NSDI and IT Evolution

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Sustainable development (SD) has been introduced as the first priority of societies. Also, information and communication technology (ICT) has played an important role in this process. It has been shown that existing social, economical and political developments are important factors in ICT's benefits diffusion and effectiveness. The developed societies could gain ICT immensely using their powerful development infrastructures while in developing societies, similar activities have been failed due to lack of such an infrastructure. It is recommended that all activities undertaken towards SD, dealing with common infrastructures could support SD and ICT, to overcome this imparity and reducing the gap between developed and developing societies. In this research, spatial data infrastructures (SDI) are introduced as one of these infrastructures, which could be developed comprehensively in different societies. Then the national spatial data infrastructure (NSDI) development is studied and ICT and national ICT strategy evolutions are traced, analyzing defined modern SDI and ICT infrastructure concepts.

Introduction

Information and communication technology (ICT) has played an important role in sustainable development. Sustainable development as the comprehensive and simultaneous development in social, economical and environmental aspects by optimum utilization of limited available resources of societies, has been introduced as the first priority of developed and developing societies affecting all their activities pervasively. This situation has created a valuable opportunity for developing societies towards taking a huge step towards reducing the gap exists between them and developed societies. Therefore, any activity, which could accelerate the sustainable development trend potentially, is under especial consideration and acts as priority of societies [16,17].

Information and communication technology (ICT) is one of these accelerators allocated itself special roles in sustainable development presenting considerable capabilities. ICT, which is created through digital era manifestation defined as the technologies which affords facilities and expedites data creation, utilization, contribution and dissemination to societies and brings the possibility of communication between societies through computer networks [1,2,6,8,17].

The ICT development and utilization experiences highlight ICT benefits diffusion dependency to existing developments of societies. While developed societies could utilized high levels of ICT benefits having the required development background, developing societies are facing by lack of such an infrastructure [1,2,17]. This situation, which has created different viewpoints against ICT utilization defects and benefits dealing with sustainable development, results some vague and complexity in ICT concepts. Accordingly in some cases ICT is known in contrary to the global sustainable development aims as it could increase the gap between developing and developed societies. This complex situation arised from the lack of sufficient and clear justifications for ICT efficiencies in sustainable development [8].

Recommended solution is aiming each activity towards sustainable development [1,17] results in simultaneous and comprehensive contribution of these activities. Applying this approach for ICT made it to act as a sustainable development enabler. Some evolutionary changes have created in ICT nature conserving its fundamental specifications. This process is carried out through utilization of new concepts in strategy and policy making for development, which entails the contribution of all the stakeholders in the development process.

Despite the activities have been carried out, the main problem is lack of definite approach, which could provide the required framework [1].

Understanding the necessity of dealing with such a supportive framework definition, this research provided and studied spatial data infrastructure concepts.

Geo-Spatial Information Rationale

Geo-spatial information, contains at least one spatial factor by which is referenced to a unique place, forms a wide spectrum of existing and potential information and datasets in societies (it has been claimed that 80% of information are geo-spatial information [10]). Regarding this comprehension, the

general nature of information (information is not consumable, not transferable, accumulative and integratable), the special charactristic of geo-spatial information as their widespread definition domain (our universe) and it's dependence to related applications and features (scale dependence) has made us to create and utilize various techniques, tools and technologies dealing with geo-spatial information. In this situation, ever increasing demand of geo-spatial information users for technological advance is the direct result of benefits and potentiality emerged from such an information and technology appliance. Similar development, which is created in user communities, entailed an extensive market known as GI-market. Simultaneously, the technical human resource has been developed in different sectors. Understanding the above-mentioned condition, GI-technology providers have been moved towards stimulating and responding to this market needs, which introduces GI-market as one of the most prosper markets [18,20]. Additionally, trends like sustainable development, globalization, environment conservation, political disputes and wars, individualization, human rights and economical reforms have effected this situation and being affected accordingly [6,26].

As all stakeholders contribution in each activity is defined as one of the main aims of decision-makings [6,11], mechanisms which create frameworks for such a contribution are under special considerations of societies. A main portion of this aim dealing with information subject could be come off through the concepts of information communication and technology. Considering the trend of communication technologies and dealing with GI, necessitate these technology growth and evolution for transferring large amount of data with various formats and meta-data and providing analysis capabilities, which is under progress [15].

Besides, the universality of illustrated trends and processes in all societies, the innovational nature of ICT is important too as it necessitates existence of especial economical, social and political backgrounds in different levels of societies for ICT diffusion [6,17].

Spanning and integrating the above-mentioned aspects for ICT towards its utilization in sustainable development introduces the subject of strategy making for ICT.

Dealing with such strategies, common aspects are distinguished as [11,17]:

- Development and utilization of ICT for public benefits provision
- Development of required human resource supporting ICT aims
- ICT management for sustainable development
- Impartial provision of ICT in societies
- Promoting and supporting the financial support creation for ICT related-activities
- Development of required technical knowledge
- Management and supervision of ICT trend

Meanwhile, as no unique solution or process has been emerged dealing with the above-mentioned aim realization, because of their local dependence [1], the effective solutions in support of ICT optimum utilization is the development of spatial data infrastructure (SDI).

Spatial Data Infrastructure

Spatial data infrastructure encompasses the resources, systems, network linkages, standards and institutional issues involved from many different sources in delivering geo-spatially related information to the widest possible group of potential users [13]. Also, adopting this definition with general definition of infrastructures, it could be concluded that SDI has following characteristics [7,29]:

- Is a set of base capabilities;
- Is a general comprehensive system;
- Has multiple effective aspects in ICT utilization;
- Includes some stable and dynamic physical components;
- Provides important, fundamental and irreplaceable services.

An infrastructure is a kind of organization, which is the main basis for other organizing activity developments contributes necessary and different activities in sustainable development. In this process new and adoptive nature is created for each activity, preserving their usual specification through strategies and policies injection and integration assuring their effectiveness [6,17].

Reviewing the evolution of information societies and their organizing activities, ICT is being affected considerably in such a process as one of the dynamic and innovational components of SDI and a sustainable development enabler [6,16]. Despite the lack of proper ICT basis for supporting SDI primary activities, simultaneous and considerable evolution of SDI and ICT is defined in modern activities that results in ICT conversion to an infrastructure.

SDI development, which is treated as an innovation diffusion process [24,28] illustrates the evolution encountered in ICT infrastructure. Regarding this and the pervasive and valuable experience resulted from various successful SDI activities, SDI development could lead them to an applicable solution for ICT evolution in societies and moving towards sustainable development [27].

SDI Evolution

Tracing SDI trend, after one decade of its emergence (1990s), its concepts have been fulfilled considerably [4,5,26]. Balancing the GI generation and utilization concentration is the main evolution resulted new SDI definitions as follow [23,26]:

- Product-based model, which represents one of the main aims of an SDI development initiative, can be used to link existing and upcoming databases of the respective political/administrative levels of the community (Figure 1).
- Process-based model, which presents one of the other main aims of an SDI development initiative, defining a framework to facilitate the management of information assets (Figure 2).

These models are emerged from SDI concept capabilities in being breaking apart into their constituents (specialization), be optimized partially and finally hybridized as a unique fully optimized definition and model [5,26]. Important specification and optimization created in these models are as follow [26]:

- Definition of a suitable role for people as main factor which provides SDI with the required dynamic nature.
- Definition of social system as a set of related units used toward SDI aims realization resolves the required participation of all related stakeholders in society [27]. Social capability is defined in this system as the levels of general education and technical competence; the commercial, industrial and financial institutions that bear on their abilities to finance and operate modern, large-scale business; and the political and social characteristics that influence the risks, the incentives and the personal rewards of economic activity, including those rewards in social esteem that go beyound money and wealth. Social capabilities complement technological capabilities and combine in many different ways to generate economic growth [17]. Then, ICT will play an important role in building the social capabilities through information and generation and knowledge appliance for sustainable development.
- Clarification, simplification and optimization of SDI components and their relationships, which improves the SDI comprehension, modeling, evaluation and development [26,27].
- These components (like communication channels, awareness, knowledge infrastructure, persuasion, decision-makings, participation, utilization and capacity building) represent high level of adoption with ICT defined concepts and requirements [26,27].

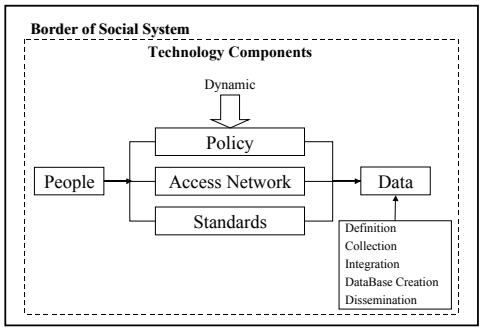

Figure 1. Product-Base Model [26]

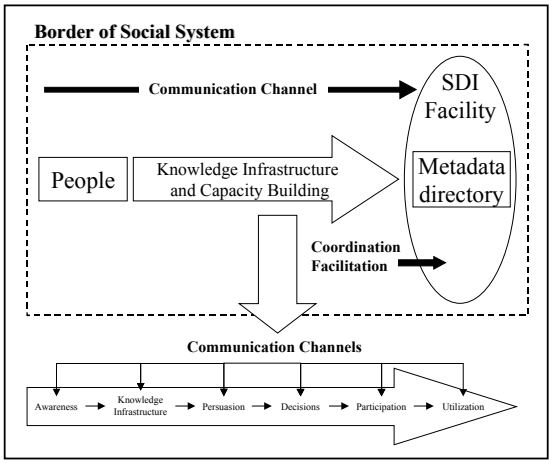

Figure 2. Process-Base Model [26]

Evolved benefits from these new definitions have created a general trend towards ICT infrastructures development and its effective contribution (esp. in European countries and Australia) [21,26].

Also, a hierarchical structure is defined for SDI, which comes from especial nature of geo-spatial data as they depend on scale and application. Regarding this structure, SDI treats in a pyramid, which its

base (corporate level) is very similar to current foundation used for desktop GIS applications development and by its promotion to the peak, SDI converts to a global infrastructure (Figure 3).

Considering this structure, the following points could be illustrated [22,23]:

- From each level we could navigate to its upper and lower levels (Janus-Effect Specification)
- Each lower level provides the building blocks of upper levels (Part-Whole Specification);
- Each upper level transfers its overall definitions and backgrounds (strategy, policy) to lower level;
- The levels relationship fastens as they come closer (Near-Decomposability Specification);

These specifications and tangibility of this structure for societies, has clarified and simplified SDI concepts and developments more.

Besides that, SDI development, very similar to past experience of LIS development, utilized an organizational structure depicted as a pyramid defines public as its base and high level managers and decision-makers as its peak.

Integrating these structures with SDI models is presented in Figure 3.

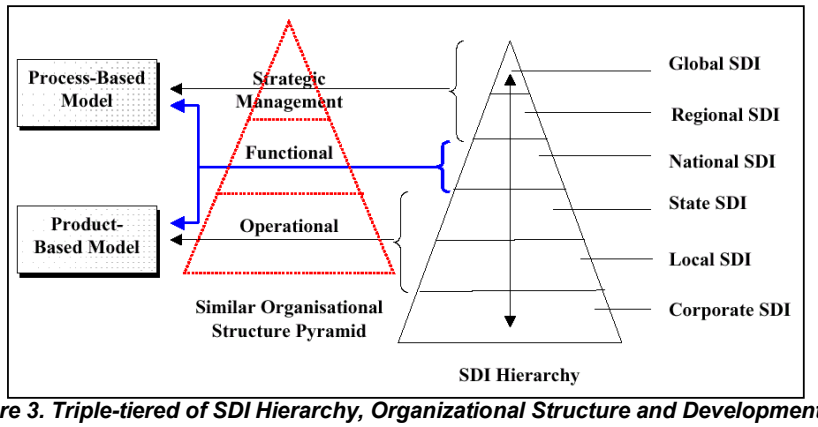

Figure 3. Triple-tiered of SDI Hierarchy, Organizational Structure and Development Models [26]

The relationships presented above could result in a huge increase in SDI universality as it enjoys the following advantages [5,26]:

- Uses current activities of societies at each level and results in the least efforts duplication;
- Offers societies with different local situations, a wide range of opportunities in dealing with SDI development at all levels, ensuring their activities integration under the SDI concepts utilization;

- Represents national level of SDI as the most important level, which could foster the completion of other levels effectively.

Therefore, SDI integrates its concepts and related components hierarchically (vertical integration) and expands it in societies (horizontal expansion) [9]. The vertical integration developed through datasets integration, duplication reduction and stakeholder participation concept. Also, the horizontal expansion, which mainly utilizes ICT, illustrates capacity building, awareness and knowledge infrastructure development and applied in base of the pyramid defined in Figure 3, which results in this base expansion (Figure 4).

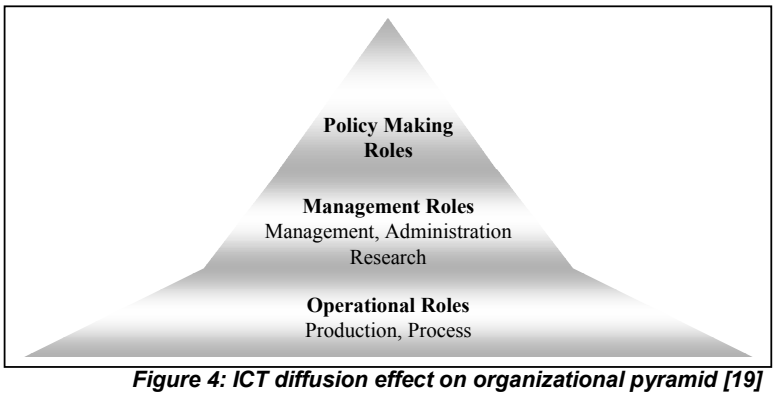

Figure 4: ICT diffusion effect on organizational pyramid [19]

ICT Evolution

Considering the above-mentioned matters, NSDI leads all of its components towards the main aim of achieving sustainable development. Here, existing ICT infrastructure could act as NSDI and sustainable development enabler. However, weakness of ICT strategy and policy in developing countries and their pervasive priorities have confronted them with serious problems [1,2,7]. In this situation NSDI could create its required foundation dealing with ICT introducing various operational capabilities of ICT as one of SDI components. Then, ICT will simultaneously be developed in NSDI evolution trend. The main evolution here emerged from ICT strategy development through NSDI activities [27].

SDI development process as an innovation is illustrated in three phases known as initiation, implementation and establishment [27], reveals ICT strategy as an enabler [1] which is based on development subject. Also, this strategy will be implemented and established through these three phases (esp. for GI) development and results strategies which introduces ICT as a sector as follow [1,12]:

- ICT diffusion strategy, which supports public benefits and ICT publication adopting with local conditions (National Capacity/Domestic Market).
- ICT market stimulation strategy, which empowered economical aspect, competition environment, ICT benefit making and its self-dependency (Export Market) considering ICT as a tool.

Finally, an integrated and powerful strategy will develop from these sector and background strategies for sustainable development, which enables ICT and SDI further evolution.

Conclusion

Sooner or later, all societies have to move towards ICT utilization and any delay will threat their further development more. Understanding this situation in developing societies, which needs ICT establishment urgently for their sustainable development. Various impediments could be mentioned in social, cultural, political and economical aspects result in a complex condition for sustainable development. Then, other activities, could handle this complexity through ICT utilization, are investigated. GI and related activities have represented proper and required capabilities and could provide the aims of sustainable development. Finally, experiences introduce SDI as a comprehensive and proper solution for simultaneous evolution of ICT and sustainable development especially in developing societies.

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