A Framework for an Effective National Spatial Data Infrastructure (SDI)

Prof. Alaa Eldin M. Elghazali[1], Ahmed Maher Zaki Ibrahim[2]

[1] Professor of Computers and Information Systems, Department of computer & Information Systems ,Sadat Academy for Management Sciences, Egypt

E-mail: [1] a.elghazali@gmail.com

[2] Researcher, Faculty of Management Sciences, Department of computer & Information Systems ,Sadat Academy for Management Sciences, Egypt

E-mail: [2] ahmedmaherzaki@gmail.com

ABSTRACT

Smart cities term has grown taking the advantage of the expansion of the Internet of Things (IOT) technology as attempts to invest and analyze tons of digital data that provide more efficient and accessible services to citizens, thus making rapid decisions corresponding to the instantaneous changes. The spatial data availability, quality, and exchange methodology of the related spatial information between different sectors of any country stand as a barrier in the way of activating GIS as an efficient system that serves context awareness for smart cities which need to be organized through spatial data infrastructure (SDI). In this paper, the researcher will propose a framework for an effective SDI to be implemented in the Arab world as a foundation for smart cities that benefit from previous studies on international, regional, and local applied experiences. The proper implementation of SDI has too many benefits in terms of city planning, decision making, coordination among government agencies, and emergency correspondence

Keywords: Spatial Data Infrastructure (SDI), GIS, smart cities, Data Accuracy, Internet of Things (IOT).

1. INTRODUCTION

The term smart cities has grown taking the advantage of the expansion of (IOT) technology as attempts to invest and analyze tons of digital data generated by the sensors and other digital data sources to provide more efficient and accessible services to citizens through the intelligent management of diverse resources and assets at the city or country level in various health, education, irrigation, transport systems, power generation, water supply systems, waste management, Detection of crime and other community services to make rapid decisions corresponding to the instantaneous changes in various readings from multiple data sources.

This study describes GIS, smart cities and SDI. In addition, it states the challenges faced in the use of SDI the raised questions and the methodology that will be used to answer these questions and achieve the research objective.

The next part of paper will display background and Literature of SDI, including SDI functions, its importance, types and classification, components and its usage in smart cities.

Data processing for Smart Cities become more challenging, facing with different handling steps: data collection from different heterogeneous sources, processing sometimes in real-time and then delivered to high level services or applications used in Smart Cities, More and more applications today use, generate and handle very large volumes of data. The large volume of data coming from a variety of sources and in various formats, with different storage, transformation, delivery or archiving requirements, complicates the task of context data management. At the same time, fast responses are needed for real- time applications. Cristian Chilipirea [1] has proposed architecture for Big Data processing in Smart Cities. Data flow from the source to the end user is the focal point of the architecture. Seven data processing steps were outlined; collection of data from heterogeneous sources, data normalization, data brokering, data storage, data analysis, data visualization, and decision support systems.

A geographic information system (GIS) is a system designed to capture, store, manipulate, analyze, manage, and present all types of geographical data. The key word to this technology is Geography; Geographic Information Systems (GIS) have become an indispensable tool for managing and using spatial information at the local, regional, national and global levels [2].

A smart city is defined as a city that engages its citizens and connects its infrastructure electronically. A smart city has the ability to integrate multiple technological solutions, in a secure fashion, to manage the city's assets - the city's assets include, but not limited to, local departments, information systems, schools, libraries, transportation systems, hospitals, power plants, law enforcement, and other community services. The goal of building a smart city is to improve the quality of life by using technology to improve the efficiency of services and meet residents' needs. Business drives technology and large-scale urbanization drives innovation and new technologies. Technology is driving the way city officials interact with the community and the city's infrastructure. Through the use of real-time control systems and sensors, data are collected from citizens and sensors and then processed in real-time [3].

Smart cities are future cities that aim to identify smarter choices to maximize end-user satisfaction and speed up urban socio-cultural and economic development. They are knowledge-based cities with the capability to uplift the growth of their respective nation by planning, management, governance and development systems where geospatial information is at the forefront helping decision makers to take right decisions [4].

The term Geographic Information Infrastructure

(GII) is synonymous with Spatial Data Infrastructure (SDI), but the latter is in more common usage internationally, so it has been adopted here for the purposes of this paper.

SDI provides a basis for spatial data discovery, evaluation, and application for users and providers within all levels of government, the commercial sector, the non-profit sector, and academia and by citizens in general [5].

Presented the concepts and values of SDIs, as well as a brief history of SDI development in the U.S. They also discuss the components of a typical SDI, and specifically focus on three key components: geo-portals, metadata, and search functions [6].

Describes research undertaken to explore current understandings of SDI governance and its challenges and to develop a model for SDI governance to guide operational responses and inform further research. The research comprised literature review, case study analysis and the development of an SDI governance model.

GSDI which is The Global Spatial Data Infrastructure (GSDI) Association was formed in 2004 as an inclusive networking organization. The purpose of the Association is to promote international cooperation and collaboration in support of local, national and international spatial data infrastructure (SDI) research and implementations that will allow nations to better address social, economic, and environmental issues of pressing importance, including sustainable development. GSDI has published SDI cookbook to be used as a reference for building SDI frameworks all over the world [7].

The main objective of this research to establish a Framework for an effective national spatial Data Infrastructure (SDI) as a foundation for Smart Cities to achieve this objective the researcher have to Investigate and identify the potential technical and non-technical barriers to the implementation of National SDI framework, Identify available enablers for effective National spatial data infrastructure framework through design and develop guidelines for an effective National spatial data infrastructure framework, and also to reach the following goals:

- Provide a better mechanism for accessing better and more data
- Facilitating the exchange of information between different organizations
- Support more effective governmental operations and services
- Provide decision-makers with an integrated set of geographic information data and spatial analysis
- One of the tools of creating new financial resource for the government
- Protection of information copyrights

Common practice in publishing data is to use a service-oriented architecture (SOA) called a service delivery index (SDI). SDIs involve documenting and publishing existing resources using dataset-
level metadata in catalogs, which are the primary means of discovery and access (OGC, 1994). While standards for detailed metadata describing dataset structure and content, as well as service requests and payloads, are beginning to emerge, establishing a common or best practice remains a challenge (ISO/TC 211). The Open Geospatial Consortium (OGC), established in 1994, develops

technical standards to ensure that SDIs function in an interoperable way. These standards are based on the broader standards for geospatial information set by the ISO Technical Committee 211 on Geographic Information/Geomatics [8].

After introducing the SDI definition and the importance of its implementation in smart cities the researcher will conduct a comparative study, analyzing three different initiatives for implementing SDI. The study will cover important steps and tools used in each initiative, as well as their respective achievements. Following this, the researcher will examine the requirements for implementing SDI in a country that currently lacks an SDI framework. This will involve conducting office and field studies to assess available resources and existing GIS projects. In the third section, the researcher will present the proposed framework for implementing SDI. This will include details on the design and implementation of the framework. Finally, the study will measure the results of implementing the proposed framework in the chosen country and offer recommendations for future steps to be taken.

2. COMPARATIVE STUDY

In this section the researcher will go through three featured Spatial Data infrastructure (SDI) and will start by the Infrastructure for Spatial Information in Europe (INSPIRE) initiative as it is a pioneer in SDI implementation globally and serves as a blueprint for most of the predecessor's national SDI implementation. Following this, the researcher will delve into the SDI of Abu Dhabi initiative, as it is the first of its kind in the Middle East and the fifth globally. This initiative was established based on the Inspire initiative and then tailored to fit the country›s unique conditions. Then the researcher will also examine the Egyptian SDI, as it is one of the most recent initiatives in the Middle East and utilized distinct tools for implementation. This diversity in implementation techniques among the various initiatives will augment this research and foster ideas for the development and implementation of the proposed framework. Additionally, it will help us tackle any issues that may have arisen in the other initiatives.

2.1 Infrastructure for Spatial Information in Europe - INSPIRE

The INSPIRE Directive aims to create a European Union spatial data infrastructure as shown in figure [1] for the purposes of EU environmental policies and policies or activities which may have an impact on the environment. This European Spatial Data Infrastructure enables the sharing of environmental spatial information among public sector organizations, facilitate public access to spatial information across Europe and assist in policy-making across boundaries.

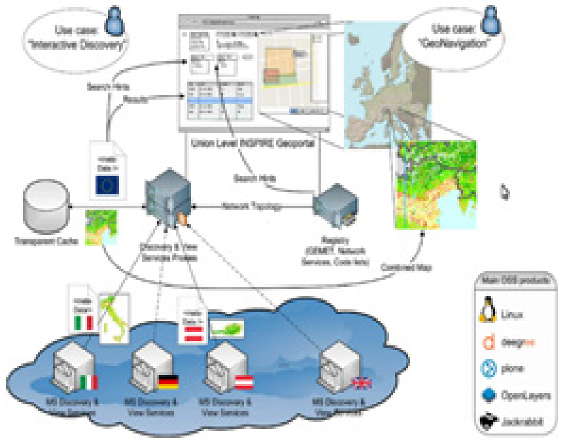

Figure 1: The System Architecture for INSPIRE SDI [12]

INSPIRE is based on the infrastructures for spatial information established and operated by the Member States of the European Union. The Directive addresses 34 spatial data themes needed for environmental applications. The development of the INSPIRE Implementing Rules and Technical Guidance documents and the maintenance and implementation framework have been based on a participatory process, involving experts from stakeholder organizations in the Member States. Stakeholder organizations are invited to propose experts for the work of the Maintenance and Implementation Group (MIG) and provide input for and feedback on the work of the MIG and its sub-groups. Experts from stakeholder organizations can also discuss implementation issues on the Thematic Clusters discussion platform [12]. The following figure [2] illustrate the main architecture for inspire SDI.

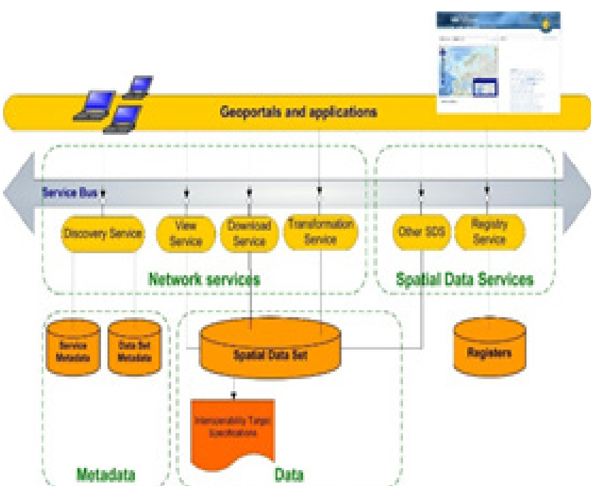

Figure 2: Geoportal and Applications for INSPIRE SDI [12]

The INSPIRE SDI is built using a variety of technologies, and it is not specific to any particular vendor or platform. INSPIRE is based on a set of open standards, which enable the interoperability of spatial data and services across different systems and platforms [12]. INSPIRE utilizes a Service Oriented Architecture (SOA) approach, which allows for the exchange of data between different systems through standardized interfaces [13]. It also employs the use of web services, such as Web Map Services (WMS), Web Feature Services (WFS), and Web Coverage Services (WCS) to enable the sharing of data and services [14].

The choice of specific software and technology used to implement INSPIRE can vary depending on the organization or agency implementing it. Some may use proprietary software such as Esri or Hexagon, while others may use open-source software like GeoServer or MapServer. The INSPIRE initiative itself does not endorse or require the use of any specific software or technology [12].

2.2 Spatial Data Infrastructure (SDI) in Abu Dhabi

The Abu Dhabi Spatial Data Infrastructure (AD-SDI) is a program of the Government of Abu Dhabi, administered within the Abu Dhabi Digital Authority (ADDA) Digital Government program to facilitate the sharing of geospatial data among government agencies and other stakeholders, and working on raising the Geo-Maturity of the Emirate of Abu Dhabi [9].

(AD-SDI) mission is to promote, facilitate, coordinate, and support the development of dynamic, entrepreneurial, and flexible geospatial enabling environment to meet Government's aspirations and society's needs, while progressing towards Geo-Mature Abu Dhabi as shown in figure [3].

Figure 3: Abudhabi SDI Building Stages

The most important partners in the AD-SDI program are the stakeholders, and the entities that generate and use spatial data. These entities generate and use Fundamental Geographic Data Sets (FGDS). Most of these agencies either have a mandate to provide critical geospatial data or are currently involved in major projects that involve the production of this information. Coordinators from each entity are assigned to work with the AD-SDI Team to help develop Abu Dhabi›s SDI.

The included stakeholders are; Abu Dhabi Local Government, Federal Government, Government Companies, and Non-Profit Organizations. Technically the SDI was build using enterprise GIS technology (ESRI platform) [9] as shown in figure [4].

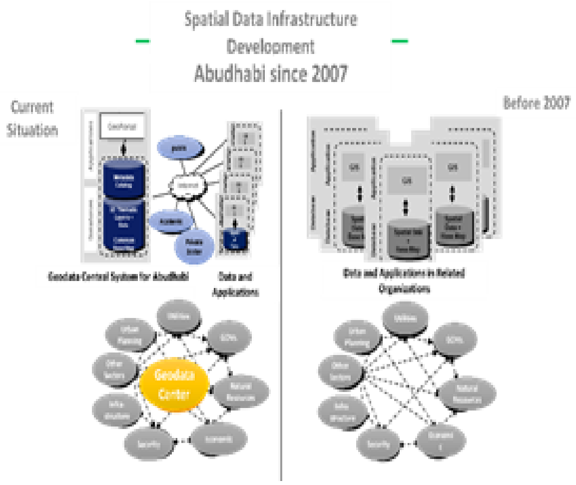

Figure 4: Abudhabi SDI Development [8]

2.3 Egyptian Spatial Data Infrastructure (SDI)

The Egyptian NSDI center was founded by the ministry of planning in August 2020. The center relies on building and making available an integrated spatial information infrastructure for the Egyptian government, using the latest satellite photography technologies. the center aims to establish an integrated national planning system, directing state investments and development efforts to areas with real needs. It consists of four central units, at the forefront of which is the space imaging unit, which uses satellite technology on behalf of specialized government agencies, to rationalize government spending. The center includes a variety of highly qualified teams from a range of academic backgrounds and working in a variety of disciplines, such as specialists in spatial data science, geographic information systems technology, urban planning, land surveying, and maps [10].

Ministry of Planning indicated what has been accomplished within the framework of the work of the availability of Satellite Imaging Unit, where satellite visuals with a spatial accuracy of 3 meters per day were made available covering the Arab Republic of Egypt, in addition to providing satellite visuals High resolution 30 - 80 cm covering populated places. The center also worked to rationalize aspects of government spending and the recurring effort in purchasing satellite images and reviewing the position of the entities' use of the satellite images available through the project, which reached an annual estimate of the entities' use of EGP 300 million. The project is also working on providing aerial photographs to the Egyptian General Authority for Survey, which encourages government agencies not to provide previously contracted needs to prevent double-spending, in addition to providing electronic accounts for the satellite imaging system for the concerned government agencies (65 government agencies and 27 governorates) [11].

Technically the SDI was build using enterprise GIS technology (Hexagon platform).

3. REQUIREMENT ANALYSIS AND FIELD STUDY

The researcher through his work was involved in preparing a roadmap for the implementation of the SDI framework in Karbala. Through the mission the researcher conducted a study aiming to investigate the status of Karbala as one of the Iraqi governorates and draw a conclusion roadmap that would help in the implementation of the SDI framework as a foundation for a smart city.

The purpose of this section is to provide an overview of the conducted study that covered all the components of the SDI framework, including data, technology, people, procedures, and policies. The research aimed to move the GIS implementation in Karbala from:

Step 1: which is the presence of agencies experienced in working with geographic information and scattered GIS projects

Step 2: which is the existence of unified data schema and cooperation between different governmental entities

Step 3: which is having geographic services to the public and finally

Step 4: applying smart cities concepts in Karbala

The Spatial Data Infrastructure (SDI) Framework implementation of Karbala province main objective was to provide a framework for an integrated exchange of spatial data between all directorates in the different sectors of the governorate, to enable the government to build clear strategies by availing the high-quality data and modern techniques necessary that supports decision-making and lead to the development of intact policies.

3.1 Activities and Findings

In order to organize and initiate the Karbala-SDI framework implementation, a series of activities to study and analyze the existing situation where conducted, these activities included conducting survey, personal interviews, field visits, in addition to a workshop that was held for 22 government entities.

Activity 1 Survey: A survey was prepared to analyze the status of the technological infrastructure of the agencies in the governorate. This survey was divided into two parts:

The first part: to find out the status of the technological infrastructure and geodatabases existing in each Directorate.

The second part: to know the experience and skills of the Human capitals, working in the operation and maintenance of the geographic information systems in these directorates.

The survey was sent to all Directorates and a reply was received from 15 departments and 22 employees and findings were analyzed.

Activity 2 Meetings: A meeting was held with the GIS Committee which included members of some of the most advanced directorates in the implementation of GIS. the meeting was held with the presence of the Representatives from the Municipality, Post and telecommunications, urban planning, education directorates, as well as the representative of the GIS unit in the governorate to discuss the existing status and choose the agencies that will be covered by the field visits.

Activity 3 Field Trips: A schedule of the field trips to various directorates was prepared to study the status to obtain detailed needs and requirements, which enabled the visit to 12 Directorates. The visits included accessing the details of the existing workflow in all the participating directorates. This gave a detailed idea of the users' needs and requirements of the implementation, as well as the obstacles and challenges that may occur during the implementation of SDI framework.

Activity 4 Workshop: The survey and field visits were followed by participating in a 5 days' workshop. The workshop was attended by 22 people to activate the participation of the various spectra officials, specialists and technicians Authority and the actors involved tasks study of the framework implementation; so, that the exchange of views and information with respect to the components of the current infrastructure for geographic information systems, and knowledge of the aspirations of the various parties with regards to objects of share and exchange data in a spatial context of infrastructure

3.2 Study Analysis Result

There is an effort in most governmental directorates and geographic information systems institutionalized in most of the districts covered by the visits with a reasonable degree of readiness to work but they are isolated islands, although some sort of coordination exists on a small scale between the different districts in this regard. The study covered four dimensions which are shown in figure [5].

Figure 5: The four Dimensions of the study

The Data Dimension

The researcher analysis results regarding the data dimension are as follows:

1- At first 12 directorates were using GIS (municipalities, roads and bridges, water, sewage, electricity, communications, water resources, environment, education, agriculture, urban planning), their work was limited to data collection and representation on the GIS, the production of maps for the Directorate and solve the problems of the Directorate.

2- There was a limited coordination in the exchange of data between the different Directorates and this did appear in the lack of circulation of the updated base maps in all Directorates, Also the satellite images existed in different accuracy and with several production dates.

3- Some Directorates were active in the collection and updating of the data like the municipalities and the distribution of electricity and sanitation Directorates

4- The data generally was scattered, and the schema did not follow any unified standards.

5- The meta data was limited, and doesn't follow specific standards in most GIS layers

The Personnel Dimension

The Human resources had a considerable amount of training and understanding of the GIS Basics and there was a GIS small team separately in each directorate working mainly on map production and the maintenance of related business layers.

The Technology Dimension

The following points describe the observations of technology:

1 Desktop geographic information systems software existed in most of directorates.

2 There was no software and publishing programs for the servers.

3 Some GIS applications existed like the QR Code in the municipalities.

4 Most of the directorates data center were served by optical cable

5 Some Directorates needed new hardware.

6 There were no data center or centralized servers suitable for the geographic information systems center.

The Policies and Procedures Dimension

There were a temp commission formed of 5 members. They were planning and coordinating between the GIS teams across the governorate directorates, with week authorities and zero written policies for data sharing.

As illustrated above the researcher conducted a series of activities, including a survey, personal interviews, field visits, and a workshop, to analyze the status of the technological infrastructure and geodatabases existing in each directorate, know the experience and skills of the human capital, study the existing workflow, and understand users› needs and requirements. The study found that there was a reasonable degree of readiness to work in most governmental directorates and geographic information systems, but they were isolated islands with limited coordination in the exchange of data between them. The next sections will propose SDI framework and draw tracks for testing it in Karbala, starting with the presence of agencies experienced in working with geographic information and scattered GIS projects and ending with the application of smart cities concepts in Karbala.

4. FRAMEWORK DESIGN AND IMPLEMENTATION

In this section the researcher will demonstrate the steps to establishing and fostering the development of SDI Framework will be demonstrated. This will result in an innovative ecosystem that will serve as a foundation for smart city and will include capability for all users to do self-service mapping, Open enterprise solution architecture that would transform GIS data layers into web services, and Data portal for discovery, access, and collaboration of the city's data from multiple data providers.

The SDI Framework will enable the consumption and use of updated maps and data to be used in planning and analysis through one of the following:

1- Provide online accessible maps and data services with suitable GIS infrastructure.

2- Provide a Web-based GIS Interface application

3- Allow browsing and query maps and data to manage (add/edit/delete) their specific layers of data.

4.1 Expected Benefits, and Outcomes

The implementation of SDI Framework in general can be expected to result in establish an accurate and up to date inventory and ongoing tracking of conditions, support data sharing and eliminate redundancy and costs in mapping and geographic data development, facilitate the exchange of information across agencies. Addition to provide decision makers with the full range of geographic data and spatial analysis and visualization tools needed to better understand issues, analyze the implications of alternative decisions and scenarios for better coordination among government agencies and Capability for all entities to do self-service mapping. Also, the following benefits, products and outcomes:

1- Data portal for discovery, access, and collaboration of the data from multiple data providers.

2- Open enterprise solution architecture that would transform GIS data layers into web services.

3- Ready-to-use apps and extendable templates including citizen-engagement apps.

4- Establishment of Executive and Technical Coordination Committees to oversee the development and ongoing evolution of the initiative

1- Training of required staff to run the program.

2- Geospatial Portal and Data Clearinghouse.

3- Develop government level shared geospatial products and services platform.

4- Promote and Support GIS Capacity Building in All Key Agencies.

5- Introduce enhancements, innovation and efficiencies to support government agency operations and services

The framework implementation success will be visible through the adaptation of geographic information and its data as well as the activation of its economic, strategic and security role in the decision-making; this will be reflected on the security, social, economic, and environmental aspects in achieving security and safety, the existence of an accurate regulatory environment which will Support sustainable knowledge-based economy and optimal planning to invest state resources. Also, supporting infrastructure such as health and education assets and Maintaining the values, culture and heritage and promote tourism

Regarding the implementation of the framework, a flexible estimated work plan that is suitable to the environment, requirements, and directions of the governorate will be adopted, this plan will be executed in two major phases as follows:

Phase I: Building a unified platform to exchange and share data through the participation of the most cooperative and ready to work government agencies. In this phase, the foundations of the spatial infrastructure Framework will be set.

Phase II: Development of an extended plan in the form of a program that offers a range of consultancy and services designed to include new agencies, as well as raising the level of maturity in using geographic information systems of the involved ones. Also, it will include the expansion in building applications that allow interaction between the involved government agencies and the community.

The SDI framework implementation is the logical development of any existing projects and geographic information systems in various agencies as shown in figure [6]. The current situation in most governorates which includes the presence of agencies experienced in working with geographic information systems is as in the situation (a) GIS projects or situation (b) GIS systems.

Based on the plan for the implementation of the SDI framework, the researcher find that situation (c) distributed networks, represents the first phase of the implementation of the framework, in which the cooperation between the agencies will be achieved through building a unified platform for the exchange and publishing of data.

Situation (d) geographic services to the public, represents the second phase of the implementation of the framework, in which an extended plan will be developed in the form of a program that offers a range of services designed to include new agencies, as well as the expansion in building applications that allow interaction between the government agencies involved and the community by providing general geographic Services.

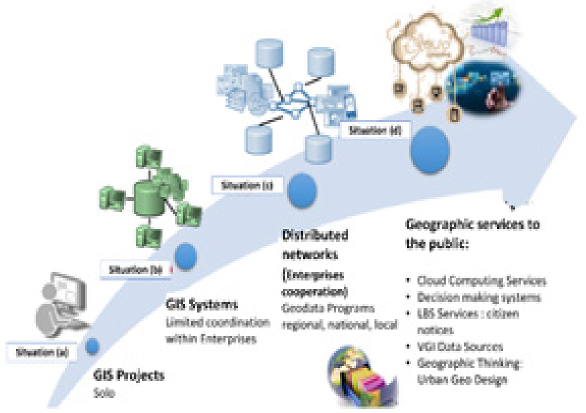

Figure 6: The logical development of GIS projects in various state agencies

In addition to the digital geospatial resources, constructing SDI also needs effective communications between communities, and among organizations and even. The following section will focus on main SDI constructing components which are geoportals, metadata, and search functions [6] as shown in figure [7].

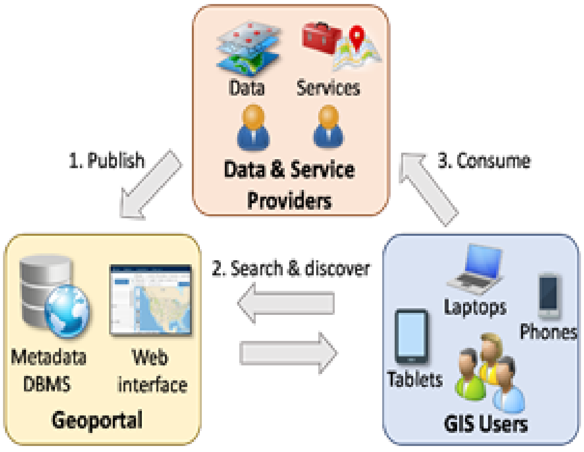

Figure 7: SDI Constructing Components [6]

Geoportals are Web gateways that provide access to geospatial data. Geoportals are the most visible part of SDIs, and the main interfaces through which users can search and find geospatial data. Geoportals are developed using Web-based technologies and off-the-shelf GIS software. A database management system (DBMS) is used to store and manage the metadata of the geospatial data in the SDI. A Web interface, which often contains a map, enables end users to interact with the SDI applications and to conduct searches. One important function of geoportals is helping users discover the existing geospatial resources and perform a search on the geoportal and potentially find the data and consume the data and services from the providers.

Metadata provide documentations on the content and the production process of geospatial resources. Metadata are often called the data about data, and include information such as titles, descriptions, data categories, the locations and time of the data collection, the data collectors, the used coordinate systems and map projections, and the data cleaning and processing procedures. Metadata can also be used for describing geospatial services by providing information about the data and functions offered by the services, the input and output, the developers, the development time, and others. In short, metadata are about all aspects of digital geospatial resources. Metadata are very important for SDIs, metadata provide the primary information based on which GIS users can understand and use digital geospatial resources.

Search functions are the major means through which users discover geospatial resources in SDI. There are two types of search functions are often adopted in geoportals: text-based search and map-based search. Text-based search is similar to Web search engines, in which a user types in some keywords and receives the results based on the matched text. Map-based search allows users to find geospatial resources by interacting with a map [6].

4.2 Overview of Spatial Data Infrastructure Framework Design

The idea of the proposed framework is based on the standardization of the spatial data specifications within the entities involved, by developing methodologies and specific rules for the production and processing of a centralized and unified spatial data sets, making it easier to integrate that data and to access it easily via the geographical portal available for different users based on their privileges.

To implement the principle of sharing and centralizing usage of data, it is necessary to convert the stakeholders' data into a common information that supports decision-making, this is done through a comprehensive analytical study of all stakeholders to identify the available data sources, and gaps in order to determine the standardized and quality control methods that complies with the international standards. as well as the latest practices in the field of GIS data; to be able to design a unified data model that fit to accommodate different data sets as well as setting the standards and work procedures for the exchange of geospatial data among government agencies.

Based on the above, the latest and up to date techniques of geographic information systems will be used to create an integrated system through which a set of rules and regulations that support the various requirements of the implementation of the SDI Framework will be designed. the framework will also be used to publish the unified centralized data sets via an electronic geographic portal that allows data sharing via the internal network to enable many users to access the data based on their privilege, as well as offering many automation tools and functions that enables the review, query and analysis of data through the portal applications.

This means that the framework will operate through three basic layers as shown in figure [8] which are the centralized spatial data, GIS technology, and the applications that will be created based on the functions of sharing, exchanging and analyzing of data, this will be done using the available GIS tools to fulfill the user's requirement. the Fig. below shoes next a simplified representation of those layers.

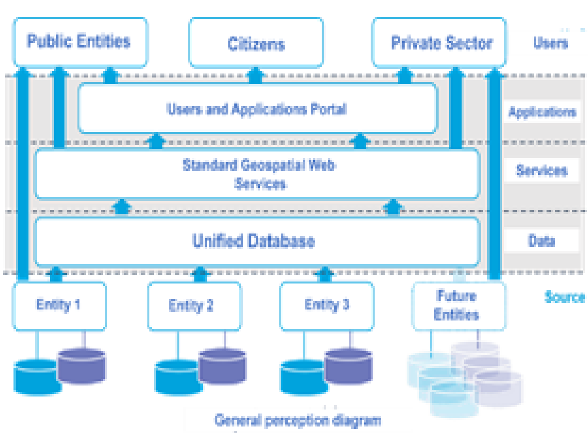

Figure 8: The basic layers of the spatial infrastructure system architecture

4.3 Framework Implementation Tracks

This section discusses the best and quickest possible ways to implement the proposed framework in a specific time frame. The implementation of the SDI requires moving in four different tracks that can be parallel or consecutive according to the detailed action plan, each track consists of a set of tasks, that can be dependent on tasks in the same track or in another one, as shown in the following figure, and each frame specific targets also illustrated as shown in figure [9]:

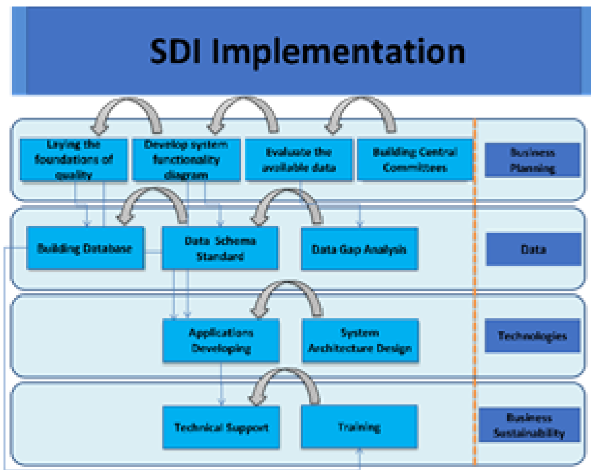

Figure 9: SDI Framework Implementation Tracks

4.3.1 Business Planning track

The planning Track of the SDI framework aims to gather as much information and data as possible according to the current geographic information system and geo-spatial data status in government agencies, identify the agencies that will be participating in the first phase of the implementation of the framework, outline the framework ‹s work scenarios, which will be reflected on the mechanisms of sharing and exchanging data, and the required standards, functions and tools.

Also, ensure the quality of the components and outputs of the framework by setting quality standards that must be adhered to during the implementation of the framework. The track includes the implementation of four different tasks:

1- Creating and preparing centralized committees

2- evaluating available data

3- Plan the framework functions

4- Define quality Standards

4.3.2 Data track

Data Track of the SDI framework aims to implementing the consolidated database and updating its content and ensuring that readiness of the data for the implementation of the scheme and the framework scenarios. The track includes the implementation of three different tasks:

1- Define data gaps

2- Set the standards of the data structure

3- Build the unified database model and processing of its content

Establishing the central Geodatabase requires building a data model, which is the database design that logically and physically organizes the data while defining relationships between items in the database.

Data Modeling is creating an abstraction to the application at hand. It would normally define specific groups of entities, their attribute values, and the relationships between these. In GIS, it is often used to refer to the mechanistic representation and organization of spatial data; for example, the vector data model and the raster data model. It is independent of a computer system and its associated data structures.

4.3.3 Technology Track

The technology track of the SDI framework aims to have a system that will enable the sharing and exchange of data within the requirements of the agencies involved. This track includes techniques to carry out two major tasks. They are Design the framework architecture and Develop the framework and needed applications

4.3.4 Business Sustainability Track

The fourth track is business sustainability to help users to use SDI more effectively through training and technical support. User's training serves and plays a significant role in the successful execution, implementation and final deployment of the SDI. Training ensures that the target users are in sync with the SDI and its needs

4.4 GIS Software Requirements

GIS Desktop Advanced: The most complete desktop GIS. It includes all the functionality of advanced spatial analysis, extensive data manipulation, and high-end cartography tools. Organizations use the power of Desktop Advanced to create, edit, and analyze their data to make better, faster decisions.

GIS data Interoperability (ETL): GIS data Interoperability that lets use and distribute data from many sources and formats. It can be used to perform spatial extract, transform, and load (ETL) processes; eliminate barriers to data sharing; and provide accurate data in a format that is more accessible to the users. And convert and export data from one format to another to extract, transform, and load spatial data.

GIS Spatial Analyst: The spatial analysis to provide tools for comprehensive, raster-based spatial modeling and analysis to derive new information from existing data, analyze spatial relationships, build spatial models, and perform complex raster operations. Self-documenting models make it easy for others to understand the spatial analysis process applied, examine what-if scenarios, and compare results for (Find suitable locations, Perform land-use analysis and demographic analysis).

GIS Roads Analysis: The Roads Analysis to provides network-based spatial analysis tools for routing, generating travel directions, finding nearby facilities, and solving complex vehicle routing problems to help to dynamically model realistic network conditions, including turn restrictions, speed limits, height restrictions, and traffic conditions at different times of the day.

GIS Server Enterprise: The GIS Server gives the ability to create, manage, and distribute GIS services over the web to support desktop, mobile, and web mapping applications.

SDI Portal (Content management system): SDI Portal to provide a map-centric collaborative content management system that can be used to create, manage, and share maps and apps within Karbala government. And ability to deploy Portal in own infrastructure and behind the internal firewall, making it the ideal geospatial portal for meeting strict confidentiality and security requirements. Collaboration within Karbala Government to contribute and draw from authoritative content. Users can create groups and invite others to work together on projects of common interest. Creating web applications and hosted within SDI Framework infrastructure,

Decision makers Dashboard: The Dashboard provides following events, operations & key performance indicators KPIs within SDI environment. And leverages responsive maps and dynamic data which update automatically as underlying information changes. It allows to create and share operation views including interactive maps, real-time data feeds, lists, charts, gauges, and other performance indicators based on live geographic data defined in a web map or web service. Use maps with dynamic data sources to provide real-time views.

5. CONCLUSION

Through the implementation of the SDI framework the Karbala did achieve a breakthrough to successfully move to the next step on its way to make Karbala the first smart city in Iraq

One of the main achievements of the framework is adding 11 policies including establishing a GIS department that reports directly to the governor with full authority and have a representative from each directorate

Another achievement is having one unified Data schema and updated data sets that is accessible by all sectors.

Another achievement is having one unified Data schema and updated data set that is accessible by all sectors. Having one Data set as well as one GIS team of about 60 expert That are familiar of the different usage of GIS in the operation of each sector also having a strategic building capacity plan help give common operational picture to decision makers across sectors.

From isolated islands with outdated database, basemap and satellite images to the completion of 84% of Karbala Data with a coverage of 93% of the province area. Karbala governorate have received a 2020 Satellite image from UNHABITAT.

Now 21 directorates data are uploaded to the GIS server on a unified database schema and each directorate can access its own data and view other directorate data.

As a foundation of smart cities some applications were implemented that serve citizens like the application of public eye smart karbala through which, the citizen can register the complaint with the its location and image, and then complaint is analyzed and redirected to the directorate to deal with the complaint, which in its turn uses its tools to solve the problem and access the complaint using GIS techniques through the SDI system

After this huge success Karbala Framework implementation objectives are getting higher and will continue the work till having:

1- a GIS center of excellency to serve the rest of Iraq

2- Working on Karbala being a smart city using IOT technology to gather data on all Iraq and use big data analytics related to GIS to make use of this data to support Iraq excellence

3- Building information management and city information management to expand the GIS capabilities

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