A Web Platform Approach forthe Implementation of Geospatial Data Infrastructure Clearing House for Nigeria.

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ABSTRACT: It is seen in Nigeria that in spite of the perceived value of geospatial information in planning and decision making, it has either been dismissed or not been put to proficient use by both open and private enterprises. This is because of non-accessibility of these geospatial datasets, as at to when and where its required so as to drastically reduce duplication in geospatial information creation.This study explores the integration of a modern trend of website business model in the implementation of a Web-based clearinghouse for Geospatial Data Infrastructure for Nigeria. This is the participants cantered model, whereby participants determine the content of the website while the administrators provide the platform and coordinate and regulate activities on the platform. This approach centres Geospatial Data Infrastructure clearing house on providing a Web-based community platform for maintaining and sharing data where data owners manage their data while increasing the discovery capacity of available data sets.
KeyWords: Geospatial DataInfrastructure (GDI),clearing house, Web platform, ASP.NET web application.

I.   INTRODUCTION

Most information necessary for planning and development have spatial content, in the sense that they are either attributes of objects located at some place or events occurring at specific locations. Geospatial information, today, is being extensively used in decision-making processes because it is a fundamental element which provides better understanding about the environment. [11]asserts that more importantly, geospatial information is a tool of democracy, which must be used in public debate, as it enables visualisation of the impact of the planning decisions on the society and to explain the rationale behind a particular decision.[5]defineda Geospatial Data Infrastructure (GDI) as encompassing the networked geospatial databases and data handling facilities, the complex of institutional, organisational, technological, human and economic resources that interact with one another and underpin the design, implementation and maintenance of mechanisms facilitating the sharing, access to, and responsible use of geospatial data at an affordable cost for a specific application domain or enterprise.

[7] quoted [2] as defining a Geospatial Data Infrastructure (GDI) as an initiative intended to create an environment that will ensure that a wide variety of spatial data users, who require coverage of a certain area, will be able to access and retrieve complete and consistent datasets in an easy and secure way. They quoted also that it can be viewed as a tool to provide a proper environment in which all stakeholders, both users and producers of spatial data, can cooperate with each other and interact with technology in a cost-effective way to better achieve the objectives at the corresponding political / administrative level.

Sustainable development relies on the control of the consequences of public decisions regarding natural resources, geo-hazards, people and the involved interrelationships. [11]argues that most of what has been written on the topic of data sharing has focused on institutional issues. He reports also that [9] seminal book, Sharing Geographic Information, including 29 separately authored chapters, is almost entirely about institutional issues.

[8]discussed ways to improve partnerships among different levels of government. The National Map proposal (USGS, 2001) encourages such partnerships with hopes that they will yield the data necessary to produce up-to-date topographic maps of the nation.The National Geospatial Data Infrastructure (NGDI) is a means to assemble geographic data nationwide to serve a variety of users. GIS applications of many different disciplines have a recurring need for a few themes of data. The framework is a <u>collaborative community</u> based effort in which these commonly needed data themes are developed, maintained, and integrated by public and private organizations within and outside Nigeria. In this framework, data and their metadata form the backbone of the NGDI clearing house. The Community framework concept was motivated by the participation success experienced in web based community forums. This approach centred on Geospatial Data Infrastructure clearing house providing a web based platform for maintaining and sharing data where data owners manage their data while increasing the discovery capacity of available data sets.

The NGDI was instituted under the custody of NASDR and so far the bulk of success of the implementation has been in the institutional arrangement. The technological implementations have lagged behind and even the steps taken, especially in the implementation of the clearing house, have testified to the low level of technological expertise involved, and also a low understanding of the subtle infusion of socio-cultural components of Web platform design that will engender participation of the majority of stakeholders identified as Users by [9].

A key feature of a national GDI is the national spatial data clearinghouse [5], which [3] defined as an electronic facility for searching, viewing, transferring, ordering, advertising and/or disseminating spatial data from numerous sources via the Internet. Such a facility usually consists of a number of servers which contain information (metadata) about available digital data [6]. The facility provides complementary services and improves the exchange and sharing of spatial data between suppliers and users.

II. METHODOLOGY

The design of the Web Platform Community Clearinghouse Model (WPCCM) includes the design of the process flowchart and the mapping of the website that will enable the implementation of required security and allow access to data through user authentication. There are three types of geospatial data support were used on this Web site platform: raster, vector and tabular data with fields for coordinate. The design of database for storing user information and also the method for configuring authentication were performed. The web application with Microsoft's Active Server Pages.NET (ASP.NET) 2.0 Technology were developed which reports the creation of web contents such as Extensible HyperText Markup Language (XHTML), client-side scripting, images and binary data.

CLEARINGHOUSE SUITABILITY INDEX

To determine the suitability of the national clearinghouses worldwide, a web survey was undertaken in April 2005 by [4] which consisted of an inventory of all existing national clearinghouses on the Internet and measured the listed characteristics. All the data measured during this web survey was classified by characteristic and assigned the respective weight. The result of the sum of the 15 class weights together formed the Clearinghouse Suitability Index (CSI) ranging between 0.00 and 1.00; 0.00 meaning that the national clearinghouse is not suitable and 1.00 meaning very suitable.

III. MODELDESIGN

3.1user Needs Assessment And System Requirements Analysis (Una & Sra)

The development of an efficient model for NGDI depends on a well-articulated system requirement analysis; therefore, a user system requirement analysis was carried out.A Clearinghouse Suitability Index was developed in order to indicate a measure for the quality and performance of a national clearinghouse using 15 clearinghouse characteristicsby[9]. The selection of these characteristics was based on the following criteria: ease of measurement, objective character and clear presentation of the people (suppliers, end-users), spatial data, technology, policy and the standards of national clearinghouses. Out of the 15 clearinghouse characteristics the following characteristics were considered to be incorporated at design-time: number of web references, languages used, level of (meta)data accessibility, number of datasets, most recently produced dataset, availability of view services, number of mechanisms (alternatives) for searching, use of maps for searching, registration-only access andMetadata-standard applied.

3.2.0 system application development
3.2.1 application development requirements

To implement the community web platform design for the clearing house, the

following are required tools: **Hardware** (Development computer, Computer server, Client computers, Broadband connection), **Software**(Map Browser, IIS, ASP.NET web application, Visual Studio 2008 etc) and **Data** (Base geospatial dataset, SQL Server database instance).

The Application Programming Interfaces (apis) and Software Development Kits (sdks)were selected based on the achieving simple server deployment and easy hosting for application; application development time and, application response time.Internet Information Services (IIS) was installed and optional components were added by using the Add/Remove Programs dialog box in Control Panel. During installation, IIS installs optional components like Common Files, Documentation, and the Internet Information Services snapin. IIS was installed with the default settings to serve documents through the webprojectdirectory virtual directory. The URL http://localhost/ngdi_project/home now references the C:\webprojectdirectory.

3.2.2 TESTING IIS

The IIS Web server installation on the intranet or development machine was tested. The procedures are as follows: Microsoft Internet Explorer Web browser was opened and the URL for the home directory of the server was entered in the Address text box. The URL was typed as follows: http://localhost/ngdi_project/home.By default, IIS looks in the home directory for a home page called default.htm, default.asp, iisstart.asp, or a page specified as the startup page for the website, in this case: http://localhost/ngdi_project/home.

3.3application program development
3.3.1 PROGRAM ALGORITHMS

The flowcharts were created for program flow of control for processes in individual modules of the application, and for the flow of different modules involved in executing an operation, using UML (Unified Modelling Language).

3.3.2 application creation procedure

Visual Basic.Net (VB.Net) computer programming language was employed in adding functionality, in a Code-behind-file model, to web pages that are requested for by the client, and served by the .aspx files created using Active Server Pages.Net (ASP.NET) server-side programming language. The programming was done in Visual Studio 2008 Integrated Development Environment.

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In the Users column, the Select authentication typelink was clicked. On the resulting page, the radio button next to **From the internet** was selected to indicate that users will log in via a form on the website in which the user can enter a username and password (i.e., the application will use forms authentication). The default setting – **from a local network** – relies on users' Windows user names and passwords for authentication purposes. The **Done** button was clicked to save this change.

Figure 3.10 Security page of the Web Site Administration Tool. (Source Author)

Next was to configure the secure folder to grant access only to authenticated users (i.e., deny access to all unauthenticated users). The Create access rules link was clicked in the Access Rules column of the Web Site Administration Tool to view the Add New Access Rule page which was used to create an access rule. The Secure directory was selected in the left column of the page to identify it as the directory to which this access rule applies.

In the middle column, the radio button marked **Anonymous users** was selected to specify that the rule applies to users who have not been authenticated. Finally, the Deny option was selected in the right column, labelled Permission, and OK button was clicked. This rule indicates that anonymous users (i.e., users who have not

identified themselves by logging in) should be denied access to any resources in the Secure directory.

Figure 3.2 Security page of the Web Site Administration Tool

(Source Author)
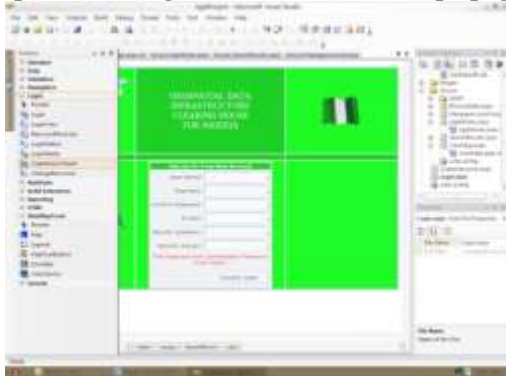
Step 4: Creating the CreateNewUser.aspx page

Figure 3.3 The CreateNewUser.aspx page (Source Author)

To provide this functionality, the CreateUserWizard control was used. The Tasks smart tag menu of theCreateUserWizard was used to change the appearance by opening it and clicking the Auto Format option. The Professional colour scheme was selected.

Step 5: Creating the Login page

The Login page is the page that allows returning visitors to log into their user accounts. To create this functionality, another page named Login.aspx was added and its title set to Login. In Design mode a Login control was added to the page's Content control. The Auto Format dialog was opened from the Login Task smart tag menu and the control's colour scheme was set to Professional. Other control formatting was done in the Login control properties box.
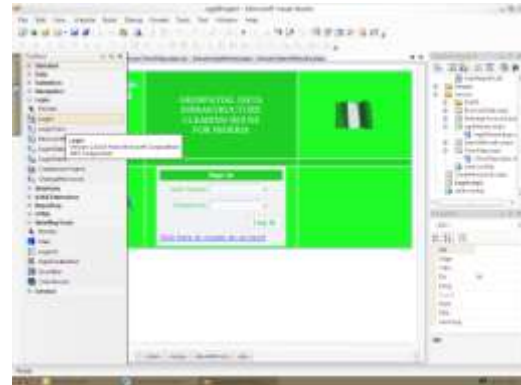

Figure 3.4 Adding the Login Control to the Login.aspx page

(Source Author)

Step 6: Customizing the Home Page

Customized Home.aspx page for a particular user, a welcome message containing LoginName control, to display the current authenticated user name, was added. Home.aspx was opened in Design mode, and "**Welcome**" was typed followed by a comma and a space. A LoginName control was added to the page from the Toolbox. When this page executes on the server, the text [UserName] that appears in this control in Design mode will be replaced by the current user name. In Source mode, an exclamation point (!) was typed directly after the LoginName control (with no spaces in between).

Next, a LoginStatus control was added, which will allow the user to log out of the website when finished viewing the listing of metadata in the database. A LoginStatus control renders on a web page in one of two ways – by default, if the user is not authenticated, the control displays a hyperlink with the text Login; if the user is authenticated, and the control displays a hyperlink with the text Logout. Each link performs the stated action. A LoginStatus control was added to the page by dragging it from the Toolbox onto the page. To change the actual text of this link, the control's property was modified in the code page with vb.net as follows:

With LoginStatus
LogoutText = "Click here to log out"
.LogoutAction = RedirectToLoginPage()
End With

Step 7: Generating a DataSet Based on the Metadata.mdf Database

A DropDownList containing geospatial data category themes and a GridView displaying information about geospatial data from the metadata database were added in the Search page

and the Results page respectively. To work with the metadata database, the approach used is one in which an ObjectDataSource control which encapsulates an object that uses its methods to provide access to the database. This helps to separate the data-access logic from the presentation logic.The dataset was created by right clicking the project's location in the Solution Explorer and selecting **Add New Item…**. Select **DataSet** in the resulting dialog and select ResultsDataSet.xsd as the filename, then click **Add**. The Yes button was clicked in the dialog that ensued to place the DataSet in an App_Code folder created by the IDE (Integrated Development Environment).

Step 8:   Creating the Map Browser
        Map tools were created Using ASP.Net web components and map functionalities were programmed with vb.net computer programming language. The map component was also configured using vb.net and AJAX.The zoom to full extent tool was created using the asp namespace tag:
```
<asp:ImageButton
ID="zoomFull"
 runat="server"
ImageUrl="~/Images/zoomFull.png"
Width="40px" />
```
within the ASPX file while the VB.NET code:
```
Protected Sub zoomFull_Click(ByVal sender As Object,              ByVale              As System.Web.UI.ImageClickEventArgs)     Handles zoomFull.Click
    Map1.ZoomFull()
  End Sub
```


Figure 3.5 Part of the Clearinghouse Interface showing the implemented map tools. (Source Author)

Step 9:   Creating the Upload Module
        The upload data module was created and the upload components were added for the various file types. The metadata form was created in this module, and ASP.Net server controls for data input were added with the appropriate Ajax validation extension controls in the Design mode.

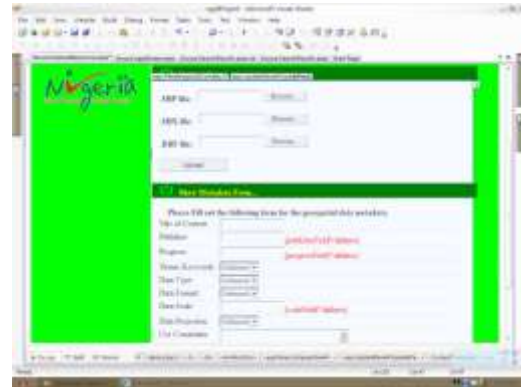Functionalities were programmed in the Code view.

Figure 3.6 The Upload module at design time (Source Author)

IV. RESULT/ANALYSIS
        The study resulted to the development of a comprehensive web-based clearinghouse based on the Web Platform Community Clearinghouse model that provides security through the authentication of participants before they are given access to geospatial resources uploaded to the clearing house storage. The model provides a database to which participants can upload geospatial data resources and grant download permissions to other participants. In this way data availability is ensured and also controlled sharing is enabled. The results include the creation of a search rectangle tool that increases discovery of geospatial data by aiding participants in defining area-of-interest in a spatial search; participants can then select a theme, that defines required data, from drop-down List box on the search page.

4.1 MODEL ANALYSIS
4.1.1   DATA ORGANISATION
        A crucial aspect of the project is data organisation, the system purport to provide a repository of geospatial data, metadata records, search results and possible links to sources of live data, as illustrated in Figure 3.0.
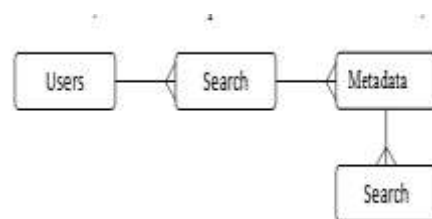

Figure 4.0Organization of data within the WPCCM database (Source Author)

The framework fororganization of WPCCM data encompassed the range of result outputs outlined by the User Requirements specification, such as: Administrative & political Bounds Agriculture & Farming, Atmospheric &Climatic, Biologic & Ecologic, Cadastral, Cultural & Demographic, Elevation, Environmental, Facilities & Structures, Geologic & Geophysical, Human Health & Disease, Imagery & Base Maps, Inland Water Resources, Surveys & Geodetic Nets, Transportation Networks, Utility Networks and other dataset categories as identified by the NGDI Committee.

4.2.2   COMPONENT STRUCTURE
The structure of the WPCCM website, including the interactions between the main components, is illustrated through flow charts in Figure 4.1
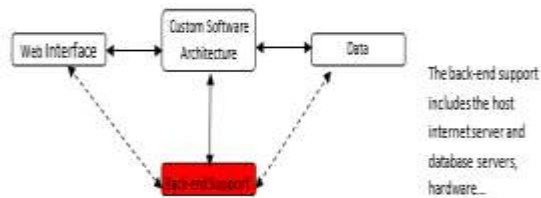

Figure 4.1 Interaction between the main components of the WPCC website (Source Author)

4.2.3 SOFTWARE ARCHITECTURE
The majority of the application development will be concerned with the software architecture. This determines the channels through which users will interact with underlying archive data.
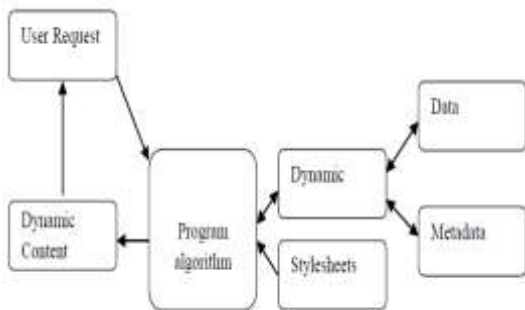

Figure 4.2 WPCCM Software Architecture(Source Author)
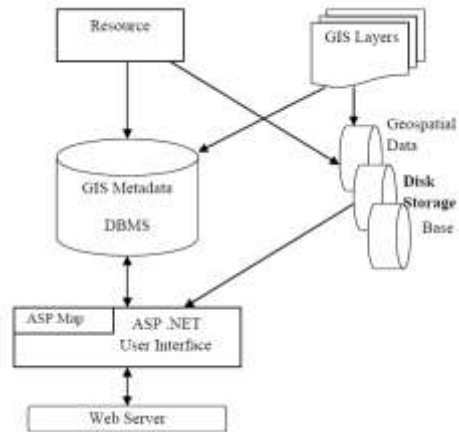
4.3.4   METADATABASE ARCHITECTURE

Figure 4.3 WPCCM Metadatabase Architecture (Source Author)

V. PPLICATION ANALYSIS
5.1 PARTICIPANTS IDENTIFICATION AND ACCESS CONTROL
The implemented clearinghouse platform ensures that the resources uploaded are not misused and that the patent and copy rights of participants are not infringed on by allowing only authenticated users to view resources in clearinghouse. This was achieved by serving the **Create a New Account** page and the **Login** page through which the pages granting access to secure geospatial data can be reached.

The implemented authentication method redirects users requesting for pages requiring authentication to the Login page. If the user has been registered previously, the user's identification is authenticated against a user's profile database and thus is logged in to the clearinghouse site. A new participant is provided a link to the **Create a New Account** page where the user can supply information that will be used to keep track of personal site activities.

Figure 5.0Page Participants login at application runtime (Source Author).

A personalised Homepage through which Participants can navigate to the site's geospatial resources was created. The personalised welcome message shows that the participant has been identified and thus his session can be tracked for providing personalised searches and information. Figure 5.1 and Figure 5.2 show the Sign-In page and the **Create a New Account**page respectively, as rendered on Windows Explorer 7 client browser, while the figure below shows the personalised home page for the clearinghouse.

Figure 5.1 Application runtime Page
Figure 5.2 Application runtime customised home page.

VI. VIEWING SEARCH RESULTS
6.1 RESULTS LISTING

Results of listings of geospatial data meeting the search parameters are displayed in the Results tab of the main application window in the browser. The displayed results are drawn from the metadata database.
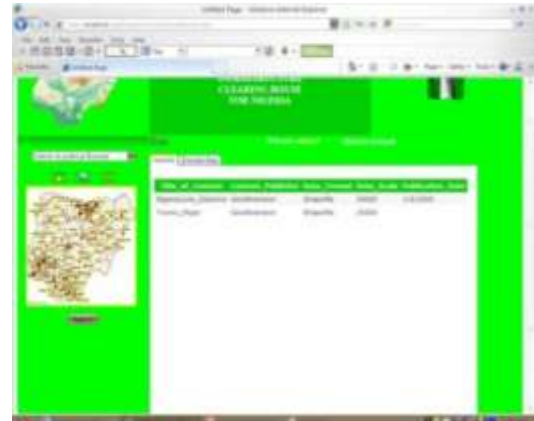

Figure 6.1Listings of results of search for geospatial data (Source: Author).

6.2 MAP VIEW OF SEARCH RESULTS

The map of results can be viewed from the Browse Map tab of the results content window. The displayed map of a selected record can be navigated using the following tools: Zoom in, Zoom out,zoom to Full Extent, Pan and Select.Participants can use the Select Search Area tool to select individual feature of a search result feature class displayed on the map to view its attributes table. This enables participant to have a better idea of the features in the dataset and view the attributes fields.

Figure 6.2 Display of Map Search results (Source: Author).

6.3UPLOADING GEOSPATIAL DATA
6.4UPLOADING GEOSPATIAL DATA FILE

The implemented clearinghouse provides an interface for data to be uploaded; for example, a participant may upload shapefiles to the clearinghouse server through the provided interface. Users are guided by the application interface to upload the files implementing the ESRI shapefile data model model, which requires the .shp, .shx, and .dbf files.
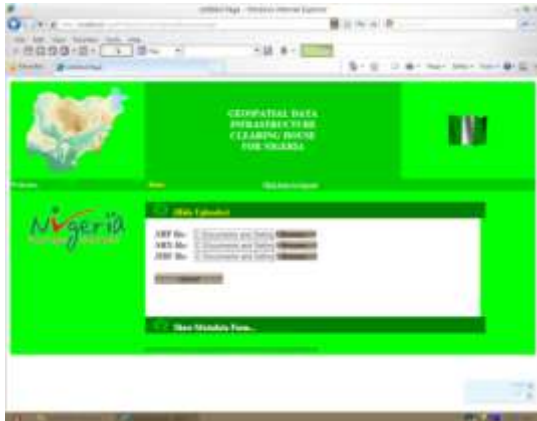
Figure 6.3 Interface for uploading shapefile
(Source: Author)

6.5 FILLING OUT THE METADATA FORM

The upload module of the implemented clearinghouse also provides a form interface that guides participants to enter the metadata of the uploaded geospatial data. Participants are constrained to accepted value domains for fields of the implemented metadata standard chosen by the NGDI committee or the clearinghouse administrators. The application automatically loads the name of the uploaded geospatial data in the "Title of Content" field, thereby eliminating the chance of typographical errors in such text fields that are application critical; thus these fields are presented as read-only.The trigger to the collapsible panel containing the metadata form is rendered inactive until a geospatial dataset is uploaded to the server. This interactivity ensures that metadata form is not filled for an inexistent dataset. Figure 5.4shows the implemented metadata form with pre-filled values (in the case of the Title of Content field) and default values, and the completed form before posting respectively.
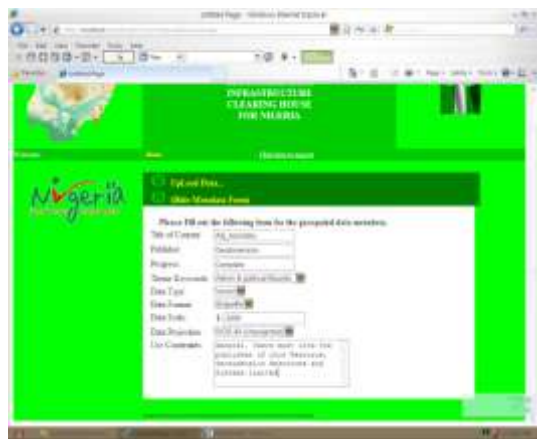

Figure 6.4 Interface showing a completed metadata form (Source: Author).

Figure 5.5 shows the field validation capability of the implemented clearinghouse application for the case where a field for required metadata element was jumped. This interaction uses dynamic callout boxes to call the attention of participants to supply appropriate values to skipped fields.
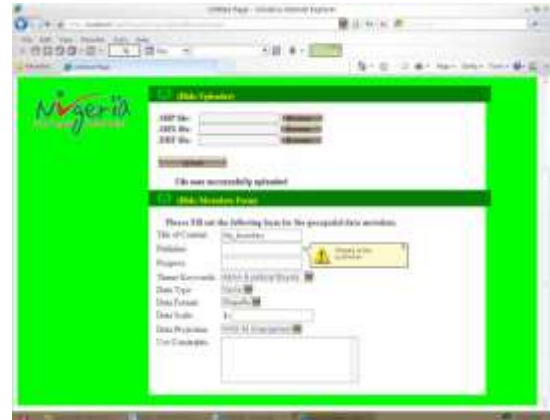

Figure 6.5 Metadata Information validation using AJAX (Source: Author).

VII.   CONCLUSION

This research work has shown that the improvements in web technologies in recent times can be used in developing modules that can be incorporated in the modelling of a clearinghouse at national and state levels, which can in turn take care of identified socio-cultural dispositions of stakeholders or the participating individuals and organizations.Once established, the metadata structure would enable the growth of the Web Platform Community Clearinghouse database within that structure. Extending the structure to cope with new data types should be a straightforward exercise as the metadata structure and the implementation was designed to be extensible enough to cope with future demands.Through continuous geospatial systems planning and adoption of the Geospatial Data Infrastructure, agencies will move toward services provided by the Apex Clearing House. Through this transition period, agencies will still operate legacy applications and maintain legacy geospatial data. Agencies will have the opportunity to maintain their own spatial data warehouses in instances relating to sensitive information and supporting legacy systems.

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