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Assessing the Development of Kenya National Spatial Data Infrastructure (KNSDI)

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Abstract

Spatial data plays a vital role in developmental activities, whether natural resource management or socio-economic development. Spatial Data Infrastructures (SDIs) facilitate access, sharing and dissemination of spatial data necessary for complex decision-making processes of the future. Thus, conducting SDI assessment is essential to guide its development, to monitor and improve its quality and to provide evidence of accountability for all stakeholders. Knowledge of the development status of SDI of a country is crucial to increase the accountability and development of spatial data information. In Kenya, there are many organisations both public and private that are involved in spatial data production, use and dissemination to meet needs of the geo-information community. However the developmental status of Kenya National Spatial Data Infrastructure (KNSDI) is unknown. This paper aims at evaluating the development of SDI-initiative in Kenya with an aim of contributing to the enhancement of SDI development to realise its fundamental objectives. Then explore the level to which Kenya is prepared to attain an operational SDI, expose best practices, identify main problems, and review the way forward. Three assessment approaches of multi-view assessment framework were adopted. They are; SDI-Readiness index, Modified state of play and Organisational aspects. Data collection was by interview and questionnaire surveys from 13 KNSDI stakeholders sampled purposively from the following categories; academia, NGOs, public and private sector, civil society, international organisations and government. Document analysis and internet search supplemented data collection. The results indicate that development of KNSDI and implementation in Kenya is ad hoc and fragmented. This paper identified funding sustainability, awareness for SDI and all-inclusiveness communication as major aspects of Kenya NSDI that need to be addressed. The paper suggests that Kenya NSDI secretariat should work towards resolving the identified obstacles by: i) Sustained funding through increased budgetary allocation from the central government and other alternative sources of funding like open source services and cost recovery on geo-information products. ii) Bottom up approach through awareness creation about importance of spatial data for sustainable development.

Keywords: Spatial data infrastructure, Kenya NSDI, development, assessment, multi-view assessment framework, approaches.

1. Introduction

Geographic information plays a major in socio-economic development of our modern society. Its central role in supporting economies and promoting business in both private and public sector, of many nations around the world is evident (Genovese *et al*., 2009). This is because great portion of decisions on natural resource management is spatial in nature. The users, suppliers and value adders to spatial information are increasing every day with diversity of applications aimed at harnessing the economic potential locked in spatial data (UNCEA, 2001). The framework that facilitates, coordination, exchange, accessibility and sharing of spatial data amongst users within the spatial community is spatial data infrastructure (SDI) (Crompvoets *et al*., 2004).

The future of spatial data today is focused on global emerging challenges aimed at improving lives. International organisation like United Nations (UN), Economic and Social Council (ECOSOC) have established programmes on Global Geospatial Information Management (GGIM) that will play a leading role in setting the agenda for the development of global geographic information and to promote the use of geographic information to address key global challenges, such as climate change, food and energy crises, peace operations and humanitarian assistance (Harvey *et al.*, 2012).

SDI provides a basis for spatial data discovery, evaluation, and application for all users and providers with all levels of national governments, NGO's, academia and civil societies. The NSDI of a nation can be used for; network survey of coordinates, waterways, transportation networks (road and railway networks), electricity supply, communication facilities, farming activities, fishing, forestry, tourism, communities to be displaced, and planning of services (Nwilo and Osenwuta, 2004). It is used for handling infrastructure development, economic planning, environmental conservation and monitoring, climate change, design and deliver of public services, and a variety of other challenges facing society. It facilitates data sharing and use among different organisation either with in the nation or abroad.

The increasing awareness on the importance of SDI for national development has led to the establishment of National Spatial Data Infrastructures (NSDI) in many countries across the world. NSDI are being implemented by many nations to better manage and utilise spatial datasets (Rajabifard, 2003). This means that the developmental status of a nation's SDI has to be determined through an appropriate assessment methodology. The results of such assessment are vital for accountability and guide to development of NSDI (Masser, 2005).

1.1 SDI Components and assessments reviewed

SDI is a multiple of entities with varying hierarchical level of infrastructures linked together and consists of five components: access network/technology, policy, standards, people and data (Rajabifard *et al*., 2002). They are considered as the building blocks of the SDI and can be used to classify SDI assessment indicators. The first SDI assessments were done for the purpose of gaining knowledge on SDIs but recently they are aimed at measuring economic benefits of SDIs against accomplishment of intended objectives (Georgiadu and Blakemore, 2006). Assessment helps to

better understand issues and find best practice for certain tasks within SDI and even improve the whole system (Steudler *et al*., 2008). The investment required for development of an SDI according to European community (INSPIRE) at the European national, regional and local levels is estimated to be between 202 to 273 million euros per year (Dufourmont, 2004). Since SDI development, maintenance and operation is a huge investment to the involved institutions, there is need for indicators to judge their success and cost benefits relations. This is an indicator for low pace of SDI development in developing countries.

The involved stakeholders are interested in monitoring both SDI status of development and attainment of its fundamental objectives (Najar *et al*., 2006). To address this, SDI assessment is important as a management control tool that supports accountability, rationalistic investment decisions and efficiency based on quantitative measures (Lance, 2008).

An extensive body of literature on SDI assessment already exists; Delgado and Crompvoets (2008) assessed the development of SDI in Caribbean for sustainable development in order to check on its development status, Makanga and Smit (2010) reviewed the status of SDI implementation in Africa with an objective of advising on SDI development on the continent, Delgado et al. (2005) developed SDI-Readiness approach that measures the degree to which a country is prepared to deliver its geographical information to the community, Crompvoets (2006) developed a clearinghouse suitability approach which examines the developments of existing national spatial data clearinghouses around the world, (Kok and Van Loenen, 2005) designed the organisational assessment approach which describes, identifies and compares the status of the organisation aspects of NSDI. All this assessments were aimed at verifying the development of SDI in line with attainment of its objectives.

1.2 Multi-View assessment framework and selected assessment approaches

SDIs have been defined differently by different researchers at different times. This indicates the multifaceted character of SDIs (De Man, 2006). Grus *et al*., (2010) agrees that SDI assessment remains problematic due its nature which is multifaceted, dynamic, and complex with vaguely defined objectives.

The multi-view assessment framework treats SDI assessment from different viewpoints. Its core objective is to measure the multiple facets of SDI and its complexity in terms of multiple definitions. The assessment framework is capable to reduce bias in assessment results on the side of evaluator and at least achieve one of the three purposes of assessment: accountability, knowledge and development (Grus *et al.*, 2010). In order to assess the multifaceted nature of SDIs a multi-view assessment frame work is proposed by (Grus *et al*., 2007).

Multi-view combines several SDI assessment approaches developed to assess a different aspect of an SDI they include: Clearinghouses suitability assessment, Crompvoets et al. (2003); the Organisational assessment approach (Kok and Van Loenen's, 2004); the SDI Readiness assessments Index (Delgado *et al*., 2005); The Performance-based assessment, (Giff, 2006); The Cadastral assessment (Steudler *et al*., 2004), and The INSPIRE state of play assessment

(Vandenbrouck and Jansse, 2008). All of these approaches cover the three purposes of assessing SDIs: Accountability, knowledge and development. According to Grus *et al*., (2008) only four operational approaches: Clearinghouse suitability (to measure the development and impact of SDI clearinghouse worldwide), SDI-readiness (to assess the country readiness to embrace the SDI development), INSPIRE state of play (to measure status and development of SDI) and Organisational approach (to measure SDI development from institutional perspectives) are fully operational and applicable in SDI assessments.

1.2.1 SDI-Readiness Approach

The SDI-readiness approach integrates factors from various points of view: organisational, national legal agreements, information, access networks, people and financial resources. Each of these factors consists of different indicators that are quantitatively measured (Delgado *et al*., 2005). Concerning the access network particularly the web connectivity and telecommunication infrastructure and people's point of view the human capacity is normally taken from UN Global Survey which is conducted regularly in order to determine E-Government readiness that is assessed by all UN member states. Delgado *et al.* (2005) defined the E-readiness of a country as the degree to which a country is prepared to participate in the network world. According to Grus *et al*. (2007) the SDI readiness approach is an existing model that assesses whether a country is ready to embrace SDI development.

This approach is very crucial to identify a strategy to address the basic obstacles of SDI development in any country regardless of the national development. The SDI-readiness index is calculated based on the value of the 16 indicators of SDI readiness (Table 1).

Table 1: SDI-Readiness measurable factors adopted from (Delgado *et al*., 2005)

Assessment Global factor	**Decomposed Decision Criteria**
Organisational	Politician vision regarding SDI
	Institutional leadership
	Umbrella legal agreement
Information	Digital cartography
	Metadata availability
People	Human capital
	SDI Culture/education
	Individual leadership
Access Network	Web connectivity
	Telecommunication infrastructure
	Own geo-information development
	Geospatial software availability
	Open source culture
Financial Resources	Government central funding
	Data policy aimed to return on investments
	Enterprise and private sector funding

1.2.2 The Organisational approach

The organisational assessment approach is based on the work of Kok and van Loenen's (2004) research. This assessment approach measures the development of an SDI from the following aspects: vision, leadership, and communication, self-organising ability, awareness, financial

suitability and status of delivery mechanisms (Grus et al., 2010). The core value of this assessment is its ability to improve performance mainly the outcomes and drive tangible organisational results. Most organisations view their performance in terms of effectiveness, efficiency, and financial viable in achieving their long term vision and mission (IUCN, 2004).

1.2.3 Modified state of play

The Modified state of play approach assesses seven SDI aspects: organisational, people, policy (legal issues and funding), data and metadata, access services, standards and thematic environmental data. The State of play assessment approach is a study developed to describe, monitor and analyse activities related to NSDI in 32 European countries- 25 EU member states, 3 candidate countries and 4 EFTA countries (SADL, 2006; Nuish, 2012). This does not mean the state of play assessment approach is used only in the mentioned above countries but it can be used in regions outside Europe. The State of play approach and methods can be used in other continents like Africa to assess the status of the six building blocks of SDI-legal frameworks and funding, reference data and core thematic data, metadata, access and other services, standards along with the thematic environment (SADL, 2005). This approach uses country reports, website visits and contacting key informants in the country as data collection methods. Grus *et al*., (2008) used for this approach.

1.3 NSDI situation in Africa

SDI development depends on cultural needs, social evolution, economic reality and national ambitions. According to Mavima *et al*. (2001) SDI development requires expertise from different multidisciplinary such as social science, system design and development, information technology and other disciplinary. The development of SDIs involves a wide cross- section of partners from various organisations and institutions each with various perspectives relative to how well an SDI is meeting its needs (Crompvoets *et al*., 2008).

Of late different countries have developed NSDI to better manage and utilise spatial datasets. In April 2005, 83 countries develop NSDI clearinghouses on the internet (Crompvoets *et al*., 2007). This indicates the willingness of different nations to participate and take ownership of NSDI initiatives. The increasing number of the national clearinghouse is the best indicators for the development of SDI. Different countries are launching SDI at different levels ranging from corporate, local, state, national and regional to a global level, to better manage and use spatial datasets Crompvoets and Bregt, (2003). Makanga and Smit (2010), prove that only two African countries (Kenya and Chad) had developed their National clearinghouse in 2003. Five years later in 2008 three countries namely: Chad, Kenya and Gabon had developed NSDI clearinghouse (Crompvoets *et al*., 2003) and are not operational.

Makanga and Smit (2010), applied a methodology similar to the INSPIRE state of play and found out that the development of African NSDIs are still at infancy as it can be epitomised by only few countries with reasonable funding for NSDI, reasonable political support and legal frameworks for NSDI. According to Musinguzi et al., (2004) factors such as lack of an efficient ICT

infrastructure, trained human resource, lack of coordination of various GIS activities and lack of funds are more relevant to NSDIs in developing countries like Kenya.

The concept and technology of Kenya NSDI started in the year 2001. However, its status in comparison with other African countries is Average. According to Mulaku et al., (2006) with the exception of South Africa, the other African countries are still in the phase where the policy and legislation, institutional partnerships, databases and metadata, standards, technology and personnel are under development (Table2).

Table 2: NSDI Development status in Selected African Countries (Mulaku et al., 2006)

Country	Approx. NSDI initiative start date	Development status
Algeria	1996	Average
Senegal	1996	Average
South Africa	1997	High
Tunisia	1998	Average
Ghana	1998	Average
Botswana	2001	Average
Kenya	2001	Average
Ethiopia	2002	Low
Nigeria	2002	Average
Mali	2002	Average
Uganda	2003	Low
Tanzania	2003	Low

1.3 Best practices for KNSDI initiative in Kenya

1.3.1 Standards

The development of KNSDI Standards was started with a stakeholders seminar referred to as KNSDI Standard Seminar I held on 29th November 2006. The aim of the seminar was to sensitise the stakeholders on the need to formulate KNSDI standards. For the KNSDI project, 6 standards were adopted from the KSISO 19100. The decision of what standard to adopt was based on; compatibility of the standards with the Kenyan geospatial data, users' technical level and consistency with technical conditions of international standards. The six standards comprise:-

KSISO 19101.GI – Reference model
KSISO 19109 GI – Rules for schema
KSISO 19111 GI – Spatial referencing by coordinates
KSISO 19113 GI - Quality principal
KSISO 19114 GI - Quality evaluation procedures
KSISO 19115 GI – metadata

They were compiled to constitute Kenya Profile for Geographical Information Standards (KPGIS). The profile which is a set of rules extracted from standards to form a document. The practical situation however, is that efforts towards standards implementation for Kenya NSDI have been done but not sufficiently to high development status the opinion held by (Mulaku et al., 2006; Owino, 2005). The adopted standards are based on ISO/TC211 and they are practically applied in mapping.

1.3.2 Fundamental datasets and metadata

Most of Kenya NSDI development efforts have been on data and standardisation but in essence a lot of data exist in analogue format and only 63% of Kenya is mapped by 1:50,000 topographical scales. Digitisation efforts were spearheaded by the joint cooperation of JICA (Japan international cooperation agency and ICRAF (International centre for research in Agroforestry) together with Kenya government but are slow and are affected by technical expertise and financial resources. Although it's an effort that has seen most datasets that cover Nairobi now in digital format most datasets are in analogue format. KNSDI have formulated the following fundamentals datasets; Geodetic control, Hydrology, Vegetation, Utilities, Geographic names, Elevation, Transportation, Administrative boundaries, Parcel boundaries and Digital imagery. Spatial datasets in Kenya are produced by different organisations including the government ministries but there is no systematic way of access and sharing. (Mulaku et al. 2006) describes this situation as lack of customer orientation and a culture of resistance to share data and information. This is because no single agency can satisfy its spatial data needs solely. Furthermore, available datasets are in various formats (analogue) and standards, making data integration difficult and time-consuming. There is no appropriate policy, institutional and legal arrangements on data sharing, access and exchange (Kalande and Ondulo, 2006).

1.3.3 Developing resources for GIS dissemination

Mechanisms of disseminating geographic data to potential users were developed, to justify economic investments in the collection, storage and management of data to be attained. Embarking on collecting and storing data in whatever form is not good enough. The data need to be shared widely and made easily accessible to users (Murage et al, 2008). Resources for disseminating geographical data includes the high speed carrier capable of providing bandwidth on demand, the internet, computer hardware, relevant GIS software, geographical data, metadata, human capability, Clearing House or GIS Portals and servers, search and access protocols, policies and guidelines for data sharing. The KNSDI Clearing House was developed using ESRI GIS Portal Toolkit, a software development kit for a GIS Portal (SDK), GIS Portal components and GIS Portal Building blocks. KNSDI GIS Portal used the following software; ESRI ArcGIS Desktop 9.2, ArcSDE 9.2, ArcIMS 9.2; for the Database, SQL Server 2000 was used; Web Server used is Apache 2.0.58; Sevlet Engine is Tomcat 5.5.17 and the development Kit is JavaSDK 1.5.0_06.This resources are however not operational.(www.knsdi.go.ke).

1.3.4 KNSDI policy

A workshop, facilitated by JICA Office Kenya, was convened by Ministry of Lands and Housing on 30th November 2005 to chart the way forward for the formulation of Kenya National Spatial Data Infrastructure Policy (KNSDI). The workshop was attended by over 70 participants from public and private sectors. Prior to this workshop, three other workshops had been held in the last three years to initiate the process for the establishment and coordination of the National Spatial Data Infrastructure (NSDI).

The outcome of these workshops was the creation of awareness among key public and private sector stakeholders on the importance of the establishment of National Spatial Data Infrastructure in socio-economic development of the country and the establishment of the Working Groups (Standards, Legal, Education and Dissemination) to develop objectives, implementation mechanisms and coordination of their respective NSDI components. Unfortunately these Working Groups were active for a short time after their formation and for the last two years they remained moribund. The 30th November 2005 Workshop was convened as a result of a Circular of April 2005 from the Office of the President to all Ministries and Public Institutions which directed the development of fundamental spatial data infrastructure to enhance e-governance and due to the on-going Land Use Policy Formulation Process which has identified the urgent need and importance of establishing a Land Information Management System (LIMS). The workshop was officially opened by the Permanent Secretary in the Ministry of Lands and Housing. It was also addressed by JICA Kenya Deputy Resident Representative. Apart from presentations on the fundamental concepts of NSDI, e-governance and review of the outcome of the previous NSDI workshops, the workshop focused on the process for the formulation of the NSDI policy for Kenya.

1.3.5 GIS education establishment

The launch of MSc. GIS and Remote Sensing Science at University of Nairobi in early 1996 was a historical landmark for the development and evolution of GIS technology in Kenya. GIS and Remote Sensing specialisation was started in the School of engineering department of Geospatial and Space technology for MSc students. At the time of the establishment of GIS and Remote Sensing discipline different thematic data were available. Among these land use and Landover classification maps, soil types and natural resources maps, infrastructures maps (roads, electric lines, telephone towers, and etc.), spatial location of towns, localities, tourist sites and parks, drainage, topographic digital elevation model and population density. The institutions of learning in Kenya have been motivated by the central government to start GIS and Remote sensing courses, they are; technical university of Kenya at Bachelors, and Jomo Kenyatta University at MSc. Level among others. The graduate students from these institutions are employed in various Ministerial and Regional organisations that are involved in data production, sharing and dissemination. For instance, majority of the staff at Survey of Kenya; the National Mapping Agency are GIS and remote sensing professionals. The increasing number of GIS and RS experts in various organisations offers another opportunity to develop geospatial professional organisation like the GIS Society of Kenya. Due to the above facts the key stakeholders of NSDI selected the establishment of GIS and remote sensing at University of Nairobi as one of the most historical events that can be considered as a major KNSDI milestones. The expansion of GIS and remote sensing science at higher institution in Kenya attract the attention of skilled manpower towards the GIS technology which is crucial for Kenya's development.

1.3.6 KNSDI Co-ordination

Co-ordination this is possibly the most important aspect of an NSDI because without it all the other ones would either not happen or do so in a very fragmented and inconsistent way. Co-

ordination requires both a long strategic plan and vision necessary to develop and maintain political support, ensure policy integration, and inclusion of different sectors and levels of stakeholders, and an operational function needed in the day-to-day initiatives and projects, including capacity building, education and training, and technical implementation. Survey of Kenya; the National mapping agency was nominated and agreed upon by all KNSDI stakeholders to coordinate the activities of KNSDI, this has been major stride in KNSDI development.Table3 indicates KNSDI activities coordinated by Survey of Kenya so far.

Table 3: Review of workshops/seminars adopted from (Kalande, 2010)

Workshop/Seminar	Date	Agenda
1	12-11-2001	Selection of KNSDI lead agency-Survey of Kenya
2	26-4-2002	Constitution of KNSDI working groups
3	10-9-2002	Launch of KNSDI website www.knsdi.go.ke
4	30-9-2005	Unveiling of KNSDI policy
5	29-11-2006	Strategising to strengthen use of GIS in Kenya
6	4-7-2007	KNSDI standards
7	21-2-2008	Standards in data sharing and building
8	19-8-2009	Adoption of KNSDI policy

2. Adopted Methodology

This study adopted multi-view assessment framework by (Grus et al., 2007). Three multi-view assessment approaches used are: Organisational aspects, SDI-readiness and Modified state of play. Data was collected from 13 KNSDI stakeholders sampled purposively (Table4) from the following stakeholder categories; Academia, Non-governmental organisation, International organisation, Public and private sector and Civil society. This number was found suitable and more representative based on the six registered KNSDI stakeholder categories.

The stakeholders interviewed were mainly heads of GIS department and are involved in KNSDI activities. Interview survey, questionnaire and expert discussions to probe for details were mainly used in data collection for multi-view assessment approach indicators. Document analysis and internet search were also used for best practices of KNSDI. This process was guided by indicators of each assessment approach and reported based SDI components.

Table 4: Sampled KNSDI Stakeholders

Stakeholder category type	Number sampled	Percentage %
Government	4	32
International Organisations	2	15
Civil Society	2	15
NGOs	2	15
Academia	2	15
Public and Private sector	1	8
Total	**13**	**100**

2.1 Organisational aspects approach

The organisational assessment approach focuses on measuring the institutional development aspects of SDI based on 6 indicators like: Leadership, Inclusiveness and communication, long strategic plan vision, Self-organising ability, Awareness for GII and financial sustainability. These

broad based indicators were decomposed into 11 more specific measurable indicators that were scored against two optional answers yes or no by the sampled stakeholders. The results were summed according to optional answers and 6 indicators.

2.2 SDI-Readiness approach

SDI-readiness approach has 16 indicators that measure different components of NSDI. Three indicators; human capital, web connectivity and telecommunication infrastructures index were taken from the United Nations e-Governance Survey results of 2008 (UN,2008) for this research while data for the remaining 13 indicators was collected from key stakeholders in the form of questionnaire survey and interview. Each of this indicators were scored against the following optional answer statements that were weighted as follows; extremely high (0.99 points), very high (0.8 points), high (0.65 points), medium (0.5 points), low (0.35 points), very low (0.2 points), and extremely low (0.01 points).The results were then processed using the Delgado et al. (2005) formula to give the overall result of the KNSDI-readiness value.

2.3 Modified State of Play approach

The modified state of play was adopted from Inspire state of play approach of multi-view assessment framework. This was modified to 8 indicators and categorised according to SDI component; people, policy, data, technology and standards.

Table 5: SDI components and measurable indicators

SDI Components	No.	Measurable indicator
KNSDI coverage **People-1**	**1A**	Territorial coverage of KNSDI is truly national.
Degree of operationality **People-1**	**1B**	One or more components of KNSDI have reached a significant level of operation.
Coordination **People-1**	**1C**	The officially recognised coordinating body of KNSDI is a National Data Producer, i.e. a National Mapping agency.
Participation **People-1**	**1D**	There exists partnership between private sector and public towards KNSDI development.
Legal issues and Funding **Policy-2**	**2A**	There is a legal framework governing spatial data pricing.
	2B	There is a legal framework or policy for data sharing and use.
	2C	The long-term financial security of the SDI-initiative is secured.
	2D	There exist personal use licenses for spatial data.
Data-3	**3A**	Most spatial datasets are available in digital format.
	3B	Metadata is captured for most of the spatial data that is created.
Access Services **Technology-4**	**4A**	There are one or more web mapping service available for core spatial data
	4B	There is a clearinghouse(s) that communicates most of the available data resources.
	4C	There are one or more on-line services to download core spatial datasets.
Standards-5	**5A**	The SDI-Initiative is devoting significant attention to standardisation issues.
	5B	The data creation process is formally standardised for all data.

The indicators were further decomposed into 15 more measurable indicators (Table 5) which were scored by sampled stakeholders against four optional answers; i) in full agreement, ii) in partial agreement, iii) not in agreement and iv) no sufficient information for assessing. The scores

of all indicators are presented in an assessment matrix (figure 3) adopted from Inspire state of play to reflect development of different components of the KNSDI.

3. Results and Discussions

The results are presented as per multi-view assessment framework approach and KNSDI components.

3.1 Organisational approach results

Figure 1 presents the summarised results of 11 indicators of organisation approach. The result indicates strong agreement on the presence of long strategic plan vision and leadership for KNSDI with 92% respondents agreed to the statement. The main reason for this agreement is that the Survey of Kenya, the national Mapping Agency has developed long-term strategic plan vision of KNSDI and discussed it with all key stakeholders in the country. Concerning the awareness for GII of the citizens on the KNSDI, majority of the respondents (85%) answered no. This indicates that the people of Kenya have low awareness on the KNSDI Initiative as well as its activities. The overall development of organisational issues indicates the status of leadership, and strategic plan is on good development path. However, the indication on Inclusiveness & communication channels, self-organising, financial sustainability and awareness of the Kenyan people is relatively low. This could be attributed to different people's opinion compared to organisations involved in KNSDI activities.

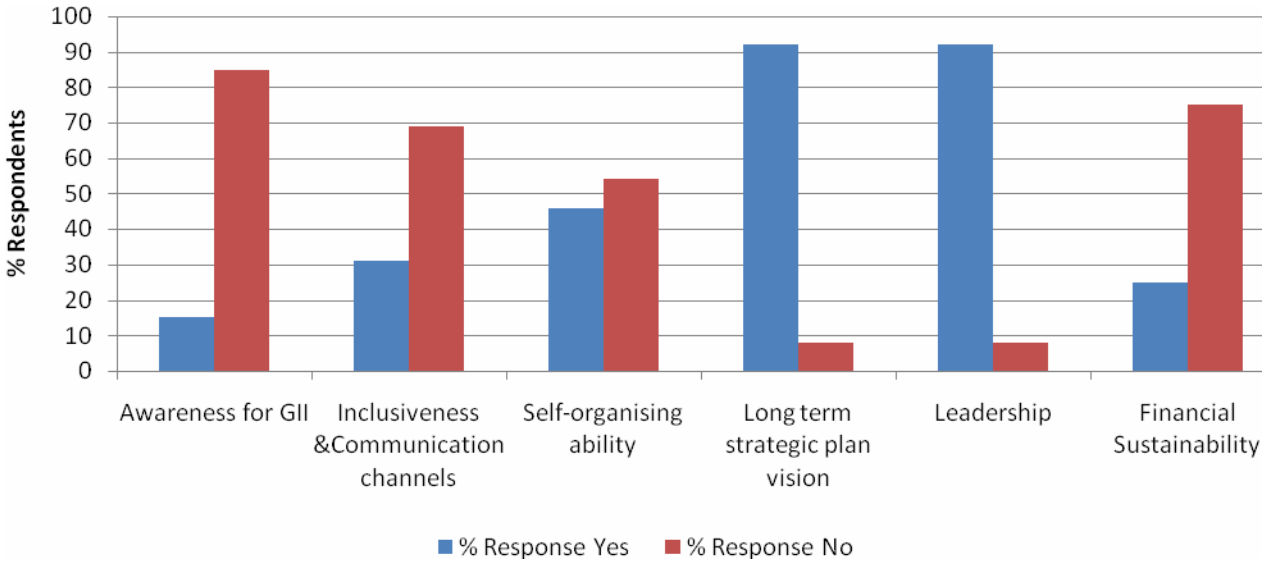

Figure 1: Organisational aspects of KNSDI

3.2 KNSDI-Readiness results

Figure 2 shows the assessment results of 13 respondents of KNSDI stakeholders based on the SDI-readiness approach. The results indicate that there is great variation of results among the stakeholders. The lowest and highest score of KNSDI-readiness is 33% and 50% respectively. The average sample value of KNSDI-readiness is 39%.This suggests that the NSDI of Kenya is not well

developed due to constraints of technological developments especially in web connectivity and associated infrastructures. On the other side these results show that the country is not well prepared to deliver the spatial Data Infrastructure to geoinformation community.

In addition to low level of technological development, human capital index of Kenya is also extremely low 0.38. The SDI-Readiness score of 39% in comparison to expected score of 100 % maximum is obviously very low. This result agrees with results of Mulaku et al. (2006) which indicated low technological development of KNSDI hence need for partnership with donor countries such as China and Japan for aid to develop technological aspects of KNSDI.

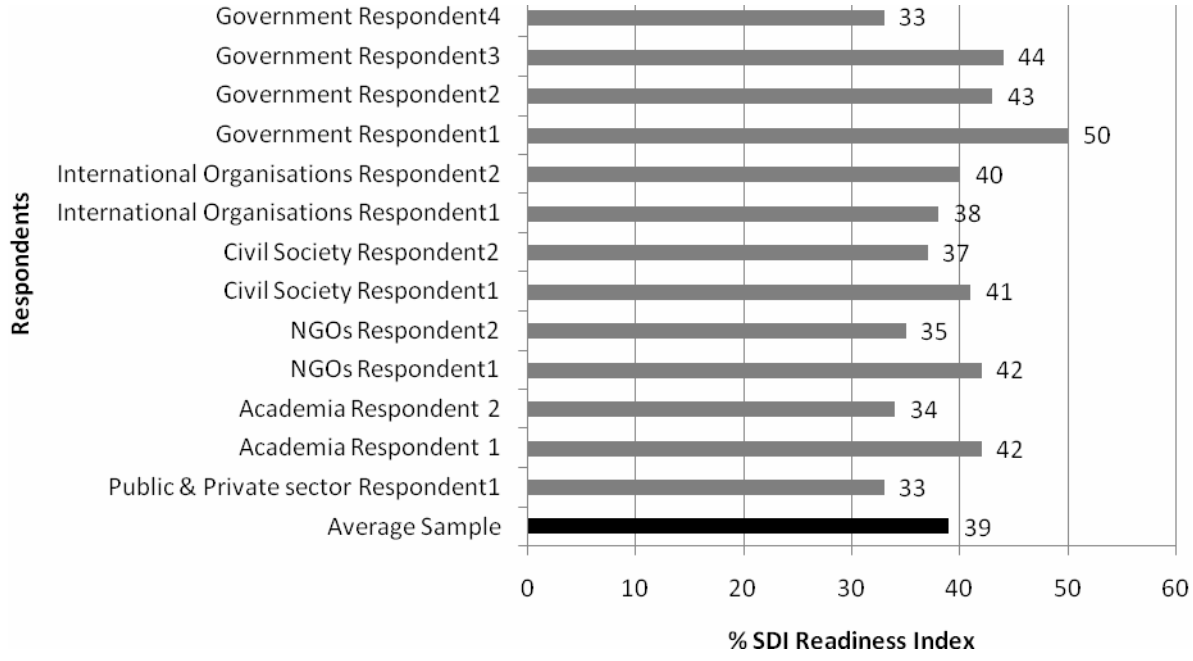

Figure 2: SDI-Readiness index value

3.3 Modified State of Play results

Table 6 shows scores in assessment matrix adopted from Inspire state of play. The colors in the assessment matrix indicate whether the respondents are in full agreement, in partial agreement, not in agreement and have no sufficient information for assessing the measurable indicators in table5. The summarised results in figure3 indicates that KNSDI coverage is not truly national, 54% of the respondents are not in agreement while 23% have no sufficient information for assessing. This is because most of KNSDI activities are only concentrated in Nairobi. There is need therefore for awareness creation to county level on the KNSDI activities. None of the KNSDI components is developed to operational level with 62% of respondents answering not in agreement with the statement while 31% have no sufficient information for assessing. This means that more efforts need to be put in place to develop at least one component of KNSDI to operational level. Survey of Kenya is an officially recognised coordinating body of KNSDI with 69% of the respondents in full agreement with the statement. This is because survey of Kenya is the national mapping agency in Kenya and the national spatial data producer.

Partnership between private and public sectors towards KNSDI development related projects is not feasible in Kenya with 69% of respondents not in agreement while 31% have no sufficient information for assessing. There is need for KSNDI secretariat to forge partnership mechanisms in its activities; this partnership could be forged with donor countries such China, Japan through JICA which have shown interest in working with them. The international organisations such as ICRAF and ILRI can assist them in digitisation of their records.

Table 6: MSOP Assessment matrix results of KNSDI

	People				**Policy**				**Data**		**Technology**			**Standards**	
Respondents	**1A**	**1B**	**1C**	**1D**	**2A**	**2B**	**2C**	**2D**	**3A**	**3B**	**4A**	**4B**	**4C**	**5A**	**5B**
RS 1															
RS 2															
RS3															
RS4															
RS5															
RS6															
RS7															
RS8															
RS9															
RS10															
RS11															
RS12															
RS13															

In full agreement
In Partial agreement
Not in agreement
No sufficient information for assessing

RS Respondent

Access services/technology all measurable indicators on this component scored varied opinions from the respondents but none indicated full agreement with statement indicating that no development has been done on download, discover, invoke, viewing and transform services although there is an inactive clearinghouse. This result conforms with Mulaku et al.,(2006). This is attributed to either less technical experts on the side of survey of Kenya staff or lack of funding and operating infrastructure development. Especially internet problems in Kenya, although survey of has been able to acquire wireless internet instead of ADSL which is prone to cable vandalism and fluctuations.

Most of the spatial datasets in Kenya are not in digital format with only datasets covering Nairobi city in digital as indicated by 62% of respondents in partial agreement with the statement, this is because of joint digitisation cooperation between survey of Kenya and ICRAF while the rest

of the country is still in analogue format. Most of the indicators that measure policy scored varied responses from respondents with 62% having no information for assessing on personal use licenses.

Long-term financial security of KNSDI is not secured with 69% of respondents are not in agreement with the statement, legal framework for spatial data pricing, sharing and use all seem not to exist in KSNDI. This is due to delayed enactment of KNSDI policy by parliament.

KNSDI is devoting a lot of its activities on standardisation with 77% of respondents in full agreement with the statement. The reason is that Kenya NSDI has developed standard specification manuals, prepared Kenya geographical information profile (KPGIS) and established standards working group. Kenya SDI secretariat also adopted 6 standards KSISO 19100. The adopted standards are based on ISO/TC211. Data creation process of KNSDI are not standardised with 77% of respondents are not in agreement with the statement. This is because of less efforts of digital data conversion at KNSDI.

4 Conclusions and Recommendations

4.1 Conclusion

The aim of this study was to assess the development of KNSDI. This paper highlights the key assessment findings as:

- The low value of KNSDI-readiness index is a clear indicator that KNSDI is not ready to give spatial data infrastructure to the people of Kenya. This is due to low level of web connectivity and IT infrastructures, and human capital index.
- Kenya has realised a strong KNSDI leadership through survey of Kenya and long term strategic plan vision to develop KNSDI but, it still faces challenges such as: lack of long-term financial security, inadequate trained geoinformation scientists, low level of technological development, serious lack of awareness among Kenyans on KNSDI and poor all inclusive partnership between private and government in data sharing in implementation of KNSDI.
- The access services/ technology component of the NSDI is poorly developed. The other problems identified were shortage of digital data and non existence of metadata. There are good efforts in place for development of KNSDI standards.

All this lead to the conclusion that the developmental status of Kenya NSDI happens to be ad hoc and fragmented in most of its components. However, there are efforts towards its development which are rather piecemeal or slow.

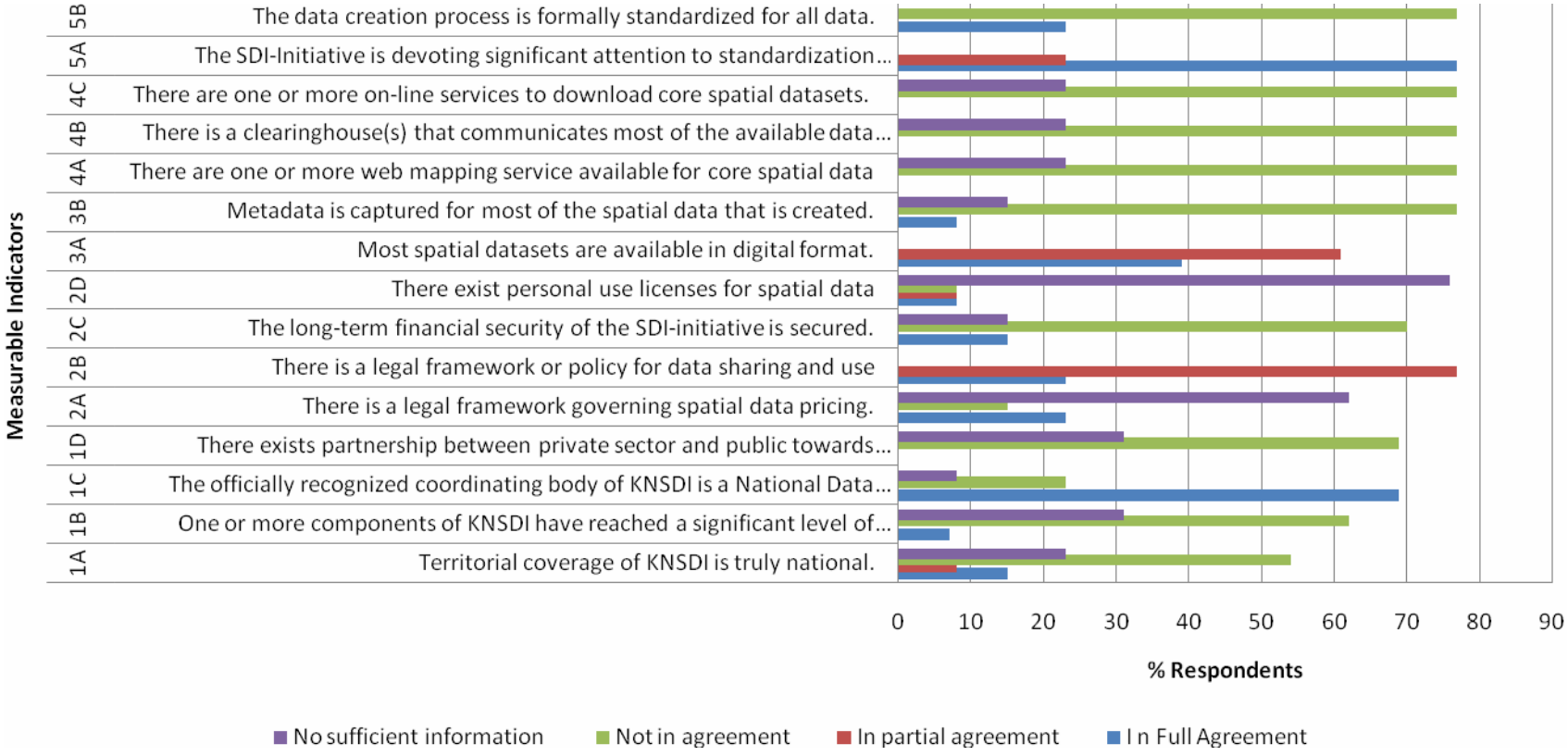

Figure 3: MSOP Summarised Results on KNSDI

4.2 Recommendations

The Kenya government should play a major role by providing and increasing financial assistance to Kenya NSDI. This can be achieved through increased annual budgetary allocations. It will also be important to initiate other alternative funding sources like cost recovery and enterprise/ private sector funding mechanisms including donor funding;

Partnership amongst institutions of KNSDI should be encouraged and focus on the improvement of technology services like download, view, discover and transform services together with connectivity. It is also crucial to increase the availability and provision of digital data on all thematic and environmental data;

The KNSDI secretariat should initiate awareness of all stakeholders on the importance of SDI for sustainable development of the country through workshop, seminars, mass media and other mechanisms; the higher institutions in the country should be encouraged to develop GIS curriculum to facilitate skilled man power in the area of SDI for the country and the trained professionals should be retained to work in survey of Kenya by offering good pay to them;

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