NATIONAL SPATIAL DATA INFRASTRUCTURE OF UZBEKISTAN: VISION, CHALLENGES AND PROSPECTS*

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Abstract

Today more than one hundred countries are developing their own National Spatial Data Infrastructure (NSDI). In 2015, Uzbekistan adopted a law about electronic governance and, most recently, the parliament of the country has considered a law to support the establishment of an NSDI. The government recognizes an urgent need to improve its interaction with citizens and the private sector, to take strides to modernize its management system, and to make access to information open to all. In this article, we consider the current situation of the NSDI implementation and assess Uzbekistan's readiness for an NSDI - according to five general factors and fourteen specific decision criteria. Moreover, we uncover challenges that the country faces, as well as, possible benefits (economic, social, and ecological) that the government and citizens might gain from the foreseen NSDI and e-government developments. We conclude that the NSDI of Uzbekistan has many prospects, but that the country should focus on addressing current shortcomings (including weak ICT infrastructure, low SDI culture, lack of human capacity, etc.). We also suggest that a wide range of stakeholders should be involved in the future development of the NSDI of Uzbekistan.

Keywords: NSDI, Uzbekistan, e-government

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1. INTRODUCTION

In this article, we describe Uzbekistan's strategy for the implementation of its National Spatial Data Infrastructure (NSDI), and its integration with the country's e-government policy. As a developing country, the implementation of digital government and the disclosure of national geospatial data would be a big step forward for Uzbekistan. However, the country faces multiple challenges in the NSDI development process - from financial to technical issues. There is no similar NSDI in the world and every country has to find its way towards implementation. In this article, we present the vision of the country towards its NSDI, together with ongoing and upcoming projects and prospects of the NSDI of Uzbekistan.

Overall, the article comprises of nine sections, including the introduction and the conclusion. The introduction provides the content of the following sections and explains their relationships. The second section (background) uncovers the history of SDIs and e-government policies, its drivers and various definitions, as well as, the core functions of any SDI. It also briefly presents a conceptual framework of an SDI and its main components. The third section (study area) explains the current social and economic situation in Uzbekistan, the challenges and inefficiency of governance, which pushes the state authorities to modernize its land tenure, land management and cadaster system. Besides this, we elaborate on already adopted policies regarding spatial data, land, cadaster, e-government and cartography during the post-soviet period in the country. The last sub-section of the third chapter depicts the available data components, involving state cadasters and responsible entities.

We introduce previous and ongoing projects regarding e-government and the implementation of the NSDI in the fourth section. This includes the "Modernization of real property registration and cadaster" (which aims to found integrated information system of real property registration - one of six components of planned e-government) and NGIS-1 (which ended in 2018 and was the initial phase of NSDI concept putting into practice). In the fifth section, we analyze the role of eight stakeholders regarding their power weight and interest in the creation of Uzbekistan's NSDI. The position of each stakeholder is defined in a stakeholder matrix diagram. In the six section, we described the current vision of Uzbekistan about the future NSDI implementation. This involves six implementation strategies that include several tasks within it. Moreover, we introduce the general four stages of NSDI implementation, each with its dedicated objectives.

In section seven, we elaborate current and possible future challenges, which the central government and responsible governmental bodies will have to overcome during the NSDI implementation and maintenance. These challenges include lack of human capacity, lack of funding, human resources turnover of staff, etc. In section eight, we reveal the prospects of implementing of NSDI. Presumably, Uzbekistan will follow the path of countries with long history of SDI development. If the country's first NSDI will be successful, its successor (involving 3D maps, demand-driven and ubiquitous) can be developed. Here, we also assess the SDI readiness index of the country according to the formula, proposed by Delgado-Fernandez (2005). Five factors and fourteen decision criteria were involved to calculate the readiness of Uzbekistan for a NSDI implementation. In addition, we provide a qualitative assessment of costs and benefits, and a SWOT analysis of the NSDI implementation. Finally, the conclusion section summarizes the issues disclosed in the article and gives recommendations for the further development of NSDI in the country.

2. BACKGROUND

The 21st century can undeniably be called “digital century”, “information age” or “century of IT” - due to rapid development of information and communication technologies (ICT). This new era of ICT gives not only a lot of new challenges but also perspectives. These changes also increase the relevance of geographical and topological information in everyday life. Due to globalization and a focus on economic development, civil society, business and government request up-to-date, more precise, more transparent and more comprehensive spatial data. Cartographers, geographers and geodesists substitute their conventional material tools (such as measures, papers and theodolites) for the latest software platforms and digital devices. Hence, the concept and vision for spatial data infrastructure was unstoppable, logical and evolving phenomenon.

The development of new ICT tools and mass digitization of maps by both laypersons and professionals led to accumulation of spatial data, which were created in various GIS platforms, with discrepant referenced geographical systems, different data and metadata standards, and were stored in dissimilar data formats. This initially resulted in issues of interoperability of these datasets, creating obstacles for multi-criteria spatial analysis and multidisciplinary decision-making. The creation of common geospatial models of physical, topological and non-physical (though still spatially dependent) information in digital format, together with the provision of open and free access to all, has then been revolutionary in history of geography and cartography.

The enormous social and economic value of spatial information has been recognized (UN-GGIM, 2020). Many experts state that wide access to digital geospatial information will undeniably contribute to economic growth, social equality and sustainable management of resources (Atumane and Cabral, 2019; Putra et al., 2019; Kim, 2010). Consequently, management of spatial data and construction of Spatial Data Infrastructures (SDIs) became a spotlight for developed and developing countries in recent decades (Williamson, 2003), with a directly link to digital government transformation (EC, 2019).

According to Crompvoets (2006), the USA initiated to create SDI in 1994. Already in 2005, the number of National Spatial Data Infrastructures (NSDI) around the world reached 83 countries. In 2006, annual spent of money for SDI foundation and maintenance reached 120 million € worldwide (Grutz et al., 2007). Nowadays, an SDI is considered as an essential part of countries e-government system. Hansen (2017) unites multiple drivers for formation of SDI concept into two categories: technological (service-oriented architecture, standards) and business (e-government and military).

3. STUDY AREA: CASE STUDY OF UZBEKISTAN

3.1. The social and economic situation in Uzbekistan

Uzbekistan is located in Central Asia, and it has boundaries with Kazakhstan in the north, Turkmenistan in the south, Kirgizstan and Tajikistan in the east. The total territory of the country equals to approximately 449 thousand km^2 (56th world rank) with population 34 million people (41th world rank). Uzbekistan is among the list of fast developing countries with annual GDP growth of 5.1 % (World Bank, 2019). Other important social and economic statistics are represented in Table 1.

Figure 1. Map of Uzbekistan. Source: https://mapcruzin.com

Table 1. Source: World Bank (2018).

Indicator	Data	Year
Population growth	1.7 %	2018
GNI (PPP)	290.47 billion $	2018
Urban population growth	1.6 %	2018
GDP	50.50 billion $	2018
HDI	0.710	2018

The country's poverty rate declined from 27.5 % in 2001 to 12.8 % in 2015 (UNDP, 2020). However, reforms to address economic disorganizations and structural impairments to growth are still at the beginning. Despite fast macroeconomic growth of Uzbekistan, there are still issues about the efficiency of governmental bodies and regulations, land property and land tenure rights and transparency of system, as well as availability of data for the wide range of stakeholders. Therefore, Uzbekistan's higher authorities recognized the urgent need to modernize its cadaster system and real property registration for social and economic benefits.

With the ultimate goal to enhance investment climate and attractiveness, in 2013, the government of Uzbekistan approved Master Plan program for the development of national information and communication system, for the period from 2013 to 2020. It has several goals, including to further promote the adoption of advanced ICT technology, accelerate the development of information resources, systems and networks, as well as to expand the range of online public services provided to businesses and citizens, geospatial services.

3.2 Policy in Uzbekistan regarding spatial data

One of the essential components of SDI is the policy component. Policy creates a prolonged strategy for the NSDI foundation and for its development by promoting funding and legal institutional support. Moreover, it also depicts standards, spatial data access, pricing, etc.

Having achieved its independence, the Republic of Uzbekistan has introduced and implemented a wide range of laws and resolution regarding land use and cadaster, geodesy and cartography, spatial data, e-government and NSDI. The legislative framework of Uzbekistan started to consider land administration and other related issues in 1992, and it currently covers wide range of directions including land law, land management, cadaster and geospatial information (see also Table 2).

Table 2. Laws related to cartography, geodesy, state cadaster, e-government and NSDI.

Law of the Republic of Uzbekistan No. 417-I dated April 25, 1997 on Geodesy and Cartography
The draft law on Geodetic and Cartographic Activities (new edition) was adopted in the third reading by the Legislative Chamber of Parliament and is currently under the consideration of the Senate. The law contains rules governing geodetic and cartographic activities, including support and maintenance of various cadasters.
Law of the Republic of Uzbekistan No. 598-I dated April 30, 1998 on Land Code of Republic of Uzbekistan
- ***The Land Code is a fundamental regulatory act governing land relations.*** - ***It contains a number of articles regulating relations in the field of land use management (in particular, the powers of state bodies to provide land plots), the state land cadastre maintenance and state registration of rights to land plots.*** - ***It also establishes the concepts of a land plot, types of rights, easement and encumbrances to land plots, the reasons why the rights to land plots can be revoked.*** - ***According to the Land Code the rights of legal entities and individuals to land plots are subject to state registration. Registration might be rejected only for the reasons specified in the Land Code.***
Resolution of the Cabinet of Ministers No. 543 dated December 31, 1998 for Conducting of State Land Cadastre in the Republic of Uzbekistan;
The Resolution approves the Regulation on the procedure for maintaining the state land cadastre, which contains the concept of a land cadastre, the tasks of its creation, principles, content and maintenance procedure. The Regulation provides for the creation of an automated land information system.
Law of the Republic of Uzbekistan No. 171-II dated December 15, 2000 on State Cadastre
- *It defines the list of state cadasters including state registration of the rights of ownership and other rights for cadastral objects.*

- *GOSCOM was identified as specifically authorized body for the state cadastres maintenance.*
- ***State registration of rights for cadastral objects is a legal act of recognition and confirmation by the state of the rights of legal entities and individuals to cadastral objects.***
- ***State registration of rights to cadastral objects is carried out by entering documented information into the state registers (according to The Resolution of the Cabinet of Ministers No. 1060 dated December 29, 2018 "Regulation on the Procedure for State Registration of Real Property Rights").***
- ***State registration of rights to real property cadastral objects is mandatory for all their owners and other right holders.***
- ***The registration bodies are responsible for losses, due to inaccurate information in the state register of rights to real*** *property, incurred by parties, who have conducted a transaction with real property in good faith. The loss is subject to compensation according to a court decision taking the legal force.*

Law of the Republic of Uzbekistan No. 560-II dated on December 11, 2003 on Informatization

- ***The Law defines the concepts of digitization, information resource, information system, owner of information resources or information systems, information technology.***
- ***Information stored and processed in information resources confirmed by an electronic digital signature*** *is an electronic document and has the same legal force as a physical document.*
- ***Information on*** *the personal data of individuals is classified as confidential.*
- ***The national information system includes information systems of state bodies, sectoral and territorial information systems as well as information systems of legal entities and individuals. It is being created taking into account the compatibility of its information systems with international information systems. Information exchange using the national information system is carried out on a contractual basis with the exception of cases provided by legislation.***
- ***The use of information systems for transactions between legal entities and individuals is regulated*** *by legislation.*
-

Law of the Republic of Uzbekistan No. ЗРУ-395 dated on December 09, 2015 on Electronic Government

- *The Law defines the concepts of e-government, public service and electronic public service, request, applicant, uniform e-government identifiers, interdepartmental electronic interaction.*
- *The e-government infrastructure consists of central databases, interdepartmental electronic interaction system, information systems and information resources of state bodies, official websites of state bodies and the Unified Portal of Interactive Public Services.*

- *The central databases of e-government are state information resources that are unified centralized sources of information, which summarize and store the basic information of state bodies for the provision of public services and interdepartmental electronic interaction.*
- **Integrated Information System for Real Property Registration and Cadastre (*IIS*RPRC)** *is a one of the central databases of e-government.*

Notably, several general laws and regulations have already been adopted in the country, covering issues related to electronic documents, electronic signatures, and e-government. Nevertheless, the use of modern computer technology has not yet been reflected in the legal acts on land administration and, particularly on issues of cadastral registration and state registration of rights to real property. This circumstance may serve as a serious obstacle to the implementation of the developed Integrated Information System of Real Property Registration and Cadaster (IISRPRC).

3.3 Data components available in Uzbekistan

Another vital component of any SDI is data. Uzbekistan's law on state governmental cadaster was adopted on 1998. It is currently is known as the Unified System of State Cadasters (USSC), and lists 21 different types of cadasters. Separate departments and agencies were assigned as responsible for one or more type of cadasters (see Table 3).

Table 3. Unified System of State Cadasters

Cadaster type	**Responsible**
State cadaster of Land	State Committee on Land Resources, Geodesy, Cartography and State Cadastre
State cadaster of Buildings and Constructions	
State cadaster of Cartographic and Geodetic	
State cadastre of Territories	
State cadastre of Water	- State Committee on Geology and Mineral Resources (groundwater resources cadaster) - Center of Hydro-Meteorological Service (surface water resources cadaster) - Ministry of Water Resources (water use cadaster)
State cadastre of Forest	State Committee on Forestry
State cadastre of Flora	State Committee on Nature Protection
State cadastre of Fauna	

State cadaster of Protected Natural Areas	
State cadaster of Waste Storages	
State cadaster of Town Planning	State Committee for Architecture and Construction
State cadaster of Hydraulic Structures	- Ministry of Water Resources - State Inspection for Water Resources Control
State cadaster of Cultural and Heritage	Ministry of Culture and Sports
State cadastre of Roads	State Committee for Roads
State cadastre of Railways	Uzbekistan Railways
State cadaster of Communication Facilities	Ministry for Development of Information Technologies and Communications
State cadaster of Electric Power Facilities	- Ministry of Energy of Uzbekistan - National Electric Networks of Uzbekistan
State cadaster of Natural Danger Areas	- State Committee on Geology and Mineral Resources - Center of Hydrometeorological Service - Academy of Sciences of the Republic of Uzbekistan
State cadaster of Man-caused Danger Areas	- State Committee of Industrial Safety - Ministry of Health, Institute of Nuclear Physics, - Ministry of Emergency Situations
State cadaster of Mineral Deposits	State Committee on Geology and Mineral Resources

USSC is a multi-purpose information system designed to provide a unified calculation and assessment system in relation to the natural and economic potential of the Republic of Uzbekistan and its individual territories. The state cadaster procedure for registering in the USSC is carried out by the entities assigned the authority in their respective areas. A State Land Cadastre, which is a component of the USSC, is a system of the latest information and documents on the geographical locations, legal statuses, qualitative and quantitative characteristics, and evaluations of natural, economic and other types of targets in a specific form.

Notably, not all layers from USSC will be available online in a single clearinghouse. Some state cadasters contain secret, national, strategic or military information and, therefore, they will not be included into geoportal layers.

In order to make USSC available to everyone via one geoportal as part of the NSDI, Uzbekistan has made several initial steps to implement NSDI and e-government policies during the last decade. These projects will be discussed in the next section.

4. "MODERNIZATION OF REAL PROPERTY REGISTRATION AND CADASTRE" AND "NGIS-1" PROJECTS

The demand for spatial data in the country is rapidly increasing, both by civil society and by legal entities. And the transition from paper-based to digital-based land registration will have multiple positive impacts according to experts: improve customer service, make geo-spatial data open to all, promote private sector and develop the country's economy. Accordingly, the registry and cadaster became a central part of Uzbekistan's e-government Master Plan, which aims to increase related investments in the country. "Real Property Register and Cadaster" is one of six countries-initiated e-registries, along with National Geographical Information System (NSDI), Census, Legal Entity, Vehicle and Address Registries (see also Figure 2).

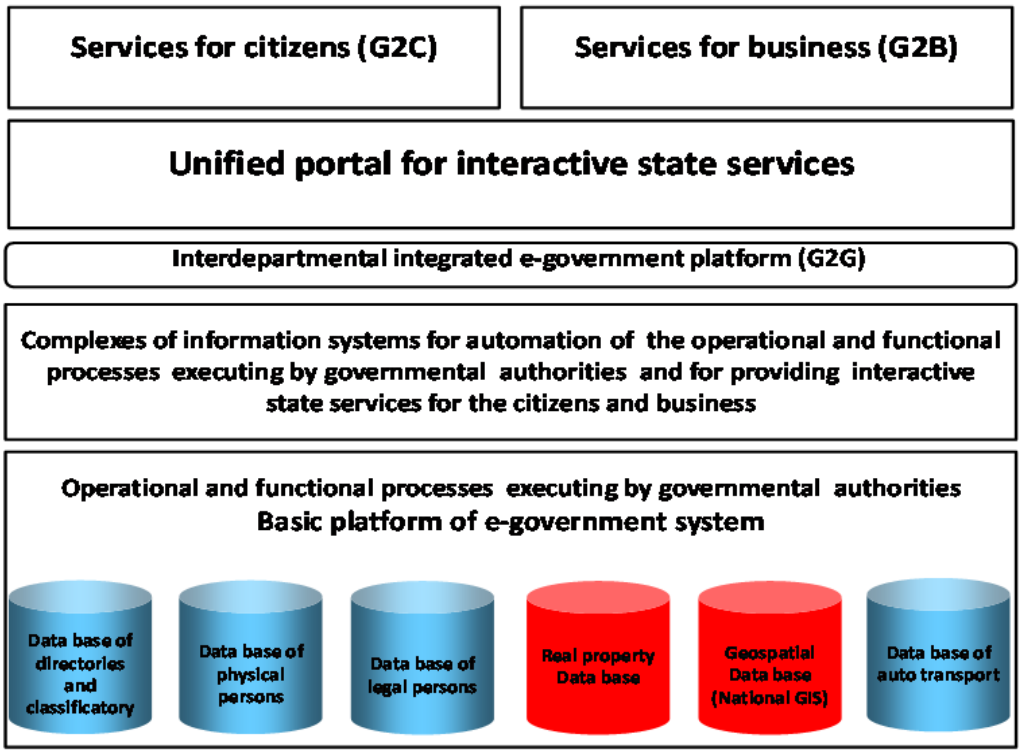

Figure 2. E-government in Uzbekistan

In a Resolution of the former president I. Karimov's (No. PP-1989, 27 June 2013), the State Committee for Land Resources, Geodesy, Cartography and State Cadastre (GKZGDK) was assigned responsible for the implementation of two e-government initiatives, including "National Geographic Information System" and "Integrated Information System for Real Property Registration and Cadastre (IISRPRC)". Later on, in 2020, under the president's decree, GKZGDK was restructured and renamed into Cadastre Agency under the State Tax Committee of Uzbekistan (CASTCU).

4.1 NGIS-1 project

Uzbekistan plans to implement the latest information and communication technologies to support better governance and to maintain stability. In September 25 2013, the President of Uzbekistan signed Resolution No. PP-2045 “On measures to implement the investment project “Creating a National Geographic Information System”, funded by South Korean Exim Bank. The most important outcome of this project (also known as NGIS-1) was the conception of “NGIS/NSDI standardization and Master Plan of the Republic of Uzbekistan” created to boost the governance efficiency of the state authorities and public service. The projects total cost was 15 million US dollars and it consisted of five components, as listed in Table 4.

Table 4. NGIS/NSDI Master Plan Components

Component №	*Name*	*Objectives*
1	*NGIS standardization and master plan*	- *Establishment of NGIS standards* - *Standardization of codes for digital mapping* - *Standardization of cadastral map codes*
2	*Establishment of State Geodetic Satellite Network*	- *Installation of satellite geodetic network by constructing 50 continuously operating reference stations* - *Delivery and installation of hardware and software for a Data Center* - *Establishment of telecommunication network*
3	*Delivery of Digital Cartographic Basis*	- *Purchasing of high-resolution satellite imagery* - *Creation of 1:200000 scale base map covering entire country* - *Creation of 1:25000 digital map excluding irrigated croplands* - *Creation of 1:5000 scale map for irrigated croplands* - *Creation of 1:2000 scale digital map for cities and villages*
4	*Implementation of Information analytical centers and Automatic Work stations*	- *Construction of a central information analysis center* - *Construction of 14 regional information analysis centers* - *Delivery and installation of 14 regional analytic centers*
5	*Development of pilot system for National system of cadaster and real property registration*	- *Development of transaction-based cadaster and registration system* - *Development of pilot systems*

The project started by CASTCU in 2015, and was implemented by 2018 in collaboration with the Ministry of Land, Transport and Infrastructure of South Korea and consulting company Anse Technologies – Meta GIS consortium. The major outcome of NGIS-1 project implementation was web-site (http://geoportal.uz). Despite that, and although all objectives of the project were reached; the geoportal still had several shortcomings and limited functionality. Therefore, it was decided to launch NGIS-2 project for further develop the geoportal and to integrate it within IISRPRC as a one-stop-shop.

4.2. Modernization of real property registration and cadaster (MRPRC)

The NGIS-1 project launched the establishment of NSDI, although not all components were successfully completed. For example, 50 continuously operating reference stations are not enough to establish a complete national geodetic navigating system. The current base stations cover only 30% of the territory of the country, and for full coverage additional 100 base stations would be needed. Besides that, components 4 and 5 remained not finished. Also, to delineate real estate and cadaster parcels, in 2015, CASTCU acquired images of Korean satellite KOMPSAT-3 with 2.5-meter pixel resolution in low priority areas and 0.6 meters in urban areas. However, these images were considered to be of too low quality to identify boundaries of real estates and other small land properties. Therefore, in 2019, the committee has decided to start taking aerial photos of urban areas and rural settlements with pixel resolution 20 centimeters. After the acquisition, the images will be referenced into a new national reference system, mosaicked, orto-rectified and used as the base map for cadastral index mapping. Furthermore, other governmental bodies will use this orto-rectified base map for precise and accurate identification of infrastructure objects, land-use, land administration and many other purposes. Eventually, these high-resolution orto-rectified photos will be available in national geoportal as one of core layers.

To (partially) address these shortcomings and progress on the implementation of the NSDI and e-government policy, a new project was set up. It is called “Modernization of Real Property Registration and Cadaster” (MRPRC). Total cost of the MRPRC project were estimated to be $25 million. In 2015, the Ministry of Finance of the Republic of Uzbekistan and the World Bank signed an agreement of purchasing $20 million loan credit by Uzbekistan for the project, which was then received in 2016. The rest of the project financing was obligated to CASTCU. According to preliminary project plan and strategy, the project has four basic components, each with its own aim and specific targets (see Table 5).

Table 5. Components of MRPRC project

Component №	*Name*	*Objectives*
A	*Real Property Registry and Cadastre System Development*	- *A.1 Business Analysis and Processes Re-Engineering* - *A.2 Support the further development of IISRPRC* - *A.3 Data Center creation*
B	*Real Property Registration and Cadastre Data Development*	- *B.1 Digitizing Data for Real Property Registration and Cadastre* - *B.2 Digital Data Integration and Population of the IISRPRC Database*

C	*Use of Real Property Registry and Cadastre Data*	- *C.1 Spatial Data Integration to e-Government Structure* - *C.2 Establishment of New Open Coordinate Reference System* - *C.3 Computer Assisted Mass Valuation Prototype*
D	*Institutional Development and Project Management*	- *D.1 Customer Services* - *D.2 Institutional Development and Sustainability* - *D.3 Policy and Regulatory Framework* - *D.4 Training and Education* - *D.5 Project Management, Reporting and Technical Assistance*

The MRPRC project was initially foreseen to end in 2021, but due to the COVID-19 pandemic, it was prolonged until October 2022. The major goals of the project concerning the NSDI are: a) the creation of a document strategy of NSDI; b) obtaining high-resolution aerial photos for basemap of geoportal; c) the improvement of geoportal.uz to international level and its integration with e-government system; d) the development of specification of spatial data, metadata and geoservices and the methodology of digitization; and e) the development of national open coordinate system based on datum WGS-84 and transferring USSC spatial datasets from Pulkovo-42 (old coordinate system, left from USSR) into new open coordinate system.

So far, none of these components could be entirely finished, but the strategy of the NSDI, and the specifications and establishment of open coordinate system are in the latest phase of development. The main issue remains the acquisition of high resolution aerial images, which is only at the initial stage. Due to pandemic situation, the flights were put on hold, and postponed to an unknown date. However, these images are supposed to serve as a base layer for the geoportal and for the digitization of real estate objects. Without this essential sub-component, the formation of Uzbekistan's NSDI cannot be completed. Besides, the government should continue to develop the CORS geodetic network, including the deployment of the 100 additional base stations.

5. STAKEHOLDER ANALYSIS

An important key for success of the NSDI is its acceptance and participation of different stakeholders. Multiple actors are involved in the implementation of the NSDI. However, their interest and authority in decision-making process differentiate from low to high. According to power/interest ratio, stakeholders can be divided into four major categories: manage closely (high power and high interest), keep informed (low power and high interest), keep satisfied (high power, low interest) and monitor (low interest and low power) (see also Figure 3).

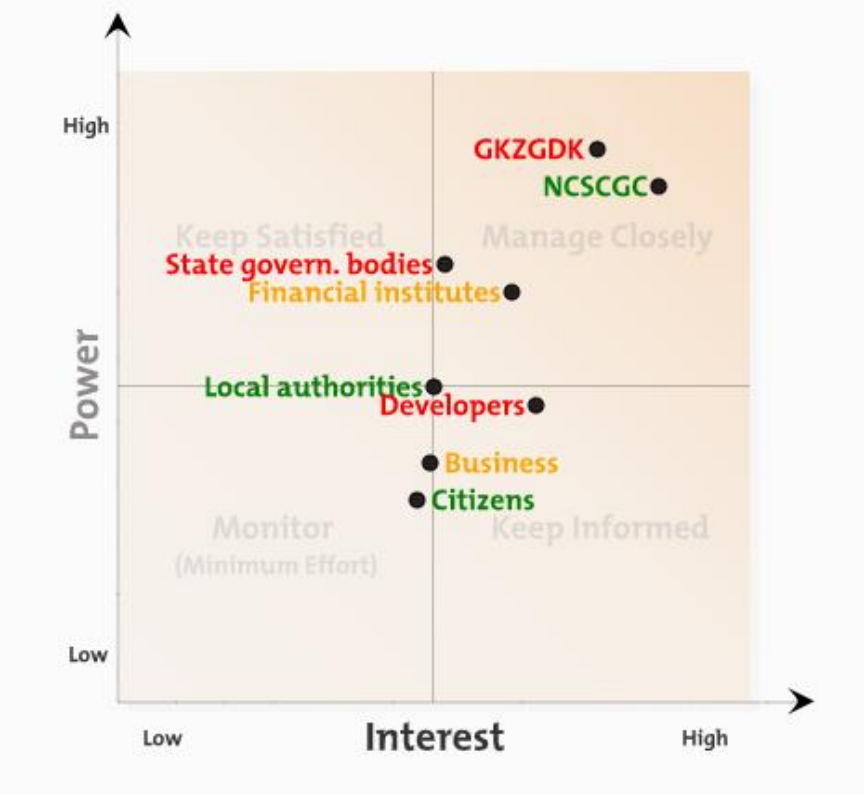

Figure 3. Stakeholder matrix according to interest and power factors

5.1 Manage closely

Four stakeholders actively participate and take final decisions regarding the NSDI implementation in Uzbekistan. CASTCU is designated as the main responsible body for implementation, management and maintenance of the NSDI. The Committee has huge potential and authorities for providing up-to-date geographical, spatial and cadastral information. It also captures, analyzes, standardizes, utilizes, stores and combines geospatial and cadastral data.

The National Center of State Cadasters, Geodesy and Cartography (NCGCGC) is the part of the Agency within its organizational structure, it mostly works independently and runs several projects on a national level, specifically concerning GIS issues. These include the foundation of integrated geographic information system, analyses of satellite aerial and UAV images, maintenance of the database of real property, provision of main analytical centers, geoserver, outline of the national strategy (The Master Plan) for the NSDI implementation and proposing it to CASTCU. Moreover, NCGCGC will be the holder of main data center and geoserver. Therefore, it has higher interest in foundation of the NSDI but less power comparing to head body.

State governmental bodies include various departments that collect specific cadaster layers according to its direction, which afterwards are united into one system by the CASTCU (see also Table 4, above). Ministries keep geospatial information in databases, which are available only for themselves. Interoperability between state governmental bodies, when it comes to up-to-date geoinformation exchange, still has room for improvement in Uzbekistan. This, currently limits planning, management and decision-making based on spatial analysis. However, state entities are interested in the creation of a national clearinghouse and ready to make spatial information in their respective area

open to everyone. One portal will simplify and enable transparent exchange of spatial information between ministries, committees and agencies, thereby eliminating bureaucratic barriers that otherwise take time and resources to overcome. The Ministry of Defense (MD) has special interest and role in representing orthophoto images. According to current resolution, MD should scan high-resolution images and delete some objects, where military of security entities are captured.

Financial institutes are international or national banks that give credit loans for long-time implementation period of the NSDI. In our case, the South Korean EXIM Bank and the World Bank are interested and have some authority in the foundation of Uzbekistan's NSDI. In 2012, the South Korean EXIM bank gave a loan to Uzbekistan's government through the resources of EDCF in the amount of 15 million USD for the project "NGIS-1". The CASTCU assigned its department NCGCGC the responsibility for project management and implementation. The project lasted three years, from 2015 to 2018, and resulted in building 50 GNSS stations that cover approximately 30 % of the territory, foundation of Master Plan, creation of geoportal.uz (BETA version), purchasing of COMSPAT-3 A satellite images as basemap layer, creating pilot project of IISCRN for Samarkand and Tashkent provinces. In 2016, World Bank gave 20 million USD credit to Uzbekistan's government for the project "Modernization of real property registration and cadaster" to create integrated information system of real property registration and cadaster and to make it of open access to every citizen of the country. One of the components of the project is aimed to support activities at enhancing public on-line of data, which form the core dataset of the geospatial data framework and the geospatial base for the variety of market economy and fiscal services. Specifically, the component will support the establishment of a geoportal that will provide the "one-stop-shop" for all geospatial information and related online services. The World Bank monitors the process of project implementation through specifically created Project Implementation Unit (PIU) in the CASTCU. Nevertheless, it does not directly influence to specific details, it has high authority and interested in final project success.

5.2 Keep informed

There are two kids of stakeholders in this category: developers and local authorities. Both of them have high interest in the project but much less influence to its terms of reference and implementation.

Local authorities comprise regional offices of the CASTCU, regional offices of other departments, khokimiyats (town councils) etc., which are representatives of head bodies in regions. Uzbekistan is known as very centralized country, where all political, economic, scientific, diplomatic life is centered in the capital. Regional authorities have very large tasks and responsibilities within their area. Current NSDI projects are initiated by government, which implies a top-down approach. However, active participation of local entities (especially regional offices of CASTCU) in creating and uploading up-to-date geospatial information into main geoportal will be of vital importance both for the NSDI development and for sustainable development of periphery.

Developers are legal and physical entities, which include GIS professionals and freelancers (e.g. master of PhD students, volunteers); national and international research institutes, which use, create and analyze geospatial information (e.g. IWMI, FAO, UzHydromet, UNDP, universities etc.). Developers are major users of raw geospatial data, which they analyze and transform into certain result of practical or scientific orientation. Nowadays, many developers claim that small transparency and low accessibility of spatial data in Uzbekistan are main challenges and obstacles in their work.

5.3 Monitor

This category of stakeholders has the least power and interest in the project implementation. In our case, we have two stakeholders in this quadrat – business and citizens. These actors are not involved into process and decision-making and have low interest due to unawareness. Nevertheless, the core idea of the NSDI is to make geospatial information open to everyone, fostering equality in social, gender assess, as well as access to information. Business has moderate interest in the NSDI implementation because of weak conversance about the concepts, advantages and positive impact of NSDI for business development.

6. VISION

The vision, or long-term strategy, of the NSDI is very important since it depicts not only the final goal of desired outcome for the process of creation, but also builds a roadmap to achieve this goal (Figure 4). Eventually, the evaluation of any SDI project implementation can be achieved via this roadmap and vision (Williamson et al, 2003). Williamson et al. (2003) state that common timescale for such a strategy lasts 3-5 years, though 3 years is more preferable due to fast technology development. More comprehensive and long timescale vision of NSDI (divided into shorter steps) can significantly facilitate the process and avoid many obstacles.

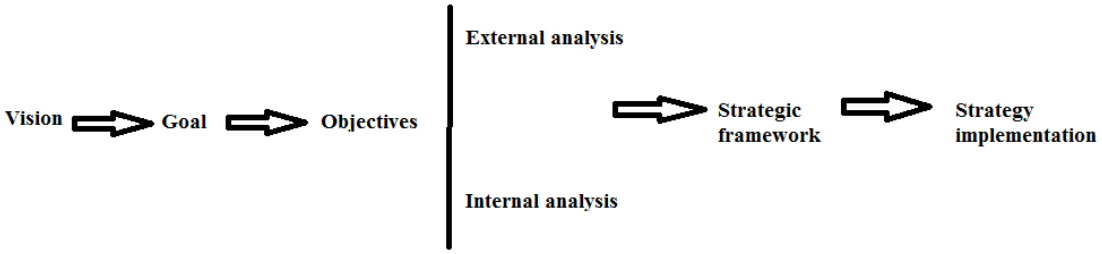

Figure 4. From vision to strategy implementation

According to the “Integrated Geospatial Information Framework” (UN-GGI, 2020) the vision identifies the obligation for countries to design and achieve better results for future generations. General vision for an NSDI for each country is “the efficient use of geospatial information by all countries to effectively measure, monitor and achieve sustainable social, economic and environmental development – leaving no one behind” (UN-GGIM, 2020).

According to the state government and CASTCU, the overall objectives of creating NSDI for Uzbekistan are as follows:

- To make operations more efficient and improve services for citizens;
- To reduce the cost of data production;
- To eradicate duplication of spatial datasets;
- To save the cost for data accessibility;
- To improve consolidation and data distribution among departments, ministries and agencies, as well as local authorities;
- To provide better available data for decision-making;
- To support more transparent governance;
- To collect and share data for more effective natural resource management, sustainable development and emergency response;

- To make spatial data available for wide range of volunteers, GIS and remote sensing specialists, as well as universities and research institutions for analysis and creation of new spatial data;
- To boost investment climate;
- To maintain financial sustainability;
- To develop tourism and defend cultural heritages;
- To support crime investigation; and
- To support competitiveness.

Generally, the vision of the NSDI for Uzbekistan, which was developed by GKZGDK, uncovers six implementation strategies comprising several implementation tasks (Figure 5).

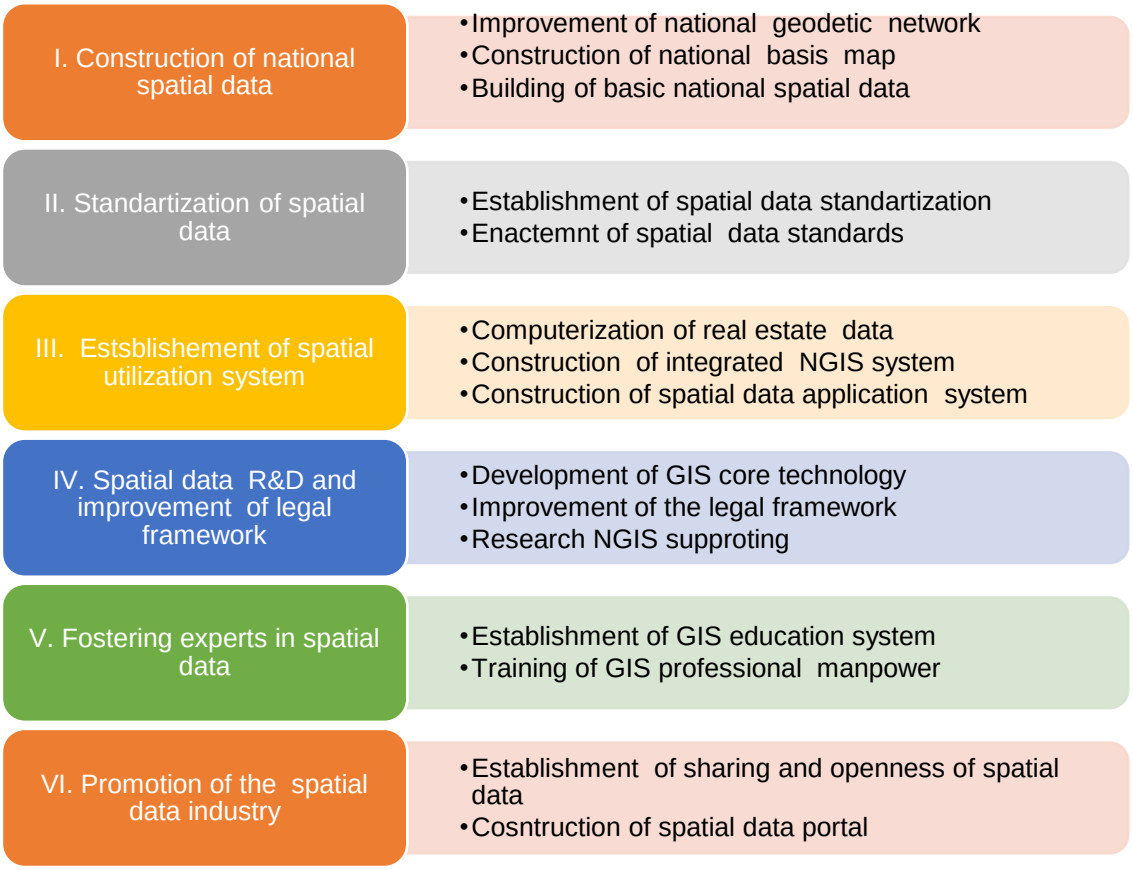

Figure 5. Implementation strategies and tasks of Uzbekistan's NSDI

According to the Master Plan, Uzbekistan's NSDI will be implemented in several stages (Figure 6). Within the current stage, Uzbekistan's government has initiated creation of this NSDI. The main law about political support of NSDI is under consideration in Oliy Majlis (legislative chamber). The political vision and institutional framework show government's clear desire and ensure support for further NSDI development and maintenance. Actually, the main objective is to finish obtaining high-resolution aerial images of the country. They will serve as a main base map and further be used for vectorization of real property.

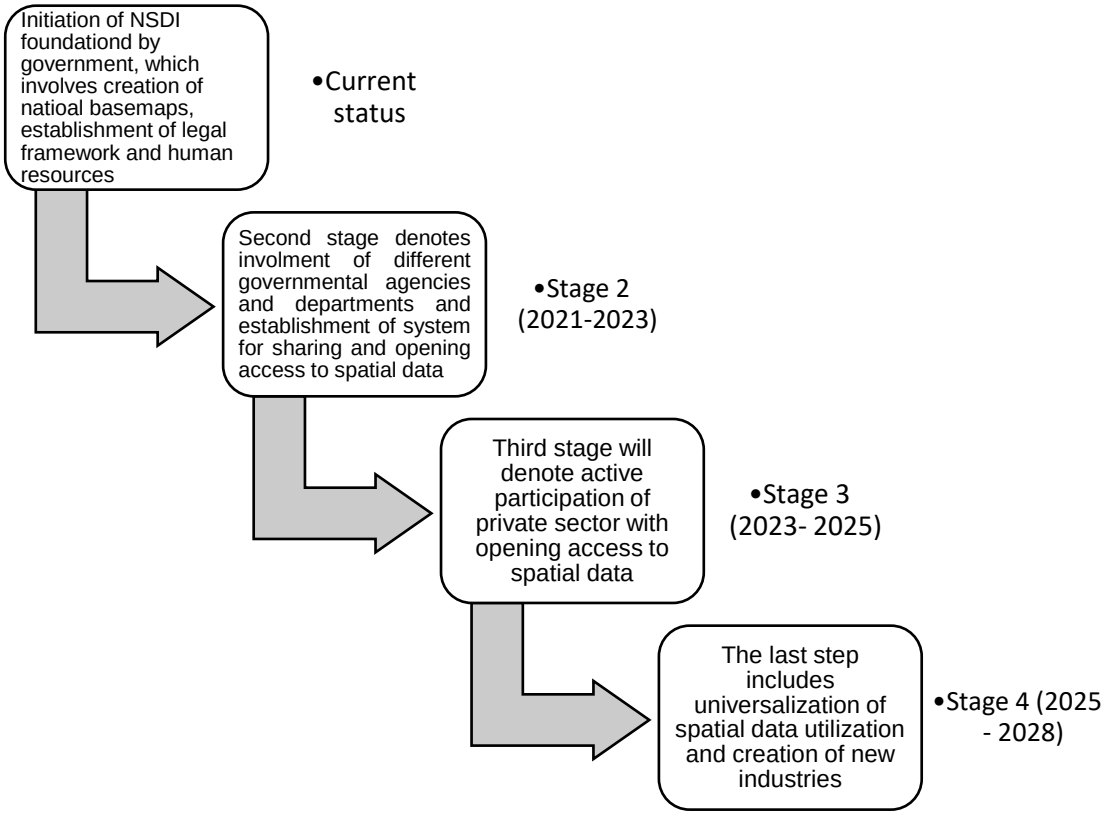

Figure 6. Stages of Uzbekistan NSDI implementation

The second stage requests participation of state governmental entities. They will enrich national geoportal with cadaster thematic layers. All governmental bodies will have free access to other geospatial information concerning other entities.

Third stage will take place from 2023 to 2025 and will denote involvement of private sector and international and national organizations, NGOs and other consumers and developers, which can contribute to NSDI development with diverse range of up-to-date geospatial information.

The last stage includes universalization of spatial data utilization and creation of new industries. This step will presumably last three years and end in 2028.

Though the vision simplifies the implementation of NSDI and portrays clear objectives and steps from the beginning until the completion, the practice of other countries (who already had implemented their national SDI) shows that the process itself has many challenges and pitfalls, which will be elaborated in the next section.

7. CHALLENGES

There are barriers to justifying the need to recognize the relevance and benefits of geospatial information, especially because these benefits often accrue over the long term after initial investments. It is often difficult to determine the role and value of geospatial information in the results of any activity. Unwillingness to invest in geospatial information, prioritizing resources, resisting change, and not using geospatial information and political

culture are examples of major obstacles to progress and success. Explaining what geospatial information is, why it is important, and how it contributes to the mandate, vision, goals and objectives of a government or organization is the first step towards further progress.

Recognition of the importance of geospatial information is accompanied by the need to invest. There are costs and resources needed to plan and implement successful, functional geospatial capabilities. Access to funding is needed either through government-provided investments, or from other sources, such as donors. However, how much investment is required is determined by the amount of work and the approach?

Starting small with one national priority is one approach; planning for full implementation is another. In any case, the required level of funding is evaluated based on the proposed approach and expected results. It is important to consider where the functional and technical capabilities develop so that the plans are not hindered by an outdated or non-existent approach. For example, not so long ago, the only option for processing huge volumes of geospatial data was the acquisition, installation and maintenance of large servers, which led to costs for equipment, technical knowledge and space. With the advent of the cloud, new possibilities are possible that transfer internal responsibilities to external services. Instead of scaling and paying for maximum storage and processing bandwidth, customers pay only for what their use. It also frees the organization from some of the IT workloads associated with managing comparable services within the company.

Human resources are another potential obstacle to the effective planning, implementation and maintenance of geospatial information and services. Knowledge of geography, geospatial information technology, and data management are key skills that are preferable to success. In situations where these skills are not yet developed or not available, other options include hiring the right specialists, training staff in basic capabilities, or receiving external help from donors or consultants. Maintaining qualified personnel is another problem when methods to minimize staff turnover contribute to program stability. Retention methods include offers on training, remuneration and benefits, increasing responsibility for the program, promotion and travel opportunities in support of the program. Outsourcing certain features, especially those that require high-level skills, is another option.

Data sharing is a barrier that reflects the culture and/or politics of a government or other involved organization. There is value for each instance of geospatial information, and it is of great value when this data is combined, shared, compared or integrated with either other spatial data or other types of data, such as geo-referenced statistics. For example, an administrative district, such as the border of a city, can be geocoded to the poverty level of its inhabitants. The received integrated information is visually informative on its own on the map, but it can also be compared with other cities in the region or country. The result is a knowledge indicator for planning, decision making and monitoring. When the practice of the organization does not allow the use of either spatial data, or they either are not only underutilized, but also hinder the innovative use of various types of data for various purposes. Making data accessible and collaborating between organizations that encourage data sharing and use are examples of lowering barriers.

The creation and implementation of the NSDI will increase the efficiency of public administration and expand public services in the creation and use of spatial information for e-government, land management, surveying, cartography and the state cadaster. An NSDI will allow in real time to analyze and evaluate relevant and reliable cartographic and other data of various thematic content to develop and support managerial decisions in the field of rational use and protection of natural resources, integrated development of territories and sectors, the economy and the social sphere.

On this basis, possible future development of NSDI in Uzbekistan, as well as countries readiness to implement and develop it is elaborately discussed in the following section.

8. PROSPECTS FOR UZBEKISTAN's NSDI

8.1 Generations of (N)SDIs

The prospects of the NSDI development in Uzbekistan is still unclear. However, it can be presumed that the country will follow the path of other countries, which developed NSDIs. We can assume that the first generation NSDI in Uzbekistan will have 2D static, digital, supply-driven and will follow a limited open data policy (see also Table 6). The most challenging and important part of this first generation of the NSDI will be vectorization of real properties and integration with IISRPRC.

The second generation of the NSDI of Uzbekistan will build on the former one, if that should be successfully completed and bring presumed benefits. The environment of the second generation implies ubiquitous technologies, following the SDI paradigmatic shift as recapitulated by Masser (2005): from a product to process model, from formulation to implementation, from coordination to governance, from centralized to decentralized, from single participation to multilevel, from data creation to data sharing etc. In addition, the second generation NSDI will focus on 3D type of information and adhere to an open data policy.

In any case, the process of the NSDI evolution requires the involment of greater variety of stakeholders and user communities from private sector and society (Cada and Janecka, 2015).

Table 6. Presumed generations of Uzbekistan's NSDI. Adopted from Eun Hun Kim (2010)

	First generation (2021-2028)	**Second generation (unknown date)**
IT Environment	Digital	Ubiquitous
Type of Information	2D, static	3D, dynamic
Subject	Supply-driven	Demand-driven
Type of business	Individual	Cooperative
Data policy	Close, Limited Open Policy	Data Open Policy
Information domain	Stand alone	Linkage integration

8.2 SDI readiness index of Uzbekistan

The SDI readiness index is an indicator purposed to assess the countries potential to embrace SDI development (Delgado-Fernandez et al, 2005). Delgado-Fernandez et al. (2005) reviewed several researches and identified the following global factors. The elements to assess SDIs include five factors: organization, data availability, people, access network, and financial resources. Each factor includes several decision criteria, adding up to a total number of 14. Organization factor embrace political vision (national SDI strategy and general master plan), institutional leadership (officially responsible governmental organization), umbrella legal agreement (general principles that will apply to more specific give-and-take contracts). Information/data availability includes two decision criteria's, such as digital cartography availability and metadata availability. People factor means human capital (professionals in sphere of SDI and GIS), SDI culture-education (SDI courses and specialties in universities, journals and conferences regarding SDI) and individual leadership (high professionals and innovators in the sphere of SDI that are internationally acknowledged). Access network contain web connectivity (internet speed), telecommunication infrastructure, and geospatial software availability. Financial resources imply government central funding (constant financial support from government), data policy aimed to return investments (cost-benefit analysis of NSDI implementation) and private sector activity (government-business partnership) (see also Table 7).

Table 7. SDI readiness index factors. Adopted from Delgado-Fernandez et al. (2005)

FACTOR	DECISION CRITERIA
Organization (O)	Political vision (Ov)
	Institutional leadership (Ol)
	Umbrella legal agreements (Ic)
Information/Data availability (I)	Digital cartography availability (Ic)
	Metadata availability(Im)
People (P)	Human capital (Pc)
	SDI culture-education (Ps)
	Individual leadership (Pl)
Access network (A)	Web connectivity (Aw)
	Telecommunication infrastructure (At)
	Geospatial software availability (As)/own development (Ad)/open source (Ao)
Financial resources (F)	Government central funding's (Fg)
	Data policy aimed to return on investment (Fr)
	Private sector activity (Fp)

On this basis, the SDI readiness index formula take the following model (Delgado-Fernandez et al., 2005):

$$SDI\ readiness = (Ov*Ol*Oa)^{1/3} * (Ic * (Ic* ((1-Ic) * Im^2))^{1/2})^{1/2})^{1/2} *(Pc*Ps*Pl)^{1/3}*(1-((1- Fg)*(1- Fp)*(1- Fr))^{1/3}) *((At*Aw*(1-((1-As)*(1-Ad)*(1-Ao))^{1/3}))^{1/3})^{1/2}$$

To assess each decision measure, we used a truth-scale per categories (Table 8). This fuzzy logic model was suggested and used by Delgado-Fernandez et al (2005) in order to minimize bias for each criterion.

Table 8. Truth values per category. Adopted from the fuzzy-logic model of Delgado-Fernandez et al. (2005).

Category	Truth Value
Absolutely False	0
Almost False	0.1
Too False	0.2
Rather False	0.3
More False than True	0.4
Equally False and True	0.5
More True than False	0.6
Rather True	0.7
Too True	0.8
Almost True	0.9
Absolutely True	1

According to the analysis of state-of-the-art situation, four experts from the CASTCU gave the following decision values for each criterion from 0 to 1 (Table 9).

Table 9. Exert values for each criterion

Factor	Decision criteria	Expert value	General factor value
Organizational	Politician vision regarding SDI	0.6	0.45
	Institutional leadership	0.8	
	Umbrella legal agreement(s)	0.2	
Informational/Data availability	Digital cartography availability	0.8	0.68
	Metadata availability	0.2	
People	Human Capital	0.5	0.35
	SDI culture	0.3	
	Individual leadership	0.3	
Access network	Web connectivity	0.4	0.348
	Telecommunication infrastructure	0.4	
	Geospatial software availability	0.5	
	Own geoinformatics development	0.4	
	Open source culture	0.4	
Financial resources	Government central funding	0.6	0.36
	Return on investment	0.2	
	Private sector activity	0.2	
SDI readiness index	**0.437**		

From this we can calculate the average SDI readiness index in Uzbekistan, according to the expert's opinion of all 16 criteria, as 0.437 from 1. This can be considered a low score of a country's readiness to implement and maintain NSDI (Table 9). The smallest index among all factors was given to the Access network (0.348) and the highest index to Data availability (0.68). Other factors are close to Access network and have low values. Regarding Data availability, as was mentioned in 1.5.5, Uzbekistan has USSC with 21 cadaster layers, each of which maintains and monitors responsible entity. Despite of the fact that spatial data interchange between departments is limited, the resolution of the Cabinet of Ministries on 14th of January 2020 on free access to cartographic and spatial information abides them to make their data open to everyone.

Concerning Access network, which investigates level of development of information and communication technologies and state-of-the-art condition of geospatial software availability and own GIS development, Uzbekistan still needs a lot to do on this direction. Internet speed in the country is considered low according to international standards. According to rating of WebSiteToolTester, Uzbekistan took 181th place from 207 countries in internet speed on average (kun.uz, 2020). Mostly, internet culture and telecommunication infrastructure are developed in Tashkent city, whereas regions and local areas has low or no access to internet as well as they have undeveloped telecommunication infrastructure. Uzbekistan plans to launch its own satellite to boost web connectivity and telecommunication quality but so far these criteria have low level of development (kun.uz, 2019).

Within decision criteria, the highest value we assigned to institutional leadership (0.8) and digital cartography availability (0.8). Whereas, the lowest values were assigned to umbrella legal agreement, metadata availability, return on investment and private sector activity (0.2 to each of them). We decided to highly evaluate institutional leadership because CASTCU is the official governmental department, executed by the President and Cabinet of Ministries to implement and maintain NSDI. NGIS-1 project success and capacity of the department make us to believe into success of further development. In terms of metadata availability general culture should be developed, because even many GIS specialists in the country underestimate the importance of metadata and international metadata standards, such as ISO 19115.

In addition, the committee and government should focus on umbrella legal agreement, financial benefits of SDI and the activity of private sector in financing and engagement into geospatial technologies development to increase SDI readiness index and enhance prospects of NSDI.

8.3 Costs and benefits of NSDI for Uzbekistan

Expenditures for NSDI depend on various factors. If the cadaster system and geospatial datasets are constantly maintained and modified by state departments and agencies, responsible for unified system for state cadaster, uniting them into one system will take less time and money. Funding security is vital for NSDI initiative and functionality, many experts mention. Besides basic capital, which is necessary to launch the project and get it to preliminary vision, it is necessary to regularly renew data, support specialists, database administration, taking new ortho-photos after some period of time (Figure 7).

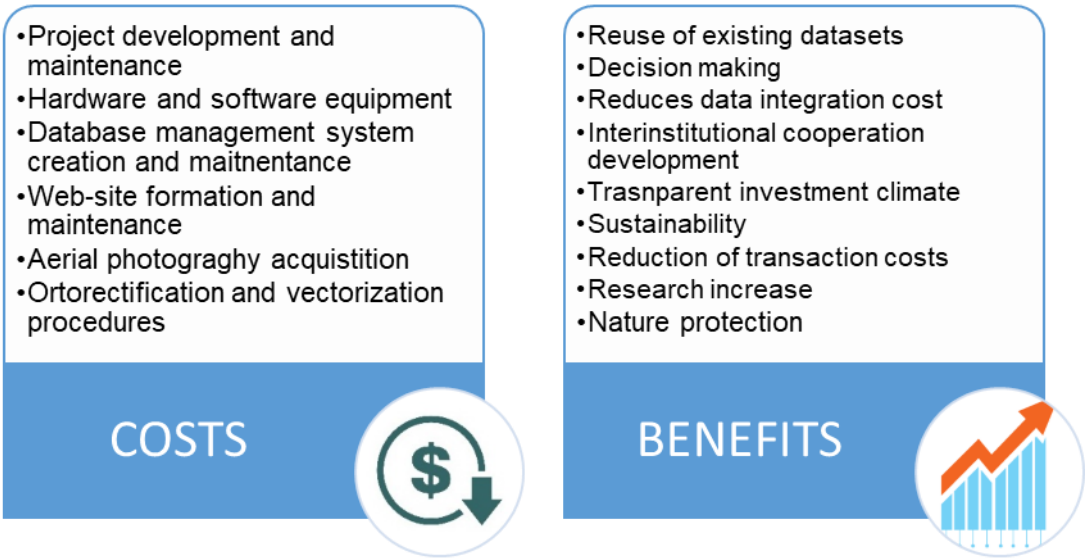

Figure 7. Plausible cost and benefits from NSDI implementation

Although, any SDI requires significant investments for foundation and maintenance, these costs can be fully recovered by financial benefits it generates. Those benefits include increase of resources that are made available for poor citizens; more job opportunities; revealing social and economic discrepancies on national and local scales; facilitating work of local governments and increase of collaboration between departments; fostering scientific research due to free and transparent access to diverse environmental spatial data; reduction of crime; land management and administration; flood mitigation; business development; sustainable urban planning and management; enhancement of infrastructure capacity data; etc. (Atumane and Cabral, 2019; Rajabifard et al., 2004; Nebert, 2004; Kim, 2010; Mansourian et al., 20; Cada and Janecka, 2016).

Several pre- and post- surveys of nations who implemented NSDI show positive boosts in multiple aspects. Kim (2010) states that after the foundation of NGIS in 2002 (National GIS, Korean national clearinghouse) the country experienced improvements in many aspects, including remarkable economic growth and development of ICT technologies.

NSDI can generate notable benefits to the country. According to Oxera (2013) in 2012, global value of geospatial services made up 0.2% from the total GDP. Generally, benefits from SDI can be divided into three categories: social, economic, environmental.

Social benefit derived from NSDI will directly influence to citizens. Stakeholders will have the opportunity to achieve up-to-date, transparent and reliable spatial information from any place of the world. Combination of various thematic layers in conjunction with attributive information can help to reveal social discrepancies in certain region of the country. To exemplify, application of dataset with hospitals location, number of doctors and beds can help to find areas with undeveloped and unsecure healthcare, lack of hospitals and healthcare personnel.

Protection of environment, particularly surface water, groundwater, natural rangelands, forests and biodiversity relies on availability of geospatial resources to the researchers and corresponding departments. Nowadays, aerial photos, satellite images and

unmanned aerial vehicles are widely used for flood and drought management, fire monitoring and prevention, climate change impacts on local and national level, as well as modelling mitigation and adaptation strategies.

8.4 SWOT analysis

The acronym SWOT means strength, weaknesses, opportunities, threats. Strength and weaknesses elaborate internal environment, while opportunities and threats are external factors. A “SWOT analysis is a simple but powerful tool for sizing up an organization’s resource capabilities and deficiencies, its market opportunities, and the external threats to its future” (Thompson et al., 2007). SWOT analyses are widely used as a strategic framework for evaluation of project, start business, decision making, strategic planning, product evaluation or strategy (Gürel, 2017).

In Table 10 we analyzed plausible implications of implementing and running the NSDI for Uzbekistan.

Table 10. SWOT for NSDI implementation in Uzbekistan

Strength	**Weaknesses**
• Several laws and resolutions to support e-government and NSDI initiatives • Credit loan from World Bank and the first credit from South Korea Eximbank • Strong institutional capacity of GKZGDK • Developed Unified System of 21 State Cadasters • Growing awareness of citizens and business about importance of geospatial information • Already created geoportal.uz, which can be further developed	• Centralized governance and small authority of local bodies • Weak ICT and GIS capacity of regions • Lack of qualified specialists (GIS, Photogrammetry, Remote sensing) • Interoperability between local state, central state and departments • Absence of unified geospatial standards

Opportunities	**Threats**
• Economic growth • Sustainable development • Support to the environmental protection • Reducing social and gender inequality • Transparent access to spatial data for all • Creation of new labor market • Crisis management • Foster scientific research	• Political risk • Inappropriate strategy • Lack of human resources • Lack of advertisement • Delays of implementation • Insufficient provision of funds from government • Low spatial data quality • Limited ICT infrastructure • Lack of operational guidance • Lack of participation of departments and agencies • Improper management • Lack of funding for maintenance and development of NSDI

In terms of strength, we consider that multiple governmental initiatives, including presidential resolutions and resolutions of the Cabinet of Ministries, show the government's firm believes in importance of e-government and NSDI as vital part of it. Credit loans purchased from the World Bank for the project "Modernization of Real Property Registration and Cadaster" in 2016 and previous project NGIS-1 (conducted in collaboration with LG-LX and Anse Technologies) can serve as clear examples for that.

Another strength that can support project is strong institutional capacity and unrevealed potential of CASTCU, which is responsible for uniting of 21 state cadasters. In addition, country recognizes growing demand for open geospatial information from citizens, business and research organizations and urgent need to satisfy the needs for data.

Regarding weaknesses, the most concerned issues according our conjecture are weak human capacity and undeveloped ICT sector in periphery. Uzbekistan is known as centralized country with huge discrepancies in economic development, infrastructure, financial capacity, institutional independence. Hence, initiatives for technological innovation and jurisdictional reforms coming from the capital and local authorities have lack or no initiative. Other weaknesses include absence of unified standards and frail interoperability between governmental bodies.

Nevertheless, implementation of NSDI will have multiple benefits at national level. First, NSDI will support economic growth by promoting open access to geospatial data. Thus, it will reduce the expenditures for creation and collection of data, saving of funds through open access to information, more effective and efficient use of spatial data etc.

Besides abovementioned, NSDI will contribute to sustainable development and environmental conservation, reduce social and gender inequality in access for important and up-to-date information. In addition, it will foster labor sector by creating new workplaces in innovation spheres, and it will support scientific researchers that involves GIS analysis.

Major plausible risks are political risks (instability), unfeasible and inappropriate strategy of NSDI, threats of financing for NSDI maintenance. Other threats are such as lack of advertisement, low spatial data quality, insufficient operational guidance etc. (see also Table 10).

9. CONCLUSIONS

As many other developing countries, Uzbekistan experiences fast population growth, uncontrolled and poorly to the environment and water resources, demographic transition, social and political shift. Uzbekistan's government apparently recognizes urgent need for modernization of the country, as well as effective and efficient government in order to achieve sustainable development. The countries endeavor to implement NSDI is clear - social, economic and ecological development and sustainability. From a cost/benefit perspective, any SDI allows geospatial data to be collected once and reused multiple times in different applications by all citizens as a public good. In general, an NSDI can be considered as an important element in the e-government and open-government movement to increase the transparency of governmental activities and to enhance public participation. Better access to geospatial data also stimulates the growth of new businesses, which may not be possible otherwise. After the collapse of the Soviet Union, in the country is still going process of transformation from centralized socialistic bureaucratic management into decentralized market-oriented information management. The NSDI could be a great step forward to a country in building democratic and transparent society. It is well-known fact that economic development of the country relies on mastering new technologies and applying them.

Uzbekistan currently lags behind with its NSDI developments, because the first steps for were made in early 1990s in developed countries (USA, Germany, The Netherlands), whereas nowadays even many developing countries (such as Columbia, Indonesia, Lithuania, Bolivia, Malaysia) has their own national SDI's. Current the readiness of the country was considered low with 0.437 SDI readiness value. However, the possibilities for the NSDI implementation seem promising from economic, social and ecological prospects. It can foster investment climate, maintain gender and social equality in free access to open spatial and other data, promote sustainable development and nature protection.

One of the most important advantages of Uzbekistan's current situation is the opportunity to learn from the experience of both developed and developing countries. Moreover, the experience of developed countries can be useful in the long term, whereas the experience of developing countries in the near future.

In this article, we elaborately analyzed vision, challenges and prospects of NSDI of Uzbekistan. Among challenges and threats to the project implementation, we consider inappropriate and unfeasible strategy, lack of human resources and control staff turnover. Other challenges and weakness include undeveloped ICT infrastructure, absence of unified geospatial standards and centralized governance, as well as small involvement of local and regional governmental entities into the project development.

The risks for the NSDI implementation in Uzbekistan are manifold. They include weak public interest, lack of constant government sponsorship, technical problems, poor strategy, undeveloped geospatial data market, technical failures, a small number of Internet advanced users, lack of use of standards, and weak human resources, difficulty

in access and usability, no differentiation across regions to be considered and law quality of geospatial data. In the long term (with successful implementation and support from the government), new risks may emerge, such as data rights, licensing and service prices, old standards, old technologies, no new strategy.

Therefore, the government that is main responsible legal entity for NSDI implementation, should consider all risks that may occur in the close and far future and prioritize them according to their impact and likelihood. Besides risk assessment, risk management should be developed, involving mitigating actions, monitoring and control. Lack of good risk management was the major reason of the low success of NGIS-1 project and current MRPRC defects. Establishment of NSDI is only the first step, after which follows maintenance and development of it. Appropriate risk management and analysis will ensure a sustainable NSDI development in the long term.

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