An investigation of a Total Quality Management System for Spatial Data Infrastructures

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EXTENDED ABSTRACT

Along with spatial concepts, science and technology development in spatial community and tremendous growth in spatially related activities throughout the last two decades, the qualification process has been under special considerations. In this situation experts recommend to bring uncertainty and quality related activities (reduction and management) as close as possible to ordinary lives, through a process of communication and towards the objective of improved geospatial information (GI) services and productivity. Also the participation of all potential stakeholders (academics, technologists, government agencies, the general public, and the commercial sector) is appreciated to take advantage of GI utilization while being fully accessed and informed [**Error! Reference source not found.**]. This paper is investigating such a process

in spatial data infrastructures (SDI), highlighting SDI deficiencies and their solutions as well as improvements which could be obtained through integrating a total quality management system (TQMS).

A comparative study of the mentioned qualification trend of spatially related activities and semiotics, which is the foundation of sciences engaged with the cognition, representation, perception and utilization of real world phenomena and activities; it could be to claim that the semantics as cognition and representation of spatiality were the dominant processes in spatial community qualifications against others as pragmatics. According to requisiteness of unknowns cognition of innovations, the spatial community has been engaged with, and dealing with pragmatics which being addressed as the requirement of each branch of science evolution and enable us to communicate to (widest possible groups of) our communities [**Error! Reference source not found.**], would be followed out seriously. Despite the inception of innovational sciences and technologies like GIS (geospatial information system), GeoVis (geospatial visualization), GPS (global positioning system) and so on which have extended our capabilities in dealing with the pragmatic aspects of qualification, it is still a skilled-base process and mainly visualization oriented. The main challenge would be the engagement of all stakeholders (data providers, value-adders and end-users) particularly in spatially related qualification activities which could be handled through organization of spatial capabilities as an SDI, which is one of the most important enterprises due to experiencing the potential benefits of new generation infrastructures for bridging the problems arisen out of the traditional infrastructures.

Reviewing infrastructures evolution, current situation necessitates high level of reliability, flexibility and quality of service for them rather than cheap utilities and commodity services provided by traditional ones, their deep embedded-ness in the spatial and economic structure and the massive capital embedded in the physical basis of our infrastructure systems seem insurmountable barriers to their timely innovation and their adaptation to changing requirements [**Error! Reference source not found.**]. These changes are results of some incentives as deregulation, liberalization, privatization and globalization as trends in accompany with the technology and markets complicated developments which have been resulted in complex infrastructures. Also, SDI as such an infrastructure inherited these complexity by interweaving the existing experiences on traditional infrastructures development, innovation-orientation, pervasive participation of stakeholders and physical and non-physical (information and knowledge) components (products and services).

Having one decade of experiences dealing with SDI shown that it is a state-of-the-art in dealing with integration of some existing components and infrastructures into a new phenomenon could reveal their potentiality as the synergy generated by SDI. This process has resulted in a modular architecture for SDI which has created considerable flexibility and reliability for introduction of SDI as an effective framework for integration of other phenomena and infrastructures as well as effective contribution of SDI experts in SDI evolution process [**Error! Reference source not found.**].

Recently, SDIs have been defined as innovational and evolutional phenomena encompasses the resources, systems, network linkages, standards and institutional issues involved in delivering spatially-related information from many different sources to the widest possible group of potential users [**Error! Reference source not found.**]. SDI is whole about facilitation and coordination of sharing spatial data which is based on the cooperation and partnerships of society in spatially related decision-makings at different levels. It is also based on integration and

downsizing of ad-hoc and sporadic organizational activities meeting the goals of bringing acceptable improvement and effectiveness in consuming over our finite natural resources and infinite knowledge resources. The success derived through SDIs development activities has stimulated a number of societies to prioritize their SDIs development activities (esp. National SDI) towards sustainable development.

Furthermore, the complexities of such activities as a need for long term development process, high level strategic, political and financial supports, handling the related risks and providing self-dependency and ensuring SDI permanency have challenged SDI development nearly in any jurisdictions. Because of these, the main mentioned deficiency of semantics dominancy to pragmatics arisen again as most of the SDIs have focused mainly on databases integration (products) rather than access (processes) which is the main object of SDI developments [**Error! Reference source not found.**].

One of the approaches dealing with the SDIs development complexities absorption and overcoming the defects, it has been defined as tasting SDI concepts with systematic essences usually granted by the integrated components. One of these is the evolution trend provided for SDI diffusion which an S-shaped continuous, totally ascending and long term process generally utilized for innovations diffusion [**Error! Reference source not found.**], through this an innovation is communicated by certain channels over time among the members of a social system. Considering the overall criteria used for evaluation of this trend are relative advantages, compatibility, complexity, trial-ability and visibility of results and their ambiguities, it has to be noted that sustainability coming through this path is the key to success. However, it is really so optimistic and even not feasible to predict a voyage free of any challenges which at least could cause partial delays or seriously endanger our trend continuation. It is recommended to stabilize what has been gained.

The trend could be evolved as a phase based process improving this situation as three phases has been defined as initiation, implementation and establishment [**Error! Reference source not found.**]. However, still more assurance is required meeting each phase, getting into next phase and also providing its permanency after last phase (establishment). This need can be envisaged as a wedge that both holds the gains achieved along this trend and prevents good practices from slipping which could be resolved by a comprehensive qualification process has to be adopted on behalf of SDIs requirements we mention it in general as a total quality management system (TQMS).

Beside appreciating the advantages could be revealed through utilization of such a process, it has to be noted that deciding on TQMSs adoption is very crucial as they usually adds a great deal of extra efforts and complexities that has to be integrated and handled effectively. Unless, they could became a serious threat through wasting our assets and impeding other components effective process.

For reducing risk and uncertainty of decision making about adoption of a TQMS, it is recommended to deal with TQMS as a strategic component which mainly utilized for defining the processes which will result in the production of quality rather than in detecting defective-nesses. Also, the objectives, integration mechanism, positions, roles and interactions have to be defined in details. All of these depict that if the rationales suffice justification of TQMSs adoption, the most effectiveness arises through integration of TQMSs in initial phases of developments. Certainly this is also true in regard with SDIs and in remaining parts we will focus

on realizing required justifications introducing TQMS as an integral module of SDI developments.

The quality of a product or service as defined by ISO 8402, is the totality of characteristics of an entity that bear on its ability to satisfy stated and implied needs. Along this line, the TQMS is also defined by UK Department of trade and economy as a set of coordinated activities to direct and control an organization in order to continually improve the effectiveness and efficiency of its performance and a management approach of an organization, centered on quality, based on the participation of all its members and aiming at long term success through customer satisfaction. Also, success of a TQMS is defined in its capability in setting directions, meeting customers' expectations, improving processes and control, reducing wastage and costs, increasing market share, facilitating the knowledge generation, involving all staffs and stakeholders and raising morale. These activities mainly done through identification and management of numerous interlinked, cross functional and complex processes.

Furthermore, ISO 9000 has provided eight principals for quality management systems as customer focus, leadership, involving people, process approach, systems approach, continual improvement, factual decision making and mutual beneficial supplier relationships.

Noteworthy, the above-mentioned concepts and SDI concepts are in mutual correspondent with each other showing their possibility to be integrated. In high level of correspondence, both have permanent duration and being continuous and being based on participation of all stakeholders' participation.

Also as mentioned above, a TQMS is developed within an organizational structure (usually the traditional pyramidal organizational structure), which SDI has effectively utilized and integrated such a structure and it could be the basic framework meeting the TQMS adoption requirements. Whilst, the organizational structure has been evolved and upgraded through its integration in SDI and related components as SDI hierarchy, models and the integrated ICT infrastructure and more stability, comprehensiveness and higher level of participation has granted to this structure.

In support of such a framework and by comparing the above-mentioned evolution trend of SDIs and issues considered in setting up a TQMS, another level of correspondence could be derived along their logical diffusion as TQMS design and build step could be adopted along SDI initiation phase as well as control, deployment and measurement stages in implementation phase and finally the review and improvement steps in SDI establishment phase continues for ever.

Dealing with TQMS and SDI correspondence in component level, TQMS principals are all met in SDI architecture as a module or an arrangement of modules defined as SDI related models.

One of the most important modules of an SDI is leadership mechanism which usually is responsible in leading the development process. It has to be the leader of the mentioned TQMS by providing unity of purpose through an appropriate strategy and policy making for qualification processes, ensuring the measurable objectives are established and demonstrating that they are fully committed to developing, sustaining and improving the SDI. Another module is people as the general source of knowledge and targets. People in SDI have been defined to meet the required dynamic nature, stakeholders' participation and customers.

Another module of an SDI is fundamental datasets which are generated and qualified on behalf of some of the government organizations as custodians. This is defined due to a policy in duplication reduction and central qualification of datasets as near to their source of generation as

possible. Also, the flow of fundamental datasets and other complementary and value-added datasets are designed through custodians, value-adders and end users interactions and even their feedbacks as a mechanism of dynamic assessment of products and services is defined in SDIs. All of these arrangements qualification are also introduced in TQMSs as the assessment of quality against a standard or set of requirements by internal audit and review known as a first-part assessment (custodians), by an external customer makes the assessment against either its own or a national or international standards as a second-party assessment (value-adders) and by an independent organization, not connected with any contract as an independent third-part (end-users).

As the above-mentioned modules are defined to effectively provide the related requirements, an embedded qualification consideration could be observed in them (usually by standardization). However, lack of processes effectiveness is the main problem of most of SDIs. In this situation, while TQMSs expertise could be handled impressively toward improving processes in this modular architecture, some valuable efforts have been carried out to empower the process aspects of SDIs too as the experts could specialize each of products and processes as different models correspondingly mentioned as product and process based models. Product based model represents one of the main aims of an SDI development initiative, which can be used to link existing and upcoming databases of the respective political/administrative levels of the community and process based model represents one of the other main aims of an SDI development initiative, defining a framework to facilitate the management of information assets [**Error! Reference source not found.**]. This specialization was created in regard with the concepts and capabilities provided by modular phenomenon to deal with effectiveness handling of micro-components and generalize them as components/models which will ensure the overall effectiveness. Also, such a structure brings us the ability to specialize TQMS components into these models that means we had the opportunity to be flexible in utilizing the best even existing or new approaches to qualify the products and services also enjoying their trustful integration.

This paper provides a theoretical perspective for justification of development and deployment of a TQMS in an SDI process dealing with its placement and roles clarification and providing the required applicability to be able to integrate it as a new and important component especially in Iranian National SDI initiative as it is now on its initial phase and is looking rigorously for procurement of the required justifications and assurance for its development. Besides that, the study of the mentioned semantic trend of qualification and its evolved pragmatics metaphor in such a TQMS is being followed. Finally it is argued that considerable qualification process evolution and improvement could be gained by adapting the mentioned results.

REFERENCES

Delft University of Technology, 2003, Next Generation Infrastructures (Summary), Delft University of Technology, Faculty of Technology, Policy and Management.

Groot, R., and McLaughlin, J.D., 2000*, Geo-spatial Data Infrastructure-Concepts, Cases, and Good Practices* (London: Oxford University Press).

Rajabifard, A., Feeney, M.E., and Williamson, I.P., 2002, Future directions for the development of spatial data infrastructures, *International Journal of Applied Earth Observation and Geoinformation*, 4, 11-22.

Rezayan, H., 2003, Development of a Conceptual Framework for Iranian NSDI, M.Sc. Thesis, Eng. Faculty, University of Tehran, Iran.

Rogers, E.M., and Scott, K.L., 1997, The Diffusion of Innovations Model and Outreach from the National Network of Libraries of Medicine to Native American Communities, Department of Communication and Journalism, University of New Mexico.

Zarycki, T., 2001, Cartographic Communication in the Perspective of the Linguistic Pragmatics, 20th International Cartographic Conference, Beijing 2001.

Zhang, J. and M.F. Goodchild, 2002, Uncertainty in Geographical Information, Taylor & Francis.