment in which people (data producers, value-adders and users) can access and use spatial data. By studying these components, five general core components can be considered for SDIs including people, policies, standards, accessing network and data [17] that all are affected by technology (Fig. 1). SDI core components have dynamic nature due to change in technology and also change in user needs. As a result, SDI has a dynamic nature.

Figure 1 shows the general SDI model including SDI core components and their relation with each other that is adopted for Iran, the case study of the research. As Fig. 1 shows, appropriate policies, standards and accessing networks can facilitate the relation between people and data with respect to collection, dissemination, access and usage.

For any SDI initiative in any community, the five core components of SDI should be satisfied with respect to the community's needs. Therefore, for SDI

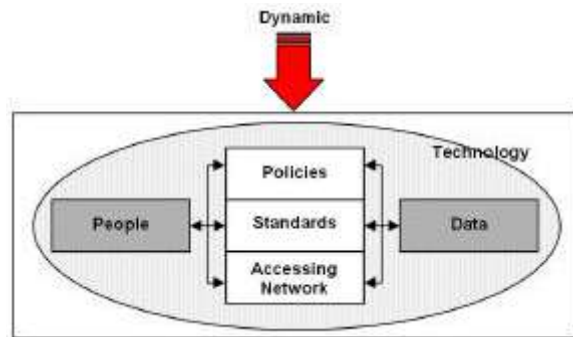


Fig. 1: SDI Components [17]

initiatives the SDI conceptual model should be initially developed by expanding SDI core components with respect to the community needs [16-20] and then the SDI is implemented based on the developed conceptual model.

Among the SDI core components, people has a key role in developing SDIs, because success of an SDI initiative in a community highly depends on collaboration among different stakeholders (people/ organizations) supporting the initiative. For example, development and implementation of a National SDI (NSDI) requires collaboration of different organizations at different political/administrative (e.g. provincial and local) levels. Such situation makes development of SDI to have a complex nature as has been highlighted by Rajabifard *et al.* [17]. SDI Hierarchy model tries to reduce such complexity by breaking SDI initiatives to different levels.

SDI hierarchy: In order to reduce the complexity of SDI development, the Spatial Hierarchy Reasoning (SHR) theory was applied to SDI and hence the general SDI Hierarchy model was developed [17]. Figure 2 illustrates this model in which an SDI Hierarchy is made up of inter-connected SDIs at local, state/provincial, national, regional (multi-national) and global levels. These levels have vertical and horizontal relationships as has been shown in Fig. 2.

There are two views on nature of SDI that help in better describing and understanding SDI Hierarchy [17]. The first view is an Umbrella View, which describes the SDI at a higher level, encompasses all the components of SDIs at levels below. The second view is the Building Block View. According to this view, any level of SDI servers as the building blocks supporting the provision of spatial data needed by SDIs at higher level in the hierarchy. Based on these views, the SDI hierarchy creates an environment in which decision-makers working at any level can draw on data from other

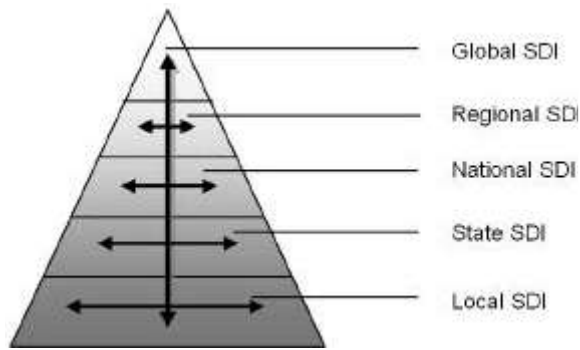


Fig. 2: SDI Hierarchy Model and the Complex SDI relationships within and between different levels [17]

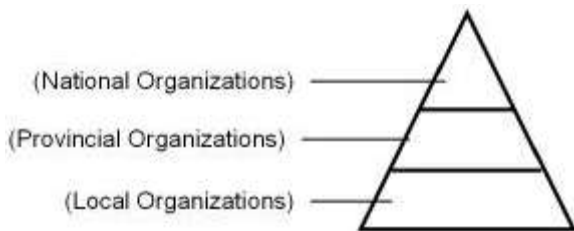


Fig. 3: The hierarchy structure of national organizations

levels depending on the themes, scales, currency and coverage of the data needed.

According to SDI views, in SDI initiatives generally policy and standard makings are based on Umbrella View of SDI (top-down) while generating and gathering fundamental datasets are based on Building Block View of SDI (bottom-up).

National SDI of Iran: A case study: Iran is a country located in middle-east region and has a non-federated governmental system. For administrative purposes, Iran is divided into 30 provinces which are individually divided into smaller counties. The president is in charge of managing executive activities at the national level through the ministries, national organizations and national councils that all are referred as national organization in this paper. Each of the national organizations has formed different provincial organizations, in charge of conducting specific technical management, planning and executive activities in provinces. The provincial organizations have also formed local organizations for offering services at the local level.

The general provincial planning is conducted through Provincial Planning Council which consists of representatives of provincial organizations. The plans are executed by provincial organizations, while each

provincial organization follows general policies of the related national organization. Some of the local services or executive activities may be conducted / carried out by local organizations under supervision of provincial organizations. Figure 3 shows the hierarchy structure of national organizations at the national, provincial and local levels.

In mid 2004, the Parliament enacted development of NSDI in Iran as part of the 4th Development Plan of the country. As a result, a technical committee was establishing in order to prepare the NSDI strategic plan. The committee included representatives of different national organizations as members and the head of National Center for Spatial Planning (NCSP) in Management and Planning Organization as the secretariat as well as the authors of this paper who were also consultants of the NCSP for preparing the draft of the strategic plan. The strategic plan had to include the vision, mission and aims of NSDI, required orders and sentences for NSDI implementation and a proposed structure for coordinating activities.

By adopting the Luzet [19] model, the draft of strategic plan mandated ministries and national organizations to be the main stakeholders and data custodians of Iran NSDI. They must accept the responsibility of production and updating the NSDI's data, based on and during their daily businesses. In other word, stakeholders should produce data through their daily businesses including road management, urban planning, land management, tax collection and so forth. Although there may be many data providers, the datasets they provide must be integrated in order to develop NSDI's datasets. Once these datasets are shared between data users, each user does not have to develop the data by oneself; the user can avoid duplicated efforts of data production. Consequently, by sharing the cost of developing the NSDI's data, data production cost can be minimized and shared between the users.

The draft of strategic plan highlights that with such a partnership model much benefit is revealed when updating. Since data are updated during daily business of organizations, they are updated most frequently. Therefore, the users are assured of using up-to-date datasets in an SDI environment. In addition, these data producers develop most detailed spatial data with high quality based on their business requirements. Another benefit of using NSDI's datasets lies in the fact that these commonly used datasets enable the users to easily share other spatial data with other users.

Prior to strategic planning, a questionnaire survey was conducted with two main aims. The first aim was to investigate the general environment of the country with an SDI view in order to:

- Identify the barriers and obstacles that may impede development of NSDI in Iran,
- Identify the weakness points that need to be strengthened for NSDI implementation,
- Identify current strengths and opportunities that can facilitate NSDI development and
- Use the previous experiences of GIS and data sharing activities in developing Iran's NSDI.

Considering the important role of national organizations as stakeholders and data custodians in NSDI, the second aim of the survey was to evaluating preparedness of national organizations for participation in NSDI initiative as data custodians. This paper emphasize on analyzing the results of the second aim.

Preparedness of national organizations for NSDI development: Daily activities of an organization are conducted by its departments. In other words, departments potentially produce, maintain and use spatial data during their daily activities. Meanwhile, data sharing is essential for preventing duplicated efforts in data collection, coordination of activities and supervising activities. With this in mind, a national organization can provide the NSDI data, if there are proper spatial data management/coordination mechanisms/policies among its departments. However, the results of the questionnaire survey highlighted that national organizations do not have such mechanisms/policies and hence are not still well-prepared to have a supportive custodianship for NSDI's data. Following are some of the considerable notes about the status of national organizations from NSDI view point:

- Most of the national organizations do not have a formal structure for coordinating spatial data activities in the organization,
- Departments are not generally aware of spatial data activities within other departments,
- National organizations do not have proper standards for data production, storage and sharing,
- Most of the national organizations do not have a clear policy for inter-/intra-organizational data sharing,
- Most of the national organizations do not have a proper accessing network for online intra-organizational spatial data exchange/sharing,
- People at policy, management and operational levels are not generally aware of the value of spatial data for daily business of their organizations. Such situation makes lack of organizational support on spatial data activities.

They do not have also enough knowledge about the concept and advantages of SDI,

- National organizations do not have generally a proper technological level for spatial data management (in different aspects such as production, maintenance and sharing) during their daily business,
- National organizations can provide required financial resources for spatial data activities. However, lack of knowledge on value of spatial data for daily business and value of data sharing make them not to assign proper financial resources for these activities and
- People who manage and coordinate spatial data activities do not have Spatial Information Science knowledge/background. Such situation causes conduction of non-scientific and non-infrastructural spatial data activities within national organizations.

Organizational SDI: An essential requirement for success of NSDI: As described earlier, success of SDI at any level requires collaboration of different organizations playing the role of stakeholders and data custodians at that level. However, the investigation in Iran highlighted that national organizations are not well-prepared to have an effective and supportive participation in NSDI as data custodians. This is due to lack of proper policies, procedures, standards, legislations and capacities (knowledge, technology and economy) for establishing and facilitating collaboration of different departments within a national organization to collect/produce/maintain spatial data based on their daily business and then sharing the data within the organization.

In this respect, it is suggested that development and implementation of Organizational SDI (OSDI) within the national organizations can resolve the problem with lack of preparedness of organizations for participating in NSDI. An OSDI establishes partnership among different departments of an organization for data production, maintenance and sharing during/based on daily businesses. This is achieved by satisfying SDI core components and paying attention to environmental, capacity and SDI organization factors within that organization. Implementing OSDI may include:

- Increasing awareness of people about the concept of SDI and advantages of spatial data for better planning and decision-making,
- Increasing the technological level of organization to be proper for supporting spatial data activities (production, maintenance, sharing, etc.),

- Design and implementation of required systems and services to facilitate spatial data management, access and sharing as part of increasing the technological level of organization,
- Culturing the use and sharing of spatial data during daily activities,
- Policy-making for spatial data activities within organization (how to share, how to fund, ...),
- Standardization of spatial data activities (preparing standards and specifications for data production storage, sharing, etc.).

It is worth mentioning that for any organization, conceptual modeling and implementing of OSDI is not independent of NSDI activities, while it should follow the general NSDI standards and policies. Meanwhile, OSDI standards and policies can facilitate preparing NSDI's. As a result the relation between NSDI and OSDI is a two-sided relationship.

RESULTS AND DISCUSSION

Expanding SDI hierarchy model: The role and effect of OSDI is meaningful for other levels of SDI Hierarchy. In other words, in order to have a successful SDI at the provincial/local level, preparedness of data custodians (organizations) at that level for an effective participation is a key factor. OSDI can prepare the provincial/local organizations to have a supportive and effective participation in implementing provincial/local SDIs. With this in mind, the general SDI Hierarchy Model can be expanded as Fig. 4. As Fig. 4 shows, having collaboration of organizations as foundation of SDIs (Collaboration box at the bottom and the horizontal arrows at each level of hierarchy), OSDI is the basin of any SDI initiative at each level of SDI Hierarchy. OSDI facilitates effective participation of organizations, as data custodians, in SDI initiatives.

For developing an OSDI, two types of coordination relationships should be attended. The first one is coordination with SDI initiative at that administrative level (say Provincial SDI). Considering that each organization at any administrative level is under supervision of one organization at the higher level, there is also a vertical relationship between OSDIs at different administrative levels (the left rectangles in Fig. 4). So, the second relationship is coordination with higher level of OSDI activities in the related organization.

DISCUSSION AND CONCLUSION

Preparedness of organizations for accepting data custodianship is a key factor for success of an SDI

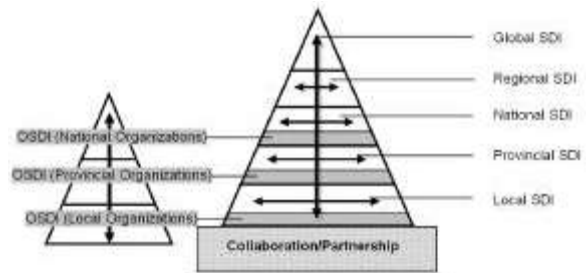


Fig. 4: Expanded SDI hierarchy with respect to organizational SDI (OSDI)

initiative. In this paper, by introducing the concept of OSDI, it was depicted that OSDI can prepare organizations for collaboration in an SDI initiative. Based on this concept, the SDI Hierarchy model was developed in such a way spatial data communities to have better adoption for SDI development and implementation. For Iran that is a country with non-federated system, OSDIs should have coordination with their general organizational policies as well as the general administrative level (local, provincial or national) policies that makes the SDI environment complex. The expanded SDI hierarchy model, simplifies this complexity by clarifying relationships.

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