# Online Service Delivery of Geo-information Data: The Case of Ethiopian Mapping Agency

Ghebrealif Assefa
Ethiopian Mapping Agency, Addis Ababa, Ethiopia
alef1995@yahoo.com

Sebsibe Hailemariam
Department of Computer Science, Addis Ababa University, Ethiopia
sebsibe2004@yahoo.com

**Abstract**

This paper explores the use of online service delivery of geo-spatial data for Ethiopian Mapping Agency (EMA). The main objective of this research is to automate online service delivery system on Geo-Information data for customers of the agency. Customers seek to get geo-spatial data timely and adequately but those living far away from Addis Ababa have been coming physically to EMA to be served without knowledge of what services and products are availed in the agency. This caused customer dissatisfaction. To boost the service delivery system of the agency, need assessment was undertaken from EMA and from 16 identified stakeholders of the agency using primary and secondary data collection methodological approach. As a result, a web portal was developed based on the requirements of EMA and its stakeholders to support the online service delivery system.

*Keywords:* Online service; Geo-information data; Service delivery

## 1. Introduction

Ethiopian Mapping Agency (EMA) is the authorized Agency in Ethiopia mandated to produce and disseminate geospatial information products and services. To accomplish this mission, the agency has been using tedious and time taking process to identify map details from hard copy of topographic maps. Due to long process of service delivery system in EMA, some regional states including most of the governmental sectors are forced to produce their own geo-information data spontaneously without legal autonomy. The result of this disintegrated geo-information production causes data incompatibility and unnecessary duplication of data which causes economic loss at national level. To avoid this problem online service delivery system and automated retrieval of map details is devised in this paper by addressing the following research questions.

1. How an existing spatial search engine (SSE) is integrated with the proposed system to support online and offline services?
2. What mechanisms are used to build a secured geo-information database?
3. What techniques are used to develop user friendly prototype and system architecture that satisfies customers of EMA?

To address these research questions, relevant literatures were reviewed to understand and share experience from various countries. New architecture was also designed to be integrated with the existing system but the SSE was adopted from Environmental Spatial Research Institute (ESRI) software products for visualization and printing of map details that can be used for Intranet and Extranet. To span the gap between demand and supply of geo-information data, we used semi structured interview with marketing officers of the agency by purposive sampling technique. Requirements were also analyzed from the existing process as well as from stakeholders to build an improved service delivery system and results were summarized from the data collected by majority respondents' reaction to the existing service delivery system.

This paper is organized as follows. Section 2 presents literature review of related works of online service delivery system used in other countries.

Sections 3 and 4 deal with the analysis and design of the developed system, respectively. Section 5 deals with prototype development. Section 6 presents discussions and finally conclusion and recommendations are briefly given in section 7.

## 2. Related Work

To understand various techniques of online service delivery systems and spatial data retrieval, a number of literatures were reviewed. Most of the literatures were valuable to obtain additional knowledge to the study. Experience of online service providers of geo-information data in other countries was also reviewed to be improved. By comparing six technologies, we selected ArcGIS server for Spatial Search Engine (SSE) to adopt on this system because it is cost effective, compatible with the stakeholders' data and interoperable with ArcGIS software. We also reviewed eleven previous related works such as: Geospatial Portal from Intergraph [1], The Atlas of Canada [2], Maps of India.com [3], Caribbeean-on-line.com [4], Google Maps [5], Yahoo Maps Local [6], Maps of the World United Nations Cartographic Section [7], Standfords [8], Microsoft's Mappoint [9], Perry-Castañeda Library [10] and The United Nations Educational, Scientific and Cultural Organization (UNESCO) [11] and we compared with the new system using four parameters and in all parameters we conclude that the new system is the best of all other systems because it is rich in Ethiopian gazetteer, download-ability, search-ability and suitability to the existing data of Ethiopian Mapping Agency.

## 3. The Proposed Solution

A new system is proposed to serve customers online and offline. The new system has a web portal to serve as extranet (network outside EMA) with detail Metadata descriptions so that the external user can have an idea of what geo-information production and services are delivered by EMA. To design online service delivery system, need assessment was made by distributing questionnaires and by making semi structured interviews for the purpose of identifying functional and non-functional requirements.

### *3.1 Functional Requirements*

In software engineering, a functional requirement defines a function of a software system or its component that explains and describes the interaction between the system and the users [12]. The new system provides the following functionalities.

- Support to search any specific locality in Ethiopia.
- Support to zoom in and zoom out detail map features.
- Support to print selected area.
- Gather complaints and feedbacks from the public online.
- Enable to initiate customer for online sale order.
- Support to register customers online.
- Track to view users' information.
- Support to approve sales by Marketing Officer.
- Support to edit users' information.
- Support to select geo-information data by category.
- Support to download resources.
- Authenticate users according to their roles.
- Support to upload resources of EMA.

### *3.2 Non-Functional Requirements*

This is a software requirement that describes not what the software will do but how the software will do it. Program needs to be able to run, but which doesn't relate to the actual functionality of the program [12].

Performance of the OSDOGID system emphasized on the challenges of hard disk space, speed, memory and bandwidth requirements. Images of raster data consume hard disk space and bandwidth to publish on the web service. To avoid these constraints we have changed the raster (.tif) files to small sized (.pdf) files for easily downloading the spatial data. The web service is configured with the following performance issues.

1. *Pooling:* This service should be pooled and used repeatedly by many clients simultaneously with maximum number of 200,000 instants and minimum instant of 1.
2. *Time-Outs/Response time:* the client can use the web service with maximum time of 600 seconds and waits to get service in 60 seconds with an idle instance can be kept running at 1800 seconds.
3. *Memory Requirement:* the system is expected to be run on a powerful server that can be accessible by many clients to search crop and the desired area for printing in large format printer. This was suitable in the intranet system.

Sixteen use cases were identified in the system with three Actors for geo-information service delivery processes as shown in Figure 1.

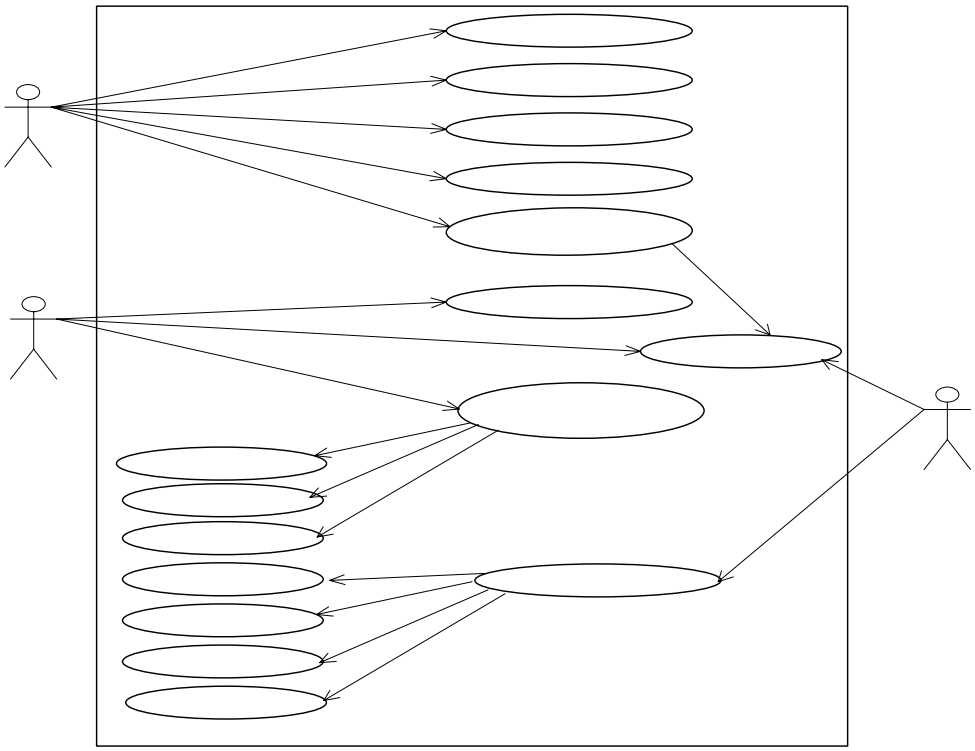

*Figure 1:* Use case diagram of the new system

*Table 1:* Sample Use Case Description for Initiate Order

| **Use Case Id** | **UC-02** | |
|---|---|---|
| **Use Case Name** | **Initiate Order** | |
| Description | This use case shows how the client initiates map resources | |
| Participating Actors | Customer | |
| Entry Condition | The customer must activate the system home page | |
| **Success Scenario** | Step | Action |
| | 1. | The customer navigates his preference links. |
| | 2. | OSDOGID displays a map product category page. |
| | 3. | The customer selects product by category. |
| | 4 | The OSDOGID displays the selected product |
| | 5. A | The customer clicks initiate order. [Alternate A] |
| | 5. B | The customer clicks on “cancel” button. [Alternate B] |
| Exit conditions | | The customer submits his request. |
| **Alternate flow A**. | 6. A | OSDOGID displays the “New Customer Registration” page. |
| | 7. A | The customer fills the registration form |

| | | |
|---|---|---|
| | 8. A | The customer clicks the "Submit" button |
| | 9. A | OSDOGID displays successful massage. |
| Exit conditions | | The customer clicks "ok" button. |
| **Alternate flow B.** | 6. B | OSDOGID returns to metadata page. |
| Exit conditions | | User can view another product or exit to the home page and get |

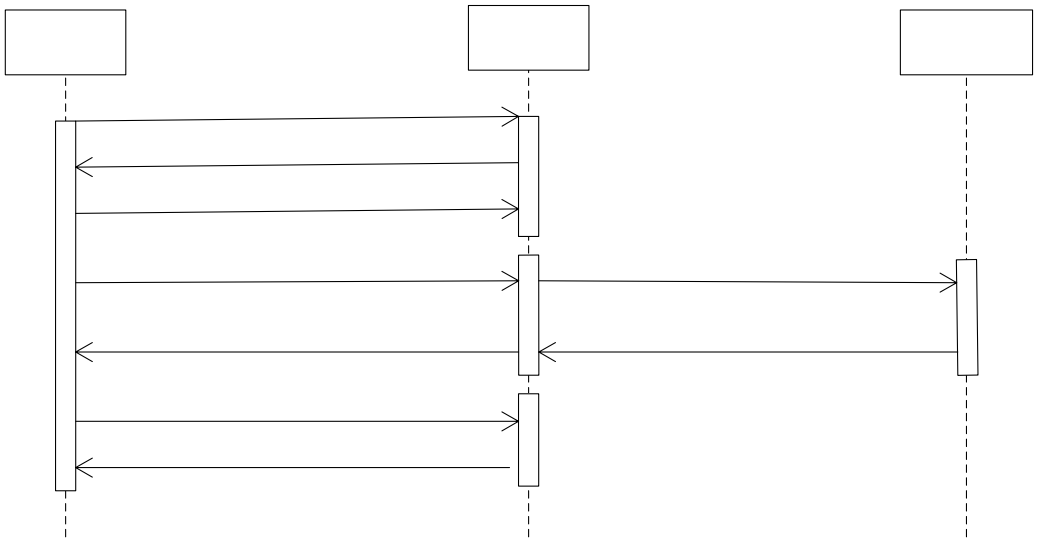


*Figure 2:* Sample Sequence diagram of map selection by category

## 4. System Design

After the determination of the requirements, it is the design that follows. The design is all about stating the design goals of the system and subdividing the system into smaller parts so as to tackle the problem in a modular approach. The output of this phase includes description of each subsystem and the deployment of the subsystems.

### *4.1 Architecture of the System*

It is the architecture that determines the type of interactions that the components are going to have.

To provide online service including intranet to be used in EMA, multi tiered (5-tiered) architecture was designed based on the requirement of the agency. The system consists of the following servers:

- *Geo-database Server and Web Server*: to support spatial searching offline in EMA and online geo-information of Ethiopia.
- *Mobile Information server:* is a server in the Commercial Bank of Ethiopia (CBE) that is responsible to manage payment information of customers and alerts marketing officers by mobile banking system which is already launched by CBE.
- *GSM Server:* is a server of ethio telecom responsible to facilitate communication between customers of EMA and Marketing Officers with CBE by mobile banking system.
- *FTP Server:* responsible to upload thematic data from OSDOGID system.

*Marketing Officer's Mobile:* is a dedicated mobile used to receive information of payment dueled from customers by mobile banking system. The officer can approve customers to download resources based on the payment requirement.

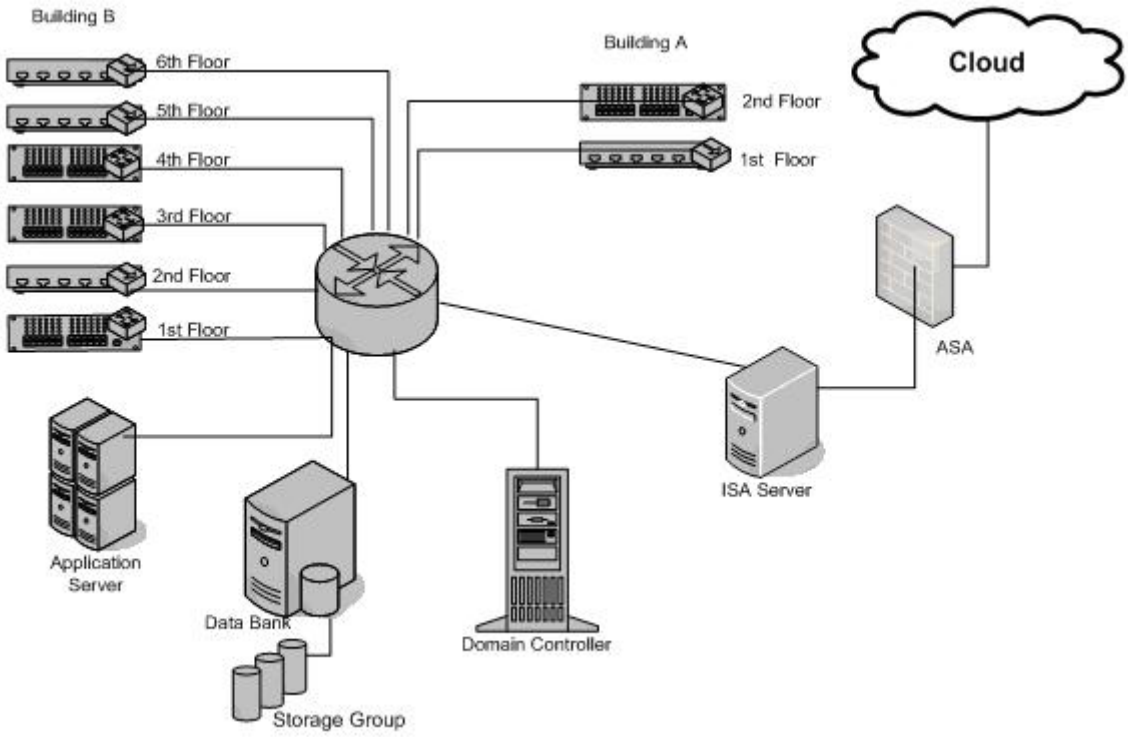


*Figure 3:* Existing Architecture of EMA

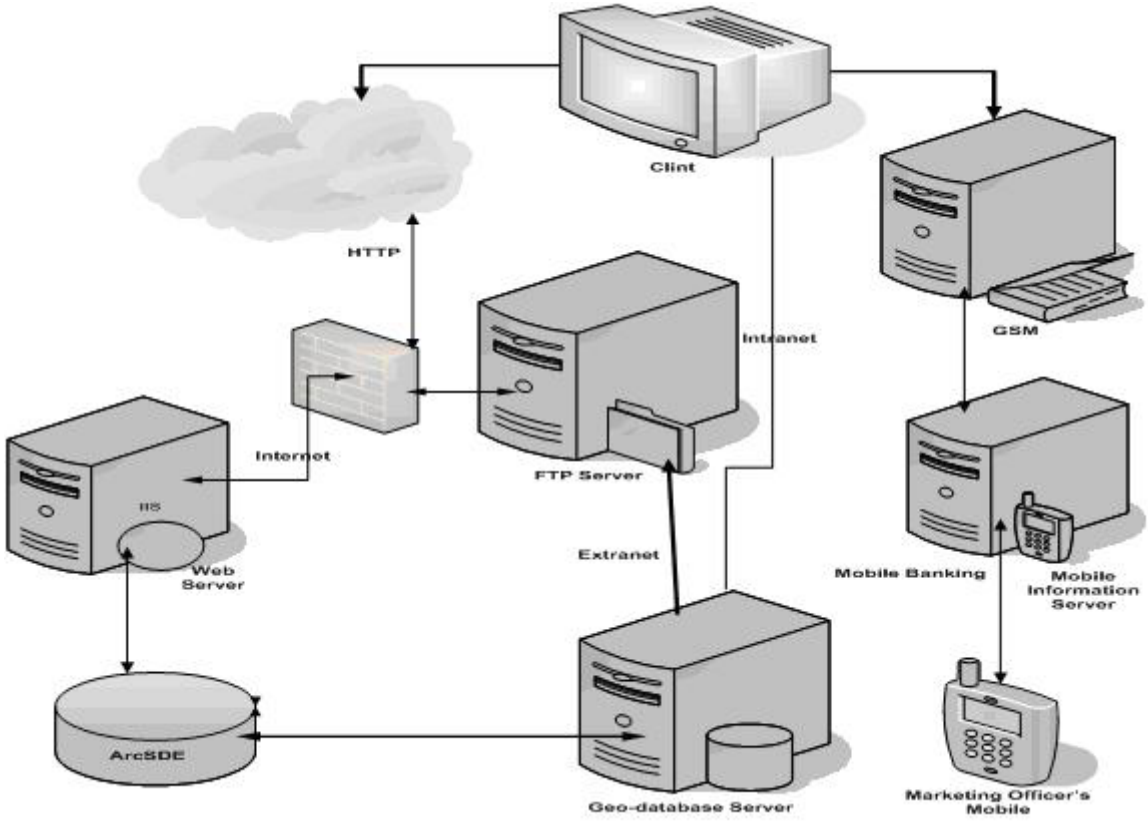


*Figure 4:* New System Architecture of EMA

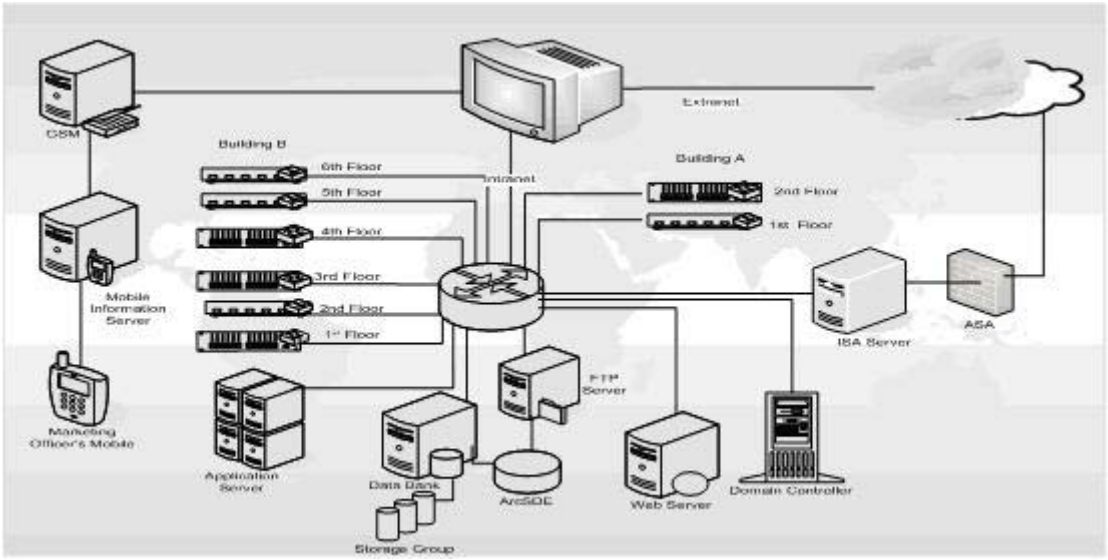


*Figure 5:* Integrated Architecture of EMA

### *4.2 Subsystem Decomposition*

In order to simplify and minimize complexity of the solution domain, the system has been divided into three subsystems. These are "Spatial Searching Subsystem", "Information Subsystem" and "Administration Subsystem". The Spatial Searching Subsystem is responsible for providing geo-information data by selecting specific area and is also responsible to edit map, zoom in/zoom out features and print the selected map(s) in large, medium and small size format. The information subsystem is responsible in providing the detailed information of EMA's products and services and the Administration subsystem enables the administrator to manage user accounts.

## 5. Prototype

This subsection of the implementation phase was about how to go through this work by developing a web portal. The portal has sixteen interfaces which were categorized into five main interface components. The system consists of the search area, Initiate Order, Customer Registration, Manage Customer Information, and Upload Resources.

The portal consists of both dynamic and static pages. The dynamic pages are integrated with the database at the backend that can be modified dynamically when new information is inserted by appropriate users such as customer information, order management, resource management, etc., whereas, the static pages are persistent information that are not integrated with the database such as: home page, search area, map products, contact us, our site, directorate profile, view information, map viewer, etc.

## 6. Discussions

To make sure that this system is feasible and successfully implemented in EMA, we tried to assess the existing enablers and opportunities found in EMA and in its stakeholders from the collected data. The majority of respondents ascertained that online service delivery system is important for time and cost minimization. The developed system is also valuable to the geo-information seeker society in prevailing standard at national level. All stakeholders have Internet connections with more than 2Mbps bandwidth whereas EMA has currently 8Mbps. Because of these enablers and opportunities, we believe that the developed system is adroit to work effectively and efficiently without bottleneck of bandwidth in data sharing activities at national level.

We have investigated the existing process of EMA related to service delivery system. Even though there were efforts in production of topographic and thematic maps, we identified the cause of customer dissatisfaction from 16 stakeholders by using purposive and cluster sampling technique. To

mitigate the gap, we developed online service delivery system for the agency that could play a positive role to contribute the sustainable development in Ethiopia.

We have also developed a web based portal that gives detailed information about the availed geo-information data in EMA. The system can serve offline and online service delivery system of geo-spatial data of Ethiopia. However, since we have used web technology, the location of users is not limited to the country. Users of web-based systems could be anywhere in the world. This means those Ethiopian and non-Ethiopian living in the country as well as outside the country can be served by the system.

We believe that this project would have a remarkable solution for data integrity and mitigating economic loss by avoiding duplication of work at national level; because, production of geo-information data at different sectors is prone to data incompatibility due to accuracy and projection parameter errors.

To meet the general objective of this research, results were summarized for each specific objective that shows advantage of the new system comparing to other systems and its result is shown in Table 2.

*Table 2:* Summary Process on Development of OSDOGID to Meet Each Objective

| *No.* | *Specific Objective* | *Method used* | *Advantage of OSDoGID over other systems* | *Result found* |
|---|---|---|---|---|
| 1. | To integrate SSE for visualizing and printing of map details that can be used as intranet and extranet. | ▪ Similar literatures were reviewed.<br>▪ ArcGIS server was used for publication and for intranet<br>▪ Web based portal was developed for extranet | ▪ Detail gazetteer data was integrated for specific area searching<br>▪ Able to edit and print in three map size format<br>▪ Can be zoomed in/out for detail features<br>▪ Used for intranet and extranet | Automated SSE used for intranet and extranet was nicely developed. |
| 2. | To build geo-information database that comprises spatial and non-spatial data. | ▪ 1:250,000 scale of Mosaic topo maps, road networks, gazetteer data, spot satellite imageries and political map of Ethiopia were used as input data<br>▪ MS SQL server used for non spatial data handling<br>▪ ArcSDE used for spatial data handling | ▪ Seven volumes of geographic name database were integrated<br>▪ Full coverage of 1:250,000 scale topographic maps of Ethiopia<br>▪ Full coverage of spot satellite imageries were integrated for the whole Ethiopia<br>▪ Metadata of EMA production and services were clearly described. | Robust dynamic pages |
| 3. | To develop prototype and illustrate system architecture | ▪ Primary and secondary data were collected from EMA and their stakeholders.<br>▪ C# and Silverlight were used at front end<br>▪ Mobile banking was used for online sales to illustrate architecture | ▪ Prototype developed based on requirements of EMA's and its stakeholders'<br>▪ Used to select multi-purpose geographic layers of Ethiopia<br>▪ Full information about products and services given by EMA<br>▪ Online customer registration | User friendly online service delivery of geo-information data was developed for EMA |

## 7. Conclusion and Future Work

This paper contributes to improve geo-information data delivery system of Ethiopian Mapping Agency. It enables to provide geo-information data online to the public without physically coming to EMA. This will help customers to buy geo-information products and services without wastage of time and money. Furthermore, it has established full information about the availed products and services of the agency so that governmental and non-governmental sectors do not need unnecessary resource wastage of time, material and human expertise due to duplication of work at national level. Prevailing of standardization was also another advantage of this work.

We believe that the application of the proposed system OSDOGID will change EMA's service delivery one step ahead. The geo server part of the system can serve as Intranet with the existing LAN without the need of Internet. EMA's staff can use the system to search any area located in Ethiopia. The user can crop the desired area and print if large format printer is attached with his/her computer. Business development experts could be able to use the system to visualize the demand area of a customer by LCD projector or by standalone flat monitor. Customers can easily identify consecutive topographic maps to be purchased by zooming in and zooming out the detail map features.

This work can be considered as gate opener on dissemination of geo-information data in Ethiopia by showing only 1:250,000 scale topographic maps. Other geo-information data is not addressed in this work due to time and resource limitations. So, the area is still open for further research on how to deliver very huge data to geo-information seekers.

E-commerce is not matured in Ethiopia. So service charge handling is also a gap in the area. Future research work on this area could come up with solutions for the above gap and related ones.

It is our recommendation for the agency involved in geo-information data production and the ENSDI members to integrate their own spatial data in one central database. To avoid duplication of work and wastage of resources at national level, ENSDI members can utilize and upgrade this work for data sharing, integration and standardization issues of geo-spatial data.

## References

[1] Okar Service Plc., "Experience the Power of the Intergraph 2013 Geospatial Portfolio, Geospatial Portal", Addis Ababa, Ethiopia.

[2] The Atlas of Canada, http://www.atlas.nrcan.gc.ca, published by Natural Resources Canada, last accessed on 12th Jan 2013.

[3] Maps of India.com, retrieved from, www.mapsofindia.com, last accessed on 3rd February 2013.

[4] Caribbeean-on-line.com, www.caribbean-on-line.com, accessed on 12th Jan 2013.

[5] Google Maps, retrieved from http://www.maps.google.com, accessed on 2nd February 2013.

[6] Yahoo Maps Local, retrieved from, http://maps.yahoo.com, accessed on 22nd Feb 2013.

[7] Maps of the World, retrieved from, www.mapsofworld.com, accessed on 2nd Feb 2013.

[8] Standfords, retrieved from, www.stanfords.co.uk, accessed on 21St Feb 2013.

[9] Microsoft's Mappoint, www.mappoint.msn.com, accessed on 2nd Feb 2013.

[10] Perry-Castañeda Library, Map Collection from University of Texas at Austin, www.lib.utexas.edu, last accessed on 18th Feb. 2013.

[11] UNESCO, the United Nations Educational, Scientific and Cultural Organization, http://www.portal.unesco.org, last accessed on 21st Feb 2013.

[12] Mark Hansen, Staurt Madnick and Michael Siegel, "Data Integration Using Web Services", MIT – Sloan School Management Working Paper No 4406-02, CISL Working No. 2002-14, 2002.