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Analyzing the nexus between Spatial Data Infrastructure Development and e-Government

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Abstract

The development of spatial data infrastructures (SDI) is crucial for the delivery of government services through linking service providers with users. The paper describes SDIs and their core components to help analyze the current status in the development of National Spatial Data Infrastructure (NSDI) for Zimbabwe. It is noted that though the development of SDI in Zimbabwe has been moving at slow pace, the emergence of the e-Government portal could be the basis for the development or a build up to the fully-fledged SDI development. This study recommends the development of spatial data infrastructures for e-Government services to allow geospatial data to be collected and reused multiple times.

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1. Introduction

Spatial data infrastructure (SDI) is the infrastructure that facilitates the discovery, access, management, distribution, reuse, and preservation of digital geospatial resources (Hu & Li, 2017). Given the prevailing economic climate in the country, SDI presents a powerful tool that Zimbabwe needs to attract investors in pursuit of economic recovery, with investors openly accessing information to build confidence for decision making. This research seeks to review the current position of Zimbabwe regarding SDI. The paper will also help to raise awareness on the importance of developing e-Government platforms with SDI component, for easy public access to interactive data and respective geographic locations.

2. Major components of a typical Spatial Data Infrastructure (SDI)

The components of an SDI include; geoportal, metadata, data standards, geospatial interoperability, web service, organizational structures and people.

2.1. Geoportal

Geoportal is a gateway website through which people can search, discover, access, and visualize the geospatial resources within an SDI. Geoportals are web gateways that provide one-stop access to geospatial resources as they are the main interfaces through which people can search and find geospatial resources (Nebert, 2019). They are sites connected to web servers that provide metadata on their geographic data or services. There are three distributed components of a geoportal as illustrated in table 1, these are;

i. A website which present the geographic application or portal.
ii. Web services which publish the geographic functionality as a web service.
iii. Data management software which manages relational environment for both raster and vector content.

Table 1. Geoportal Architecture: (Mohamed et al. 2010)

Component	Element	Environments	Functions
Web Portal	Website	HTML, HTTP, XSL, ASP, XML, JS	Search, map viewer, publish, administrate
	Web Controls	Java Beans, NET	Query, geocoding, mapping, edit
Web Services	Geographic Web Services	XML, SOAP, WSDL, WMS, WFS, GML	Query, map render/feature, transaction, geocode
Data Management	DEMS	SQL	Raster, vector, tabular
	Geographic and tabular data		

The initial interface of the geoportal may contain a search bar that allows users to enter keywords in order to find relevant resources. A database management system (DBMS) is used to store and manage the metadata of the geospatial resources contained in the SDI.

2.2. Metadata

Metadata are essentially important for SDIs. Metadata refers to the documentation about who, when, how, what, why, and many other facets of the data including the data production process. Metadata can be used for describing not only data, but also tools, services, and other geospatial resources. Mavima (2000) cites that metadata provide documentations on the content and the production process of geospatial resources, and this data includes titles, descriptions, data categories, the locations and time of the data collection, the data collectors, the coordinate systems used and map projections, as

well as data cleaning and processing procedures. When data and services are integrated into an SDI, metadata provide the primary information based on which GIS users can understand and use digital geospatial resources (Maphale, 2019). Hence, a well-constructed metadata makes it easy for data and services to be reused.

2.3. Metadata/Data Standard in Geospatial Industry

Data standard is a component of SDI which provides an outline of a commonly agreed design on how data should be recorded and described (Nebert, 2019). Embedded within the SDI is the geospatial interoperability and web service. Geospatial interoperability focuses on the ability of different geographic information systems to share, exchange, and operate geospatial data and functions (Sjoukema et al., 2020). Web service is also important as provides standardized application programming interfaces to allow remote access to data and functions over the internet.

Regarding SDI, Siebritz & Fourie (2015) recommends the creation of vertical and horizontal information highways to enable stakeholders from different organizational structures and institutions to share data in order to avoid duplication and redundancy at the different levels. This approach to recycling information through different levels of the spatial data infrastructure will ensure that datasets are current and compatible.

The issue of metadata is premised on the discovery of existing data, the availability of correct datasets, and the process of obtaining the data (ESRI, 2010). Therefore, standards for datasets are also essential. Data standards involve creating data transfer from the service provider to the user, and ensuring the service provider keeps responsibility over data, while users may be allowed to look into the provider's dataset (ESRI, 2010; Nebert, 2019).

Therefore, in order to realize the full implementation of SDI, Mwange et al (2018) suggest the need for the provision of adequate funding, advancement in SDI Research and innovation, incorporating fundamental datasets and metadata within relevant organizations, as well as cross-departmental workshops, seminar events and SDI partnerships.

3. Assessing the current status of SDI in Zimbabwe

Zimbabwe, among other African countries continues to be faced with some developmental issues which according to research could be resolved through open access to spatial data (Mwange et al., 2018). Research results have shown that SDI is not yet at an acceptable level in most developing countries whose economies are weak. However, laws and administrative regulations have been put in place to give exclusive directives to government departments to carry out some of the activities that contribute to the SDI initiative (Paradzayi, 2005).

The initiative to establish a functional spatial data infrastructure (SDI) in Zimbabwe began in the late 1980s, but lack of awareness of SDI issues, technical skills, and lack of government support, among other factors, has contributed to this slow pace of development (Maphale & Smith 2021).

The National Spatial Data Framework (NASDAF) was stablished in 2000, mainly comprising of GIS professionals and some government officials. However, the objectives of the body were not realised due to inadequacy of resources and an

environment that was not conducive for long-term activities (Mavima, 2000). The Zimbabwe Metadata Working Group was then formed following a meeting at the SADC Regional Remote Sensing Unit (RRSU) in 2003, with representatives from Scientific Research Institutes, NGOs, Private GIS companies, Government departments and universities in Zimbabwe.

Despite some of the current problems hampering the establishment of a legal spatial data infrastructure, some of the efforts that have been undertaken by the Zimbabwe Spatial Data Infrastructure practitioners towards the formalization of a legal Zimbabwe Spatial Data Infrastructure Framework have been realized (ESRI, 2010). A research conducted by Useya et al. (2014), found out that there exist in the private and public sectors, spatial data users and producers who are already exchanging information. The findings also noted that there was willingness among participants to have the SDI for Zimbabwe, though the process is being accepted at a slow pace.

A study conducted by Ogunbiyi (2021) on the review of the status and technological trends of SDI developments within five Southern African countries which include Zimbabwe, South Africa, Botswana, Tanzania and Malawi, findings are that SDI implementation process in Zimbabwe is still at the early stages and there are no formal SDI activities apart from the country reports. Meanwhile, Zimbabwe has managed to produce topographic base maps and other thematic maps, maintenance of National geodetic control network and the implementation of Zimbabwe geospatial tool.

4. Development of the e-Government Infrastructures (Web Portal)

This section seeks to assess the e-Government Portal for Zimbabwe as a stepping stone for the development of a SDI. Meanwhile like other governments, Zimbabwe developed its web portal which is a build up to a comprehensive national SDI. A government website can be part of an SDI if it provides access and interoperability to locational data.

According to Geospatial Data Act (2018), national SDI shall ensure that geospatial data from multiple sources is available and easily integrated to improve the understanding of the environmental and social set up. From the Government Web Portal interface in figure (1), it is noted that the portal allows users access data about various government departments and ministries.

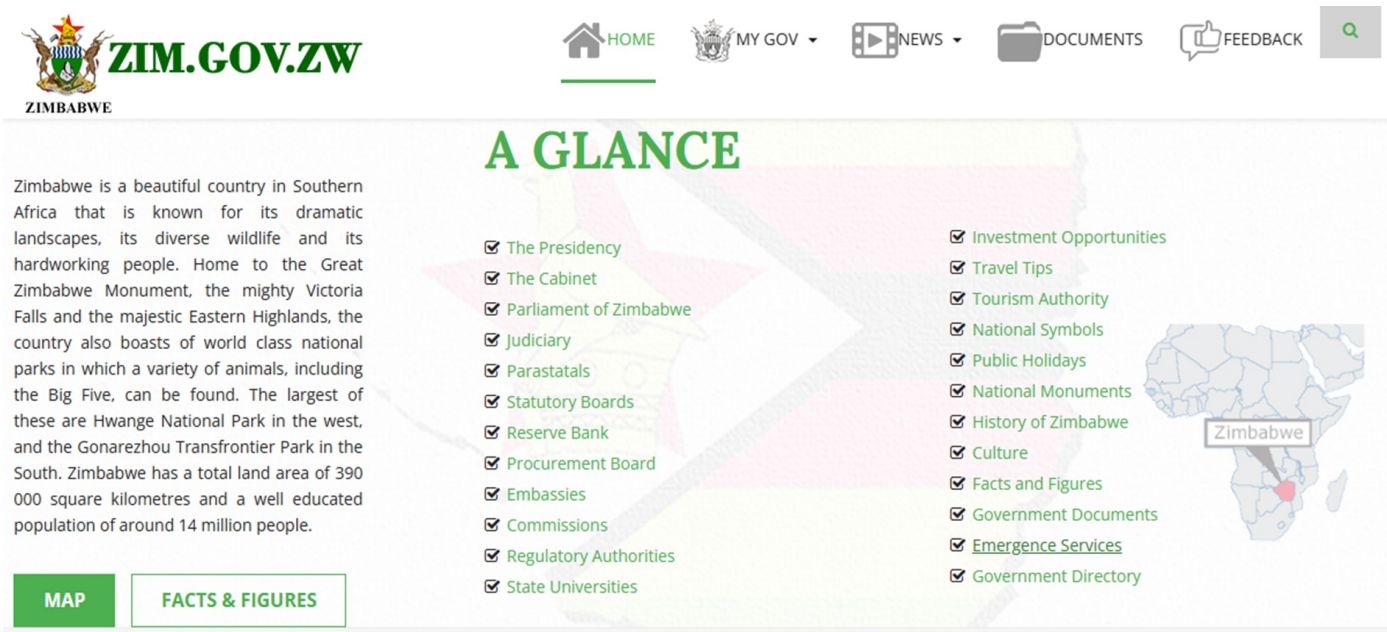

Figure 1. Official Web Portal for the Government of Zimbabwe (Available from: https://www.zim.gov.zw/index.php/en).

However, though the Web portal does not fully utilize geospatial data, the foundation for the development of SDI has already been laid. Figure 2 below shows how the search function operates on the web portal. The use of search function allows user to interact with the map, exploring phenomena. Given that an SDI is a data infrastructure that implements a framework of geographical data, metadata, users and tools that are interactively connected; the e-government portal for Zimbabwe provides such functionality, allowing users to explore phenomena from various locations around the country.

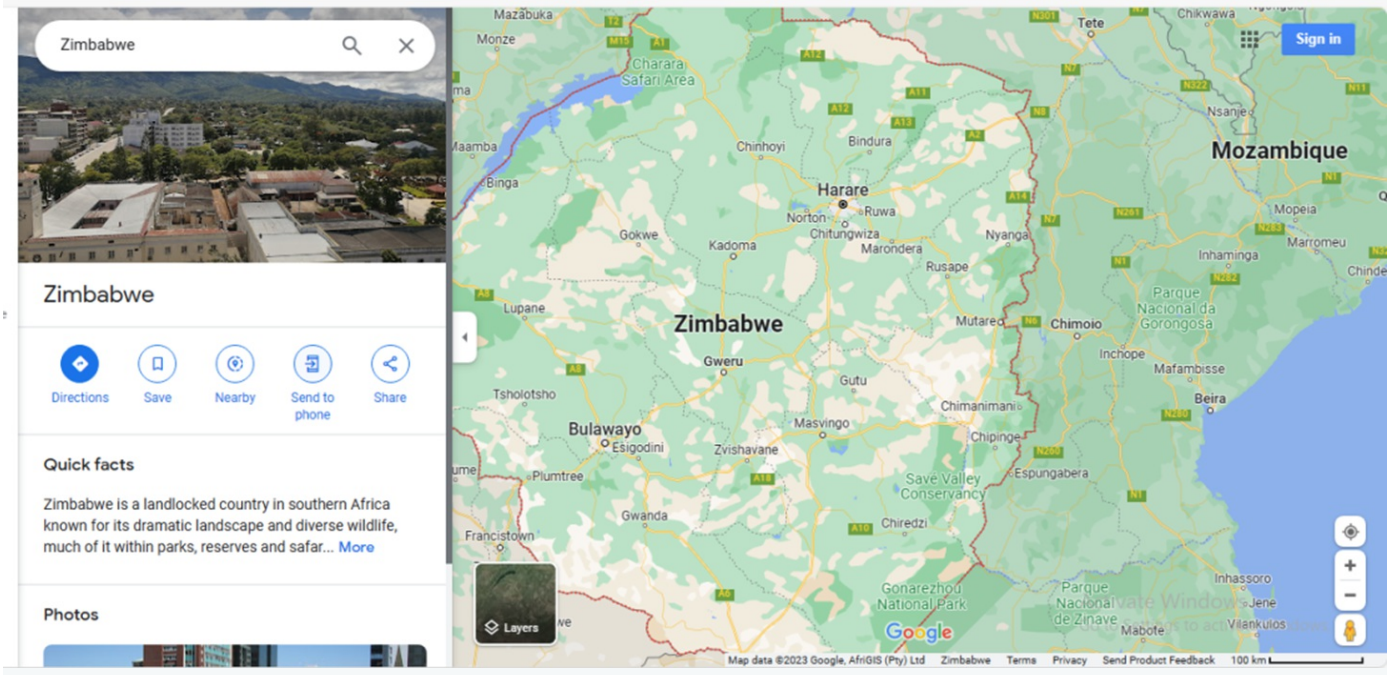

Figure 2. Map navigation tool on Government of Zimbabwe Web Portal (Available from: https://www.zim.gov.zw/index.php/en/).

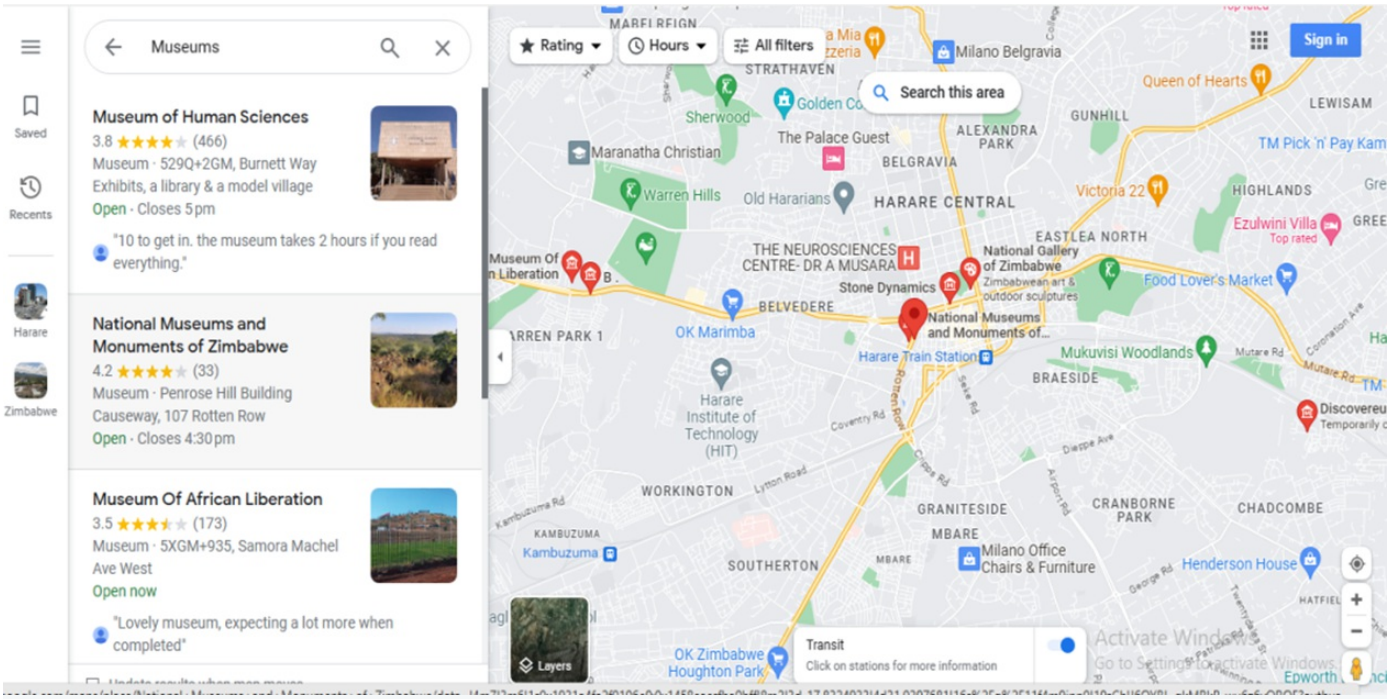

Figure 3. Search function based on Government of Zimbabwe Web Portal (Available from: https://www.zim.gov.zw/index.php/en/).

Map-based search on the government portal allows users to find geospatial resources interacting with the map, and the user can navigate, utilize the zoom key. For instance, as displayed in figure 3 above, the user can use filtering option to search for the location of Museums in Harare, including their operating hours, which is one of the main characteristics of a SDI of allowing the user to utilize geospatial resources in a SDI as outlined in the Geospatial Data Act (2018) and other researches (Kuhn, 2005; Hu & Li, 2017; Maphale &Smit, 2021).

5. SDI for e-Government based on Geospatial Services

The SDI is the main database of e-government providing spatial data and geospatial services for e-government decision support (Zhang et al. 2010). In the context of Zimbabwe, the e-government platform contains a traditional SDI which allows for spatial data visualization and query browsing. This study notes that Zimbabwe's e-government is still lacking complex spatial analyses which include assessment tools, professional services, among others, which makes it inadequate.

6. Recommendations

From this study, the following recommendations could be made to improve SDI in Zimbabwe:

- Emphasis should be aimed at redefining geospatial resource metadata and policy to increase the visibility of spatial data infrastructure on the web, and developing a national framework to access geospatial datasets.
- It is recommended that collaboration of universities and industries in research programs tailor-made to suit the

country's SDI initiative is capitalised, and ensure that outreach programs are conducted to draw potential stakeholders and key stakeholders, thereby fostering a successful all-inclusive e-Government portal with SDI implementation.

- For the full development of SDI, it requires working closely with standards organizations and departments such as the Standard Association of Zimbabwe (SAZ) and the Surveyor General's Office, to offer spatial data and metadata standards in the country.

7. Conclusion

The development of e-Government platform with SDI components would be a welcome development, given that locational data is important in everything that the government manages. This initiative is a basis for the development of a fully-fledged SDI with spatial datasets and records for various sectors of the economy. The growing importance of e-government platforms has prompted the need for governments from developing countries to develop the same. However, the development of SDIs for e-government services is hinged on the relevance of geographic information for public administration purpose.

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