An Innovative Approach to the Development of Spatial Data Infrastructures and Web 2.0 Technologies

Laosuwan, T. and Ritjareonwattu, S.
Department of Physics, Faculty of Science, Mahasarakham University, Khamriang Sub-District, Kantarawichai District Mahasarakham 44150, Thailand, E-mail: teerawong@msu.ac.th

Abstract
With insufficient budgets, many metropolitan areas are confronted with the rapid population growth and the ineffective city management. The citizen participation in these problems is likely to be the key factor to the success of municipal administration. Some strategic plans incorporated with monetary tightening policy are used to solve the problems from fast demographic changes. At the moment, the Internet is an effective channel for promoting the citizen participation. Geographic information system (GIS) has been combined the World Wide Web (WWW) system in last two decades. There were some hindrances when using the combined system as the e-Participation system. The Web 2.0 technologies have led to the significant development in the internet technology. This may be a promising solution for solving the problem in e-Participation system. With such Web 2.0 technologies, the information is more accessible and hence increases the participation of the citizen. In Thailand, spatial data infrastructure has been established by the Geo-Informatics and Space Technology Development Agency (GISTDA). This has enhanced availability of the qualified geodata, such as data related to a spatial context. Therefore, the e-Participation can benefit the municipal administration and planning. In this research, the e-Participation for the city management in Maha Sarakham (Thailand) was investigated and the status of spatial data infrastructure and Web 2.0 technologies was also reviewed.

1. Administration of Municipal and Planning

The root of democracy is based on the consensus of individuals in the society. To date, the public however has limited participation in developing plans and policies. This makes such plans and policies impractical to solve the problem of the society. Without the full public participation, the municipal planning is likely to arrive at the ineffective solution for the public. The planning with the full participation can propose more compromise and more effective solutions to the people in the society. This reveals that the relationship among the state, the economic system and the society has changed significantly from the past. This leads to the growing need for public-oriented planning and administration. In addition, people in the society are eager to take part in such planning. However, the channel for participation is still limited for all individuals in the community. The increase of the disenchantments of people to the politics and their representatives reflects the lack of the participation of the people to public decisions (Blankenbach and Schaffert, 2010). In the next upcoming decades, the population in Thailand is likely to shrink significantly due to the increase of the elderly population. Demographic shrinkage and also money tightness raise questions about municipal services and also accustomed planning practices. Appropriate solutions for these problems are of importance for people in the society. Ideally, all people in the society should participate in municipal administration and planning. The participation from the society thus occupies the crucial role in solving the municipal problem. Krueathep (2009) showed that the participation enhancement primarily requires organization adjustment and new technology. Despite the increase of the research in this area, the studies to solve the municipal problems are still limited. In this study, the city management in Maha Sarakham (Thailand) was thus examined. In addition, the status of spatial data infrastructure and Web 2.0 technologies was investigated.

2. User- Centric Spatial Data Infrastructure

Researchers generally experience difficulty in accessing to information sources when working on computational space representation (Davis et al. 2005). Spatial data infrastructure (SDI) is used to resolve this difficulty (Maguire and Longley 2005). It provides an environment in which each segment deals with the others with the proper technology to achieve their goals more effectively at different administrative levels (Chan et al., 2001).

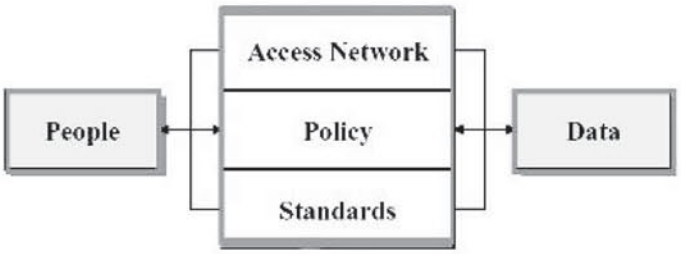

Figure 1: SDI components

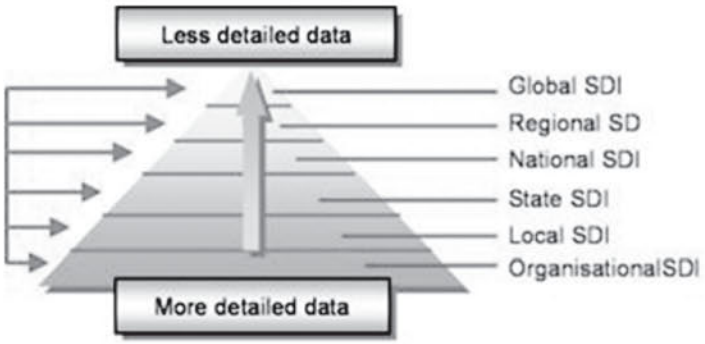

Figure 2: SDI Hierarchy

Rajabifard et al., (2003) stated that such environment is employed to facilitate shares, accesses and uses of spatial data across different communities via design, implementation and maintenance of mechanisms. As shown in Figure 1, five main components of the SDI are people, access network, policy, standards and data (Rajabifard et al., 2002). To generate the spatial data infrastructure, the process can be divided into three main steps, namely a data-centric SDI, a process-centric SDI, and a user-centric SDI as shown in Figure 1 (Rajabifard, 2006 and Budhathoki et al., 2008). In data-centric and process-centric SDI systems, users are passive recipients of geospatial information (GI). In contrast to both systems, users in the user-centric system are active receivers. Various processes were designed for the process-centric SDI system based on data gathering in the data-centric SDI generation. While designing processes, preferences and interests of the end user have, however, not been considered. As the first generation system, the data- government organizations are a main provider and/or supplier of the geospatial information to users (Budhathoki et al., 2008). However, the user has partial and full contributions in the process-centric SDI and the user-centric SDI, respective. Government organizations gather and collect the data in the first-generation data-centric system. The other organizations have to support the system by providing any required information under the certain mandates (Goodchild, 2007). After the gathering process, all data are then sorted and structured based on the type of data. It is evident that users may encounter difficulties in accessing to the data since it is not user-friendly system. This is an obstacle for the SDI users to accessing the system. The process-centric SDI, the second generation of SDI systems, was then developed after the information and communication technologies (ICTs) had evolved significantly. The data-centric SDI, the process-centric SDI is more user-friendly system by using some new technologies, such as WEB 2.0. The process-centric system is however unable to fully serve the user as an active recipient since it is not designed to respond to all the users' interests. This therefore leads to the need of a third-generation SDI, a user-centric SDI. User roles are changed significantly from the passive position in the previous systems to the active position in this architecture. The system changed to the second and the third generations of SDI in 2000 and 2007 respectively. Additionally, the data-centric, process-centric and user centric systems are compared in this figure. In the first-generation and the second-generation SDIs, some conceptual tools have been developed, such as metadata standards, interoperability, policy and organization (Budhathoki and Nedovic-Budic, 2007). These tools can be employed in the third-generation system by moderating some compulsory elements. This will lead to the optimization in the

third generation to gain the benefits of the previous SDI systems while cooperating with users based on their needs Figure 2.

3. Participation in the Management of Municipal and Planning Legacy

In Thailand, the Thai citizen has, by law, the full rights to participate in any municipal and planning activities. Although there have been some participations offered to the citizen, the ineffective procedures and also the inappropriate logistics discouraged them and constrained their participations (Ministry of Science and Technology, 2011, Geertman and Stillwell, 2009). In fact, the citizens need to inspect some municipal and/or administrative plans. Some restrictions, such as the availability of time and locations, lead to the limited participation of the citizen. The citizens who have willing to exam the disclosure draft of a preparatory land use plan, for example, can only do during a defined time period and only in a location defined in public authority. In addition, the public bodies charged of planning tasks need very much time and effort to execute the mandatory participants as requirements in a plan's disclosure case, for example, the procedure must cover an appointment, organizing, and conducting steps in order to execute someone. Moreover, media disruption is an additional disadvantage occurs in ordinary planning process. Most of media data were kept in digital form so far, but the plan's draft and any received objections were usually presented in hard copies (Ministry of Public Health. 2007). Lacking of participation efficiency is not unique for formal planning processes as mentioned before. It usually occurs during informal situation, for example, incidence planning, open council, and so on. The appointing, organizing, and conducting the planning steps take very much time and (in some possible cases) some organizer and participants need much of budget in cooperation. To overcome the disadvantage of traditional participation and to involve broader public, new forms of organization and technology have to be developed (Blankenbach and Schaffert, 2010). For these purposes, the internet is likely to play a crucial role in this context, especially for municipalities (Bow, 2011). From this assumption, a plenty of efforts have been undertaken to apply the WWW to municipal issues during last two decades. It can be said that now the internet applications with various participation enhancements can be found and most are in either in researching or practicing status (Sinnig, 2003). All were proven for e-participation enhancement quality and quantity of administration and planning issues by GISTDA (2011) and none of them look fulfill the requirement for Thailand public use. According to the juridical perspective that regulates domestic market, it is necessary to improve Thai municipal IT facilities to ensure that all formalities and procedures will be completed (at a distance and by electronic means). This will be implementing in municipal levels which are "relevant competent authorities" for this issue of Thailand. Within this context, various Thai municipal organizations thus establish web base service platforms as part of e-Government municipalities to enhance the administrating efficiency. According to the fact that municipal administration and planning are strongly related to their spatial context, geodata utilizing and handling are thus a crucial concern in the municipal e-Participation facility enhancements. Furthermore, the geodata handling is particular importance in connecting of e-Participation applications to the municipal administration and the public. In particular, combination of Geographic Information System (GIS), Spatial Data Infrastructures (SDI), and Earth Viewers is a promising way as shown below. However, combination between the internet and geo information for participation purposes is not innovative invention. A large number of researches have been carried out in this context and several Public Participation GIS (PPGIS) and online Planning Support Systems (PSS) have been developed so far. The Figure 3 illustration participation GIS (PPGIS) in Muang District, Maha Sarakham Province.

4. Web 2.0 Technologies – A New Model for PPGIS Prototype

A significant improvement of the WWW and a crucial advancement in term of participation are founded in the Web 2.0 technologies. The "major release" version of the Web 2.0 technologies based upon new interactive and collaborative elements (Blankenbach and Schaffert, 2010). This version dissolves the former trouble which is limiting of information providers while there are excessively information demands. In particular, with regards to information exchange, the high cross-linking intensities among user communities result to new WWW handling features. The Web 2.0 technologies enables any users publicize, edit or distribute desired information. This, in turn, leads not only to the end of the centralized information exchange period, but also change the information exchange manner to be new and dynamic fashions (see Figure 4).

Figure 3: Public Participation GIS (PPGIS)

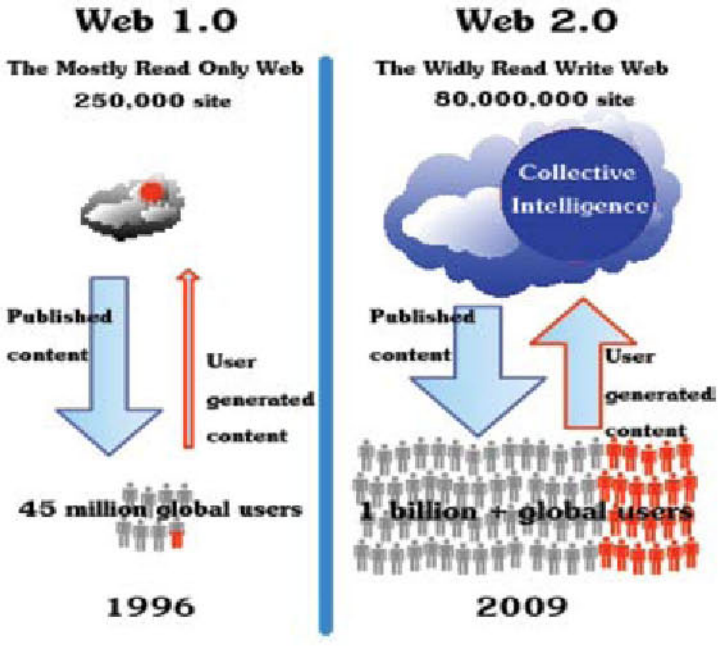

Figure 4: Web 2.0 technologies

To overcome such suffered background, the Web 2.0 technologies now offers new participation chances with specific technologies (ordered tools), starting from blogs and social networks (e.g. Facebook) to new ICT (Information and Communication Technologies) concepts like cloud computing and web protocols such as AJAX (Asynchronous JavaScript and XML). Furthermore several other technologies (e.g Twitter) enable the users to consume and distribute information not only from traditional stationary platform such as a desktop computer, but from dynamic platform such as a cell phone also. Being integrated with these technologies and applications, the Web 2.0 technologies enable users to exchange, interact, and collaborate in new styles which make "real"

participation possible. The Earth Viewers are alternative form of Web 2.0 technologies technology that establishes new dimension regarded to geodata distribution and exchange. The Google Earth and Google Maps are two of best known Earth Viewers which set a new standard concerning geo information perceptions to the WWW system in a very short exiting period. Google Earth which is the first virtual globe causes notably stir when it was debuted in 2004. Based on numerous satellite images and a global terrain model, it contributes three dimensions images upon the Earth's surface. By using XML based Keyhole Markup Language (KML), all users can publish their desired contents (e.g. a 3D city model) with Google Earth Mash up. On the other hand, the Google Maps is a 2D service which allows the users retrieve and visualize any location (spatial) Points of Interest (POI) based on available maps or aerial images. Similar to Google Earth navigating manner, the Google Map or Map viewer possesses some intuitive controls for zooming and panning to facilitate picture handling. These features are constructed by JavaScript's API that can allow both Google Maps embedding in one's own website and user content publishing. Several commercial applications and services have taken advantages from Google Maps to visualize their own geocoded content in WWW.

5. Spatial Data Standards and Spatial Data Infrastructures

The availability of WWW geodata manipulation has extremely increased so far. However, this is not only the Web 2.0 technologies and its (spatial related) applications or platforms advantage. Spatial Data Infrastructures (SDI) are currently established in different administration levels (global, continental, national, regional, and local) to enhance the access of geodata via the internet and to ease the geodata integration into future applications which a large number of qualified geodata (spatial base data, municipal and environmental related geodata, etc.) are going to be available and accessible via the internet. One important reason for SDIs establishing is the necessity of interoperability under open geo standards, especially the standards elaborated by Open Geospatial Consortium (OGC) in 1990. The geo data accessing and distributing with SDI, under geo-service standard so called OGC Web Services (OWS), are already specified. The OWS will ensure that the geo data is well distributed via Hypertext Transfer Protocol (HTTP) and predefined request and respond methods- frequently by applying XML. The Geo standard that is extremely important in this context are (Blankenbach and Schaffert, 2010):

- Web Map Services (WMS). These services allow dynamic map creation usually present in a raster data format (JPEG, PNG, etc.)
- Web Feature Services (WFS) are interfaces for data access operation on geographic features.
- Transactional Web Feature Services (WFS-T) are a WFS variation that further provides manipulation methods on geographic features.
- Catalogue Services (CSW) is services used for geo data and geoservice publication and finding based upon available meta data.

Next adjuvant SDIs development step is an integration of online processing services which offer different data services shown above and diverse functionality for web-base data analyzing. The standard for Web Processing Services (WPS) has already been elaborated by OGC. Other important advantage of SDIs is to allow municipal planning to access and distribute various 3D data and visualizations. The services that allow 3D city models following the Virtual Reality Markup Language (VRML) or Extensible 3D (X3D).

6. Web 2.0 technologies and SDI to E-participation

Well accepted Web 2.0 technologies concept together with availability increase of web-base (qualified) geo data (Earth Viewer and SDIs) allows the development of modern online participatory tools possible. Thus, promising possibilities in term of the tool-citizen connectivity and the municipal administration requirements are given here (Social Networking Info Man, 2011, Angermeiner, 2005 and O'Reilly, 2005). The points are discussed according to following observations:

- Due to Earth Viewer popularity, the benefit offered by geo data can be reached the public's awareness. The Google Earth and others offered geo information are in fascinated and fun manners.
- Other Web 2.0 technologies features are voluntarily participated by public people and taking part in social networks like Facebook. In addition to social networks, online geoservices and spatial related games such as various route planning services can also be participated by public people in the same manner.
- SDI establishing allows the distribution of qualified geo data available. The Qualified geo data, in turn, is an essential part of municipal administrating and planning processes and cannot be replaced by community base geo data or data provided by the Earth Viewers.

- OGC geo standard ensuring interoperable access to geo data for everybody is an important point required by the participation
- Geo data integrating into the municipal SDI framework ensures the storing persistence of gathered data and prevents data losing from web's temporary space.

The handling of spatial issue on web can be fun, as indicated by the observation 1 and 2. It is found that the amounts of users who get fascinated by geo data and intended to the spatial data using/handling are as voluntary basis. If this type of services can be used in municipal administration and planning, it will reach new e-Participation quality. The possibility looks high, at least new generation of e-Participation tools can be blended to both Web 2.0 technologies (observation 1 and 2) as well as existing municipal IT infrastructures by using SDIs (observation 3 to 5) to prevent media disruptions. The e-Participation tools with Web 2.0 technologies integrated in is a crucial one for many reasons. One of those comes from the success of the Web2.0 which is necessary to support the e-Participation tools only for few barriers, rules, and obstacles. However, precaution involves risk of misuse are possibly occurred at least some parts of the tools. To avoid these risks that come along with lax rules and barriers (without being forced to give up the Web 2.0 technologies advantages at the same time) the Web 2.0 technologies based e-Participation tools are supposed to be integrated into municipal e-Government structures. By this way, the municipality can put the responsibility to the persons (or committee) who is e-Participation moderator position and set up a safety system to guarantee user's privacy and data security. Thus, the e-participation tools are now an integral part of municipal e-Government so that the spatial context can be an additional dimension of a municipal SDI. In technical implementation point of view, evolving of e-Government portals may has some similarity to SDIs which were implemented under SOA (Service Oriented Architectures) principals.

7. Addition e-Participation Tool to Support the Public Municipal Administration

As the Muang District, Mahasarakham e-Government platforms and web gateway are being established (e.g. e-Government). With cooperation of Muang District, Mahasarakham office and Mahasarakham University, this idea has been taken up by starting a Web 2.0 technologies e-Participation tool prototype development as part of existing municipal e-Government gateway. At the first step, this instrument is supposed to enable mahasarakham citizens to inform the city administration about infrastructure problems (e.g. hole in the street, midden and street road lighting). With this service, reporting citizens do not need to look for any telephone number for contact, they just send information (for example location and incident) with a free text posting through given email address (without personally know the recipient and without any arrival notices). Unlike existing Web 2.0 technologies based application with similar functionalities, the e-Participation tools (so called 'MSK citizen's service') is supposed to become an integral part of the city's e-Government municipal SDI structure under Office of Government Commerce (OGC) standard. The well designed "MSK citizen's service" can be accessed via a web browser from anywhere even at home. After starting the application, a web form appears with predefined input fields and selectable categories for more precise problem description. The reporting begin with the user selects a category, attaches a describing text and/or picture of the incident (optional). Then, the incident will be located by pinning an actual location on the Google Maps. In addition to real time work, all existing reports within selected area are also shown to the user in order to prevent repeatedly reporting the same incident. The visualized screen Muang District, Mahasarakham government office via Google Maps is shown in Figure 5. By using standardized XML file formats, which can be directly generated on the Web Feature Service (WFS) using an Extensible Style sheet Transformation (XSLT), for instance, making the report immediately visualize on the Google Maps based applications. In the following section, some possible extensions will be described. These extensions can enhance the "MSK citizen service" efficiency and sustainability even they are currently under development.

8. Practical Strategy of Municipal Planning

The e-Participation tools are suitable for a variety of contexts (Hachmann, 2009). The multi-functionality of the e-Participation tools described above also fit in municipality planning process. The e-Participation tools enable the citizens to take part in planning process via the internet or predefined web forms. By using WFS based planning service, all citizen's criticisms, comments, and suggests can be written and stored in the same database deployed in planning process. Similar to the functionality of "MSK citizen service", the e-Participation tools also allow the geocoding of the citizen remarks as in the Google Maps (Figure 6). Again, the traffic light indicators can also be used in the same manner as in

the municipal administration. To meet municipal planning demands, additional interfaces of spatial base data or qualified planning related data (e.g. the municipal SDI geoservice) are required to visualize the plans through the Google Maps following the development plan approach, for example, it can be combined to a Google Maps image via Web Map Service (WMS) as a ground overlay.

Enhanced visualization techniques like 3D representations can be used with the aid of appropriate 3D geodata services (such as Web 3D Service) and file standards (such as KML) can facilitate the Google Earth usage. This may urge much of user's imagination. In addition, the planning department can also benefit by sharing the same database via WFS and enrich the planning process with more people's knowledge.

Figure 5: Illustration of Maha Sarakham District office

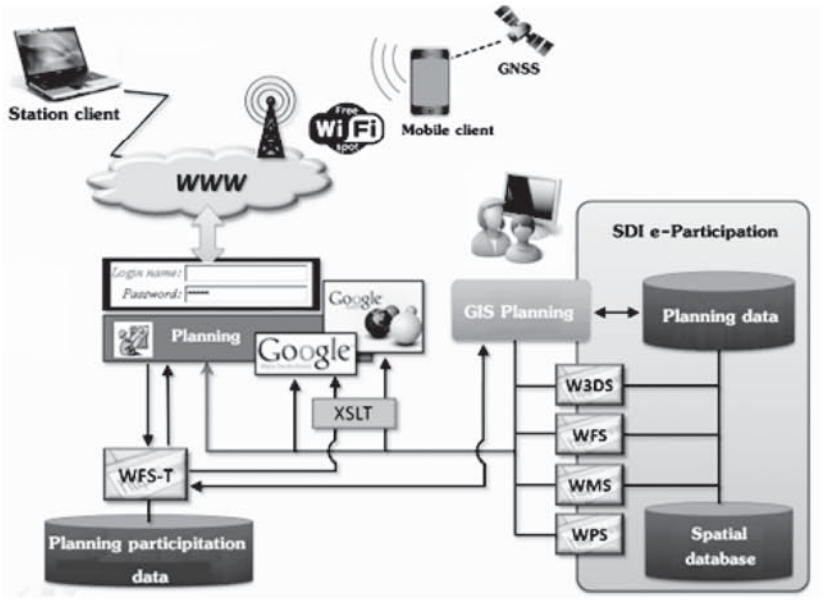

Figure 6: Web 2.0 technologies and MSK citizen service of municipal SDI (Modify from Blankenbach and Schaffert, 2010)

9. Conclusion

One most basic but essential requirement for the democratic system is collaboration between the public authority and the citizen. With the Web 2.0 technologies assisting, the promising collaboration will be surely established through e-Participation setting up. Considering this state-of-art web technology development, the outstanding applications like cloud computing or Google Wave or even more dynamic Web2.0 tools will be available soon and the real-time e-Participation system can also be possibly achieved soon. With open geo standards and SOA, the combination between Web 2.0 technologies and qualified geo data (that is always inevitable for municipal administration and planning) is thus possible. In addition, this e-Participation approach includes data disruption avoidance and persistent gathered data storage. Moreover, and e-Participation tools in this context is more than a municipal SDI, its additional benefits are universal availability for the gathered (geo) data and interoperable integration in specific municipal software applications. This architecture makes it usable with further developed applications and processes in future, for example, it can be used with a Mobile Workforce Management to enhance the "MSK citizen service" which can enable bidirectional communication (without media disruption) between service manager and field service staffs to enhance any effective fault clearing through mobile communication technology (e.g. wireless networks, mobile devices, etc.). The "MSK citizen service" system is currently developing and implementing under cooperation with Muang District, Mahasarakham office. The developing process is conducted as teamwork comprised the city's staffs to ensure that the tools are usable for both city's staffs and citizens. In the course of specific process implementation, the process details have to be elaborately constructed. In perspective view, the presented approach is supposed to be more extended and distributed to wider municipal areas or processes.

Acknowledgements

The author would like to acknowledge the financial support from the revenue budget for the year 2011, The Faculty of Science; Assoc. Prof. Dr. Wanna Kanchanamayoon, Deputy Dean, Faculty of Science Mahasarakham University, Thailand.

Reference

Angermeiner, M., 2005, TagCloud des Web 2.0, Available: http://kosmar.de/archives/2005/ /11/11/thehuge-cloud-lens-bubble-mapweb20/.

Blankenbach, J. and Schaffert, M., 2010, A SDI and Web 2.0 Technologies based Approach to Support E-Participation in Municipal Administration and Planning Strategies. FIG Congress 2010. Facing the Challenges – Building the Capacity. Sydney, Australia, 11-16 April 2010.

Bow, N., 2011, Internet Communication with Thai Politics, Available: http://www.vcharkarn.com/ vblog/40382/68

Budhathoki, N. R. and Nedovic-Budic, Z., 2007, Expanding the SDI Knowledge Base. In H. Onsrud (Ed.), Research and Theory in Advancing Spatial Data Infrastructure, Redlands: ESRI Press, 7–32.

Budhathoki, N. R., Bruce, B. and Nedovic-Budic, Z., 2008, Reconceptualizing the Role of the user of Spatial Data Infrastructure. *GeoJournal*, 72 (3–4).

Chan, T. O., Feeney, M. E., Rajabifard, A. and Williamson, I. P., 2001, The Dynamic Nature of Spatial Data Infrastructure: A Method of Descriptive Classification. *Journal of Geomatica*. 55(1): 451-458.

Davis Junior, C. A., Souza, L. A. and Borges, K. A. V., 2005, Disseminação de Dados Geográficos na Internet. In: Casanova, M. A. et al. (Org.). Bancos de Dados Geográficos. Curitiba: EspaçoGeo, 353-378.

Geertman, S. and Stillwell, J., 2009, Planning Support Systems - Best Practice and New Methods, Heidelberg.

GISTDA, 2011, An Approach of Thailand NSDI. Available:http://www.gistda.or.th/gistda_n/dmd ocuments/20090223_map_02_ThaiSDI.pdf

Goodchild, M. F., 2007, Citizens as Voluntary Sensors: Spatial Data Infrastructure in the World of Web 2.0. *International Journal of Spatial Data Infrastructures Research*, 2, 24–32.

Krueathep, W., 2009, Participatory Budgeting in Subdistrict Administrative Organization: Or Else Is Beautiful? Paper Presented at the *11th Annual Conference of King Prajadhipok's Institute*, November 6, 2009, United Nations Bangkok Office.

Maguire, D. J. and Longley, P. A., 2005, The Emergence of Geoportals and their Role in Spatial Data Infrastructures, *Computers, Environment and Urban Systems*. 29 (1), 3–14.

Ministry of Public Health. 2007, Participation of the people. Handouts of the meeting, Ministry of Public Health, Thailand.

Ministry of Science and Technology, 2011, Public Administration and Participatory Participation of the People. Available: http://portal.in.th/scipaticapate/pages/6900/

O'Reilly, T., 2005, What Is Web 2.0, Design Patterns and Business Models for the Next Generation of Software, http://oreilly.com/web2/archive/what-is-web-20.html

Rajabifard, A., Feeney, M. E. F. and Williamson, I. P., 2002, Future Directions for SDI Development, *International Journal of Applied Earth Observation and Geoinformation*, ITC, 4(1), 11-22.

Rajabifard, A. and Williamson, I. P. 2003, Anticipating the Cultural Aspects of Sharing for SDI Development, *Spatial Science 2003*.

Rajabifard, A., Binns, A., Masser, I., and Williamson, I., 2006, The Role of Sub-National Government and the Private Sector in Future Spatial Data Infrastructures. *International Journal of Geographical Information Science*, 20(7), 727–741.

Sinnig, H. 2003, IFR-Jahrestagung 2003, Raum.Planung.Internet" am 19.9.2003 in Gelsenkirchen Economist Intelligence Unit (EIU) (2009): E-readiness rankings 2009: The usage imperative. A report from the Economist Intelligence Unit, Available:http://www.935.ibm.com/services/us/gbs/bus/pdf/ereadiness_rankings_june_2009_final_web.pdf

Social Networking Info Man, 2011, Study: eParticipation and Web 2.0 technologies in German state and local government – Still in beta phase, Available: http://www.socialnetworkingsitehq.com/ social_networking/study-eparticipation-and-web-2-0-in-german-state-and-local-government-still-in-beta-phase/