Evaluation and Development of Cadastral Information System by Using Web GIS Techniques: a case of Adama Tows, Ethiopia

Deme Berhanu Kumsa

Thesis Submitted to the Department of Geomatics Engineering
School of Civil Engineering and Architecture
Presented in Partial Fulfillment for the Requirement of the Degree of
Master of Science in Geo-Informatics

Office of Graduate Studies
Adama Science and Technology University

June, 2022

Adama, Ethiopia

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APPROVAL SHEET

We, the advisor`s of the thesis entitled "Evaluation and Development of Cadastral Information System by Using Web GIS Techniques: a case of Adama Tows, Ethiopia" and developed by Deme Berhanu Kumsa, hereby certify that the recommendation and suggestions made by the board of examiners are appropriately incorporated into the final version of the thesis.

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We, the undersigned, members of the Board of Examiners of the thesis by Deme Berhanu Kumsa, have read and evaluated the thesis entitled "Evaluation and Development of Cadastral Information System by Using Web GIS Techniques: a case of Adama Tows, Ethiopia" and examined the candidate during open defense. This is, therefore, to certify that the thesis is accepted for partial fulfillment of the requirement of the degree of Master of Science in Geo-Informatics.

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Finally, approval and acceptance of the thesis is contingent upon submission of its final copy to the Office of Postgraduate Studies (OPGS) through the Department Graduate Council (DGC) and School Graduate Committee (SGC).

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DECLARATION

I hereby declare that this Master Thesis entitled "Evaluation and Development of Cadastral Information System by Using Web GIS Techniques: a case of Adama Tows, Ethiopia" is my original work. That is, it has not been submitted for the award of any academic degree, diploma or certificate in any other university. All sources of materials that are used for this thesis have been duly acknowledged through citation.

Deme Berhanu Kumsa	______________________	________________
Name of student	Signature	Date

RECOMMENDATION OF ADVISORS

We, the advisor`s of this thesis, hereby certify that we have read the revised version of the thesis entitled "Evaluation and Development of Cadastral Information System by Using Web GIS Techniques: a case of Adama Tows, Ethiopia" prepared under our guidance by Deme Berhanu Kumsa, submitted in partial fulfillment of the requirements for the degree of Mater's of Science in Geomatics Engineering (Specialization in Geo-Informatics). Therefore, we recommend the submission of revised version of the thesis to the department following the applicable procedures.

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TABLE OF CONTENTS

CONTENTS PAGES

LIST OF TABELS

LIST OF FIGURES

FIGURE PAGE

LIST OF ACRONYMS

AACA	Addis Ababa City Administration
DB	Doing Business
DCDB	Digital Cadastral Data Base
ECOSOC	Economic and Social Council
ELADM	Ethiopia Land Administration Domain Model
FDRE	Federal Democratic Republic of Ethiopia
FIG	International Federation of Surveyors
GGIM	Global Geospatial Information Management
GIS	Geographic Information System
GPS	Global Positioning System
ICT	Information and Communication Technology
ISO	International Organization for Standardization
KLIS	Korea land information system
LADM	Land Administration Domain Model
LAS	Land Administration System
MDA	Model Driven Architecture
MoLPP	Ministry of Land and Physical Planning
MULDHC	Ministry of Urban Land Development, Housing and Construction
NGO	Non Government Organization
NLC	National Land Commission
NLIMS	National Land Information System
NSDI	National Spatial Data Infrastructure
OSS	Open source software
QGIS	Quantum GIS
SDG	Sustainable Development Goals
SDI	Spatial Data Infrastructure
SQL	Structured Query Language
UDIG	User friendly Desktop Internet GIS
ULARIA	Urban Land Adjudication and Registration Information Agency
UN	United Nations
UN-GGIM	The United Nations Global Geospatial Information Management
USA	United State of America
VILIS	Vietnam Land Information System

ABSTRACT

The Cadastral Information System is used to create a secure and reliable real property registration system in order to improve land administration system and thereby contribute to the processes of achieving sustainable development goals. Urban cadastral system of Ethiopia has not been successful due to cadastral policy and legislative gaps, poor institutional arrangements and technical deficiencies. Also the unsuccessful practice of the Ethiopian urban cadastral system is the result of the absence of nationally agreed methodology that can measure and evaluate the performance of the urban cadastral system. Cities/Towns in Ethiopia have common problems and/or challenges in managing their cadastral information system. And Adama Tows is one of the tows phasing various problems and challenges related to cadastral information system. Now Days the dissemination of digital cadastral data on the internet by open source Web-GIS has become essential to enhance communication between administration, decision-makers, and the society. Therefore, the main objective of this study is to evaluate the existing cadastral system of Adama Tows and demonstrate modern Cadastral Information System by Using Web GIS in order to enable digital cadastral data sharing and information dissemination. To achieve the study's objectives, primary data such as questionnaires and interviews are collected by using the SDI-Readiness Approach developed by Delgado et al (2005), and mixed research method data collection and analysis is used to analyze the data. Secondly, the researcher developed cadastral web maps by using secondary data obtained from Adama tows land management office. And the findings of the study imply that there is a knowledge and technological gap in the process of developing cadastral information system of the study area. Therefore: to support sustainable development, it is critical to create awareness and building capacity of the tows at all levels in order to modernize the existing cadastral information system in accordance with scientific standards.

KEYWORDS: CIS, Evaluating, Web-GIS, Adama Town

CHAPTER I: INTRODUCTION

1.1. Back Ground of the Study

The human to land relationship has been associated with the concepts of cadastral system, land administration, and land management (Ting & Williamson, 2001). In some countries, cadastral system and land administration system are treated as the same while different in other countries (Krigsholm et al., 2017). Also the understanding of the cadastre and its potential has been continually altered due to dynamic human kind to land relationship and the consequent development of the cadastral science (R. M. Bennett & van der Molen, 2011).

According to Henssen (2010) Cadastre is a methodically arranged public land inventory of data concerning properties within a certain country or district, based on a survey of their boundaries and also help to streamline land transactions, fast track land dispute resolution, enable credit access, enforce land use controls, and ensure fair land taxation (Henssen, 2010). Also Cadastral system is the ascertainment of land ownership, which is a legal consequence of identifying and recording interests on the land parcels. These interests are expressed in terms of rights, restrictions, and responsibilities (RRR) (Chekole, 2021). In addition cadastral system is the foundation and an integral component of parcel-based land information systems (LIS) that contain a record of interests in land (I. P. Williamson, 1985). Moreover Cadastral system serves as a fundamental source of data infrastructure for land management (Enemark, 2009b).

Cadastral System is an institutional framework varied and complicated by the tasks they must perform, by national cultural, political and judicial settings, and by technology (Enemark et al., 2005). According to (Crompvoets et al., 2018) governance of cadastral information can be realized 'through the assignment of related tasks to one single organization or through the division of tasks among different organizations'. Additionally, spatial data infrastructures (SDI) provide an important platform to share and disseminate the existing data (Sjoukema et al., 2020). Also Government agencies; ministries and departments, citizens, organizations, professionals and businesses involved in land and related services need real-time access to reliable and detailed land information (Ogechi, 2021).

Cadastral system plays in supporting sustainable development is also well accepted and developed and developing countries accept the need to evaluate cadastral systems to help identify areas of improvement and whether their systems are capable of addressing future needs (Rajabifard, 2019). Hence, significant efforts have been invested all over the world for the correct management of land, including the development of reliable cadastral systems towards a secure land recordation (Dawidowicz & Źróbek, 2018; Krigsholm et al., 2017). Accordingly the modern cadastral infrastructure vision is established and the visions were actualized at the 20th FIG Congress in Melbourne, Australia in 1994 where "Cadastre 2014" was established to create a vision of how cadastres would work and look like twenty years from 1994.

Cadaster 2014 was an initiative introduced by FIG to standardize the cadastral system of the world following six statements. These are: - Complete legal situation of land (public, private); No separation between maps and registers; Cadastral mapping will be replaced by modeling; Manual Cadaster will not be longer; Private-public-partnership cooperation; and Cost recovery (Kaufmann & Steudler, 1998). Today, many countries in the West have moved from the traditional cadastre to modern multi-purpose cadastre through the implementation of Cadastre 2014. And also majority of the countries, land registries have been modified to include coded building information and utilities, and land information systems are already web-based (Wayumba, 2013).

After Cadastre 2014 The UN (UN, 2015) has envisioned 17 goals for 2030 in the form of Sustainable Development Goals (SDG). The SDGs are the blueprint to achieve a better and more sustainable future for all; countries require access to an effective, efficient, and modern land administration system (LAS) based on a cadastre engine that contains spatially accurate land parcels and corresponding rights, restrictions, and responsibilities to achieve sustainable development goals (SDGs) (Rajabifard, 2019).

According to many Literature studies have documented that Ethiopia's urban cadastral system has not been successful (Chekole et al., 2020a). The problems and challenges faced in implementing cadastral systems basically fall within the realm of policy and legislative gaps, technical deficiencies, and inadequate institutional arrangements (Tigistu, 2011). There have been many projects developed to implement the urban cadastral system; none of them could be successful. Each of these projects contained trials for implementing cadastral systems, yet these were often not complementary to earlier projects. This has resulted in overlaps, redundancies, and ill-functioning and inconsistent cadastral systems throughout the country the aforementioned issues are results of the absence of a progress performance evaluation of the project in each project phase. In other words, there is no systematic assessment and evaluation of the strengths and weaknesses of earlier projects, and there is no systematic set of guidelines used at the start of projects (Chekole et al., 2020a).

In this framework, using spatial data acquisition techniques that are not standard based, Ethiopia have carried out large-scale mapping for the land certification programs to enhance land tenure security and proper land management. In Ethiopia the program was undertaken in two phases, first level land certification using local land measurement techniques consisting of rope or tape, and traditional measurement techniques known as *timad,* an area of land a pair of oxen can plow per day and the second level is carried out using modern techniques, mainly ortho-images (K. Deininger et al., 2008; Eversmann, 2019).

Therefore; the study shall focus on evaluation of Adama Tows Cadastral information system based on SDI-Readiness Approach designed by Delgado. The SDI-readiness approach integrates factors from various points of view: organizational, national legal agreements, information, access networks, people and financial resources (Delgado *et al*., 2005). The second major aim is to develop a cadastral web map by using a sample parcel block from the study area and publish it on the web in order to stimulate data sharing and dissemination. This enables users to see cadastral maps using a web browser without the need for any geospatial software.

1.2. Statement of the Problem

Cadastral system is carried out to provide a safe and reliable real property registration system to foster land administration which in turn, achieve sustainable development. And a good functioning Cadastral information infrastructure also helps to address the sustainable development goals in the global development agenda (UN-GGIM, 2013). One of the oldest and still continuing issues in geospatial systems and applications is access to spatial data to use it efficiently for decision making. The Internet, in particular the World Wide Web, is fast becoming an integral part of our daily lives and an essential medium for satisfying everyday needs (Skarlatidou et al., 2013). Within the past few years, the popularity of interactive web maps has exploded (Hazzard, 2011).

Many developed countries have already established multidisciplinary land administration systems. For instance, in the Netherlands, the Kadaster information system has been built for the distribution of geographic information, registration of cadastral data, national registration of personal data, real estate. Also, Kadaster has constructed a spatial data infrastructure (SDI) that connects the European land information service system to other sectors (Ebbeling, 2011; Van Oosterom & Lemmen, 2001).

The nature of developments in the modern society dictates the type and quality of land information to be accessed real-time, this is also in support of Land Administrative functions of land tenure, value, use and development (Ogechi, 2021). Providing land tenure security to all remains the ultimate goal of any well-designed cadastral system (Enemark et al., 2014; Silva & Stubkjær, 2002). Despite the role of a cadastral system for sustainable land administration, an estimated 70% of people in Africa did not enjoy secure land and property rights (Rajabifard, 2019).

In order to determine the fulfillment of Sustainable Development Goals (SDG) objectives, cadastral systems need to be effective and sustainable in their implementation. For this reason, performance evaluation mechanisms are needed (Hirano, 2003). Standardized methods or a quality framework to measure and evaluate urban cadastral system around the world are still lacking (Ali et al., 2010). This is maybe largely due to the fact that the natures of cadastral systems are dependent on the cultural and social values of the societies of the prevailing country in which they operate (Shibeshi et al., 2015).

Urban cadastral system of Ethiopia has not been successful due to the absence of nationally agreed methodology that can measure and evaluate the performance of the urban cadastral system policy, absence of systematic assessment and evaluation of the strengths and weaknesses of the urban cadastral system, problems associated with understanding the concept of institutional merger versus institutional divide and exclusion of the private sector from the activities of the cadastral system (Burns et al., 2017). In this respect, for Ethiopia, as an implementer of two types of cadastral systems (urban and rural), there is no nationally accepted methodology that can measure and evaluate the performance of the urban cadastral system (Gebrewold, 2016). In this regard, DB (2020) reported that Ethiopia is ranked 142nd out of 192 countries in the world with respect to cadastral system (Chekole, 2021).

In light of the foregoing, the use of cadastral information systems in supporting of municipal task planning, decision-making, and execution is critical in many ways. In terms of the cadastral Information system of Ethiopia, other cities/towns are more or less the same as or similar and Adama Tows is one of the tows phasing various problems and challenges related to cadastral information system.

Therefore the study is motivated to perform two major tasks. The first task is to evaluate how well the town's Cadastral Information System is performing using primary data such as interviews and questionnaires collected from various stakeholders in Adama Towns Urban Land Management office, including employees with various educational backgrounds, experts, and authorities, by using Delgado's SDI-Readiness Approach. Secondly develop cadastral Web map that includes a sample parcel block from the study area and publish it on the web to encourage data sharing and dissemination, this allows users to view cadastral map in a web browser without having to use any geospatial software.

1.3. Objective of the Study

1.3.1. General Objectives

The main objective of this study is to Evaluate Cadastral Information System of Adama Tows and Develop Cadastral Web Map Using Web GIS Techniques.

1.3.2. Specific Objectives

- ✓ To evaluate the existing cadastral information system of the Tows Based on Acceptable Standards
- ✓ To identify the major existing gaps related to Cadastral information system of the Tows
- ✓ To develop Cadastral Web Map

1.4. Research Questions

- ✓ What scientific methodologies are preferable for evaluating cadastral information system of the Tows?
- ✓ What are the major problems and existing gaps related to cadastral information systems of the Tows?
- ✓ How to Develop Web Map for Cadastral information system?

1.5. Significance of the Study

The major goal of this study is to Evaluate Cadastral Information System of Adama Tows and Develop Cadastral Web Map Using Web GIS Techniques in order to encourage cadastral data sharing and dissemination. The study also included a requirement analysis based on primary data obtained during the study, as well as Develop Cadastral Web Map by using secondary data. The study may be used to fulfill the following gaps:

- ✓ Used to identify the gap of existing cadastral information system of the Tows
- ✓ Used for decision-makers to select a better way in designing cadastral information system for the Tows.
- ✓ Helps the developer in determining the best method for sharing cadastral maps with various stakeholders in the towns.

1.6. Scope of the Study

The scope of this research is confined to evaluate and develop cadastral information system of Adama tows by using Web GIS techniques. And the study is limited to Adama Tows Administration.

1.7. Thesis Structure

This thesis is organized in to five chapters. The first chapter is introduction part, which includes the back ground of the study, problem statements, objectives of the study, research questions, Scope, Significances, and Thesis structure. The second chapter is literature review, and it also includes the theoretical framework, such as definition, methods; empirical framework which includes previous studies related to this study and finally, the conceptual framework developed from the existing theories to achieve the objective of the study. Third chapter contains little overview of description of the study area materials to be used in the study and methods proposed. In forth chapter results obtained from the data analysis to achieve the objectives of the study follows together with interpretation of results and discussion. Fifth chapter contains conclusion part and recommendations for future studies based on the result obtained from the study.

CHAPTER II: LITERATURE REVIEW

This chapter covers the pertinent literature and studies, also be seen as a theoretical, empirical, or conceptual framework.

2.1. Concept of Cadastre

The United Nations and organizations such as the International Federation of Surveyors (FIG) have for many years' undertaken studies to understand and describe land administration systems and particularly the cadastral system component (Ting & Williamson, 2001). Accordingly The International Federation of Surveyors established a working group in 1992 to clarify "The FIG Statement on the Cadaster" (FIG, 1995). The statement explains the Cadaster as an "up-to-date land information system containing a record of interests in land. It usually includes a geometric description of land parcels linked to other records describing the nature of the interests, the ownership or control of those interests, and often the value of the parcel and its improvements." The FIG cadastral concept is shown on Fig: 2.1.

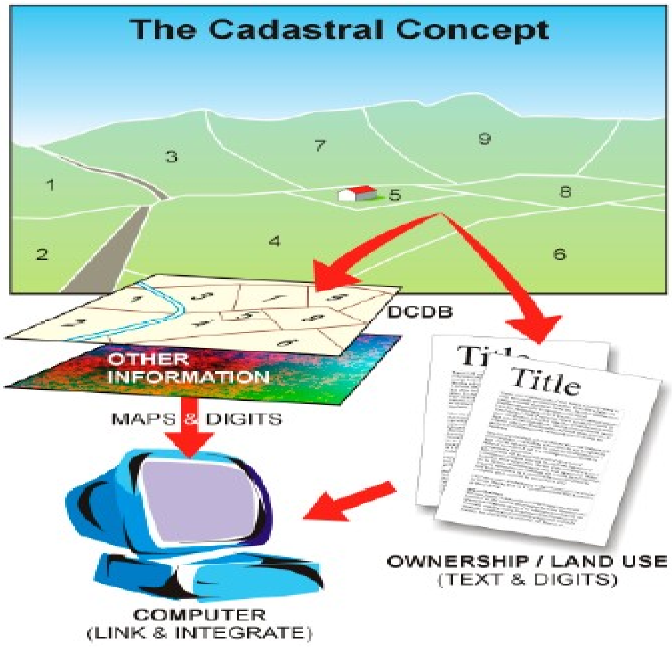

Figure: 2. 1. The FIG cadastral concept (FIG, 1995).

Cadastral systems are the central component of the land administration and land management in a state or jurisdiction (I. Williamson & Henssen, 1990). And supports the institutions in their mandate to maintain transparency, accountability, and responsiveness for the management of social, economic, and environmental issues (Declaration, 2004). Also Cadastres are argued to support good governance, and specifically good land governance (Enemark & FIG, 2010). And Cadastral systems facilitate administration (i.e., both the information management as well as the regulatory processes) of three main areas: Land tenure, land use, and land value. Figure: 2.2, describes cadastral systems as the engine of any land administration system and posits that these underpin any country's capacity to deliver sustainable development (Enemark, 2006).

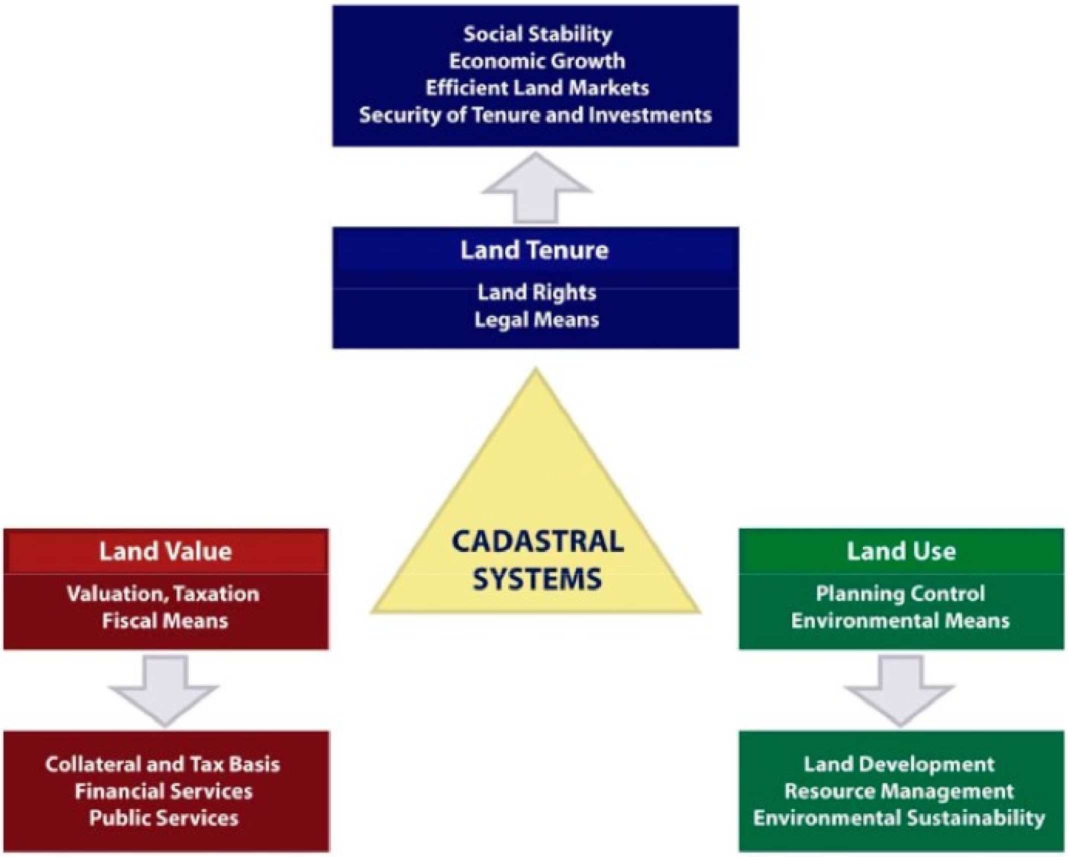

Figure: 2. 2. The nexus among cadastral system, land use, land value, and land tenure (Enemark, 2006).

Cadastral systems are dependent on a country's contexts of political, social, and economic dimensions. Due to this, cadastral systems are also different in different countries since policies, regulations, institutions, economic level, political ideology are specific. In some countries, cadastral system and land administration system are treated as the same while different in other countries (Krigsholm et al., 2017). Even, within the European countries, how cadastral information is collected and managed differs considerably. Some countries operate their cadastral system by separate institutions while others operate by a single institution (UNECE, 2014).

Modern cadastres are argued to have evolved from those found in ancient Mesopotamia into fiscal, legal, and multipurpose cadastres (I. Williamson et al., 2010): fiscal cadastres support land valuation and taxation; legal cadastres support security of land rights; and multipurpose cadastres support land use planning and management functions in addition to fiscal or legal functions. Con-temporary literature argues these cadastres are one prerequisite for economic, social, and environmental development under any form of land tenure regime (K. Deininger & Feder, 2009; K. W. Deininger, 2003).

2.1.1. Components of a Digital Cadastral Map

According to (Wan & Williamson, 1995) A digital cadastral mapping system should have the following components

- ✓ Reference to a geodetic control network.
- ✓ Current base map layer (ideally, photogrammetrically derived).
- ✓ A cadastral layer delineating all real property parcels.
- ✓ Vertical aerial photographs and/or images (ideally, ortho-rectified).
- ✓ A unique parcel identifier assigned to each parcel.
- ✓ A means to tie spatial data to attribute data (owner- ship and parcel characteristic files).
- ✓ Additional layers of interest to the assessor, such as municipal boundaries, zoning, soil types, and flood plains.

2.2. Cadastre in Ethiopia

The origins of the cadastral system in Ethiopia dated back to 1907 when Menilek II signed Ethiopia's first decree related to urban land administration (K. Deininger et al., 2008). It was by a French company that the cadastral system was introduced but remained without maintenance for more than 80 years (Chekole et al., 2021). Now days Ethiopia, as one of the fastest developing countries in Africa, is in the process of implementing a modern urban cadastral system at the country level (Chekole et al., 2020a).

2.2.1. Current Cadastre Unique Identification System of Ethiopia

To locate a parcel in the cadastral map, it is necessary to link the parcel number with the geometry of the map, i.e. the geodetic reference system. Therefore an independent district and numbering concept for cadastral purposes with the Woreda as the smallest cadastre district was proposed by Hansa Luftbild and accepted by AACA (Addis Ababa City Administration). This unique identification numbering system for the parcels consists of 14 digits with the following information code: (Zein et al., 2012) rrcccsswwppppp

rr   number or code for the region (AA for Addis)

ccc   number of tows (000 for Addis)

ss   number of sub-tows (e.g.: 06 for Bole, 08 for Nifas Silk Lafto)

ww   number of Woreda (e.g.: 10 at Bole)

ppppp number of parcel (00001, 00002, 00003, …)

As an example: Parcel 235 in Woreda 10 of Bole (06):

AA000061000235

This concept uses parcel boundaries as district boundaries and includes road, railway, and river parcels. It is intended that this numbering will remain constant regardless of any future changes in administrative boundaries. Furthermore it is very similar to the German system which has continued to run reliably for more than 100 years (Zein et al., 2012).

The advantages of this solution are:

1. It is independent of future changes in administrative structure;
2. Database consistency checking is simple because a check on area coverage of the parcels within the cadastre district (Woreda) is possible;
3. Special numbering concept for roads, railways and rivers is not needed.

All buildings inside the parcels were also captured and were also assigned a unique identification number. The number consists of 15 digits defined by the following code:(Zein et al., 2012).

Rrcccsswwbbbbbb

rr   number or code for the region (AA for Addis)

ccc   number of tows (000 for Addis)

ss   number of sub-tows (e.g.: 06 for Bole, 08 for Nifas Silk Lafto)

ww   number of Woreda (e.g.: 10 in Bole)

bbbbbb   number of building (000001, 000002, 000003, …)

As an example:

Building 439 in Woreda 10 of Bole (06):

AA0000610000439

2.3. Countries Practice in modernizing their Cadastral Information System

Today, many countries in the West have moved from the traditional cadastre to modern multi-purpose cadastre through the implementation of Cadastre 2014. These countries include Sweden, Denmark, Netherlands, Germany, Canada, USA, Australia and New Zealand among others. In the majority of the countries, land registries have been modified to include coded building information and utilities, and land information systems are already web-based (Wayumba, 2013).

Accordingly many developed countries have already established multidisciplinary land administration systems. For instance, in the Netherlands, the Kadaster information system has been built for the distribution of geographic information, registration of cadastral data, national registration of personal data, real estate. Also, Kadaster has constructed a spatial data infrastructure (SDI) that connects the European land information service system to other sectors (Ebbeling, 2011; Van Oosterom & Lemmen, 2001). And also In Korea, the KLIS land information system was set up to accurately manage the land information database (Hwa, 2014).

Also Currently in Kenya, the Ministry of Land and Physical Planning (MoLPP) has developed a web-based NLIMS (National Land Information System) dubbed Ardhisasa. Ardhisasa is an online platform that allows Citizens, other stakeholders and interested parties to interact with land information held and processes undertaken by Government. It was developed through the joint efforts by the Ministry of Lands and Physical Planning (MoLPP) and also the National Land Commission (NLC) and key stakeholders in Government. The NLIMS provides an interface on which applications for various services offered by the Ministry and the Commission are lodged. The applications are handled through the platform and responses presented through it. The applicant first of all registers their credentials in the system before they can log in for the land services (Ogechi, 2021).

Some of the land services to be accessed through the Ardhisasa LIS platform include;

- ✓ Land Registration – Caution, charge, lease, registration of titles, replacement of title, restriction, search, stamp duty, transfer.
- ✓ Land Administration – Pay land rent, Subdivision, extension of lease, change of user, consent, lease preparation, extension of user, renewal of lease.

- ✓ Physical planning – Approval of part development plans, plan requisition, certificate of compliance.
- ✓ Survey and Mapping – Subdivision, amalgamation, new grant, sectional property, extension of lease, change of use.
- ✓ Valuation – Assets valuation, government leasing, government purchase, estate administration, arbitration.
- ✓ Adjudication and settlement – Adjudication and settlement.
- ✓ National Land Commission – Land Allocation

2.4. Spatial Information in Cadastral System

Land management with the use of information and communication technology (ICT) is a crucial element for improving housing management and urban development (Aydinoglu & Bovkir, 2017). Also by adding geo-coded addresses, cadastres can show how parcels of land are arranged into properties and businesses (I. P. Williamson & Wallace, 2007). However, the re-engineering of cadastral and land registration systems using Geo-ICT infrastructure to support various demands encounters challenges including financial, technical, legal and organizational (Tuladhar, 2003).

The generation of accurate and good functioning cadastral information depends on the quality of data acquisition processes (in terms of data accuracy, metadata, standard, and workflows), information dissemination platform, and its management framework in line with how and why decision-making processes occur. One school of thought to make this functional is by designing some sort of harmonized governance of land information (I. P. Williamson et al., 2006). According to (Crompvoets et al., 2018) governance of cadastral information can be realized 'through the assignment of related tasks to one single organization or through the division of tasks among different organizations'. Additionally, spatial data infrastructures (SDI) provide an important platform to share and disseminate the existing data (Sjoukema et al., 2020).

The development of cadastral system was and still is determined by the dynamics of the growth needs of globalization, including changes of many factors such as: the development of spatial information technology (IT), development of the theory of sustainable space development, intensity of natural phenomena and the economic need for 3D/4D visualization in real time, the desire to data standardization / normalization and the interoperability of the systems (Dawidowicz & Źróbek, 2011).

Particular attention should be given to the dynamics of the multiple systems technological modernization due to the creation of advanced information technology (IT) arising with the trend of globalization. An important feature of globalization was to create a global information system, whose main link is the connection global network and especially the Internet system providing comprehensive ability to communicate. Development of the Internet is also possible to access to a wide range of geospatial information, including cadastral information (Dawidowicz & Źróbek, 2011).

2.5. Web Mapping

Since the beginning of the web and the first World Wide Web conference in 1994, the interactions among and between information and people have evolved dramatically. Also over the past few decades, in line with the increasingly expansive presence of the internet in daily activity, both personal and commercial, the availability of spatial information online has grown exponentially and has led to the rapid transition of GIS technologies from stand-alone GIS systems for the GIS expert to networked systems supported by distributed client-server applications (Lemmens et al., 2006). These distributed applications, also known as web mapping applications or web GIS in the Cloud, are defined by Esri, the leading commercial provider of GIS technologies, as any GIS interface which makes use of web technology to communicate between a client and server and is available as a web browser, desktop application or mobile application. These distributed web mapping applications allow users to access, interact and visualize spatial information dynamically from a range of often heterogeneous data sources and communicate effectively with other users based on this information (Rowland et al., 2020).

The web now is not simply a developing technology for content, but involves people who generate content, communicate and interact in collaborative environments (Hall & Tiropanis, 2012). New user needs evolve which are accommodated in further technology developments, which in turn lead to wider usage and additional user needs creating an iterative cycle of technology development and user/application growth and expansion. Moreover, from the technological point of view the methods and tools for making maps available on the web have changed dramatically. The early origins of web mapping applications were "simply" tools allowing agencies and individuals to publish maps with user choices limited to browsing, zooming, panning, and turning on/off layers (Veenendaal et al., 2017). The users were supposed to be active readers of the data but passive with respect to the possibilities of uploading pieces of information to the map itself and performing often-needed spatial analyses. Today, web mapping applications are introducing a broader range of functionality, including what traditional desktop GIS has provided but expanding beyond that to incorporate growing application requirements, with the advantage of being able to share content and analyze map data on the web (Veenendaal et al., 2017).

The concept of web mapping is more general and focuses on providing and supporting mapping functions at different levels of complexity, for applications and users. There are more terms, which are sometimes confused with web mapping and Web GIS. These include Internet GIS, Geo-Web (or Geo-spatial Web) and Distributed GIS. Internet GIS is a term often used synonymously with Web GIS and it is an Internet geospatial application that can use more services than only the web. Therefore, it is broader with respect to the applied technology, but not as pervasive in usage as the term Web GIS. In reality, the web is the most commonly used Internet technology and Web GIS is the most common form of online GIS (Veenendaal et al., 2017).

2.6. Open Source Software's (OSS) for Cadastre

In deploying new, or modernizing existing land administration and cadastre systems the relevant authorities / agencies are often confronted with an important decision - should they use open source or proprietary software? Neither option can fully cater to the requirements of land administration and cadastre authorities. Both types of platform will require customization in order to meet the requirements of the requesting authority, region or country. The motivation of proprietary software companies is to make a profit and commercial foundation of proprietary software is the license. The more licenses sold the more profit the software company makes. And also Proprietary software companies are under pressure to continually upgrade their products and to sell users upgrades and new versions. Whenever there is a new software release, customized applications have to be updated (ZEIN et al., 2015).

Open source software refers to products, in which source codes are publicly available, and users have free access to them. Moreover, open source software allows viewing, modifying, and upgrading of source code based on certain principles. Currently, open source software includes software running on the server and workstation. Open source software on the server: the main functions are the spatial database management, attribute, and analysis, information processing. On the other hands, workstation software is mainly used for accessing information, analyzing data on personal computers (Quang Cuong et al., n.d.).

According to ZEIN et al., (2015) there are several license types for OSS. The best known are:

- ✓ GNU General Public Licence (GPL) (FSF, n.d.)
- ✓ Apache License (Apache, n.d.)
- ✓ MIT license (MIT, n.d.)

All these licenses have features in common, which form the core characteristics of OSS. These features are:

- ✓ The source code is available, can/must be distributed, and can be modified
- ✓ No licence fees are charged

Although OSS does not charge for software usage (licensing costs), costs may still be incurred by the end-user. These will be the result of software tailoring, and services such as support and training (ZEIN et al., 2015).

2.6.1. Countries Practice on using (OSS) for their Cadastral Information System

In Germany most regional spatial data infrastructure solutions have been implemented on the basis of open source software. The Bavarian Administration for Surveying and Geo-information uses self - developed tools based on open source software to capture / store data and deliver data via web services (Steudler et al., 2010). The administration decided to implement its digital cadastral and land administration systems using OSS because any available proprietary software would have needed extensive customization to meet their requirements. Figure 10 shows the elements of the Bavarian surveying and geo data management system (ZEIN et al., 2015).

The customization of the OSS was undertaken by software developers employed by the Bavarian Administration for Surveying and Geo-information (ZEIN et al., 2015). These developers also implemented applications and tools to manage and administer the cadastre and geospatial data. The Bavarian cadastral data was integrated into the national spatial data infrastructure through several web services which are also based on open-source software. The positive experience of the Bavarian land information administration with OSS led to the Bavarian government requesting its public administration to implement, as far as possible, OSS for all information technology requirements. The benefits of open source as viewed by the government are multiple - reduced software licensing and software maintenance costs, independence from software vendors, and software updates and bug fixes quickly and efficiently implemented (ZEIN et al., 2015).

A further German example is that of the tows of Bonn. Many of the cities administrative departments, including the cadastre and land administration services, have implemented technology solutions using OSS. Figure 11 shows the current system infrastructure technology of the Bonn geo data management system and the OSS used to develop it. More than two thirds of the cities 30 administration authorities input and maintain data on a daily basis. The entire system is essentially always current (ZEIN et al., 2015).

2.7. Cadastral Data Base (CDB)

The cadastral database also contributes to the work of land registration that aims at filling the cadastral file system to protect the legitimate rights and interests of land users. Database design and creation is one of the fundamental processes in every Cadastral work executed. It is the process by which real world entities and their relationships are analyzed and modeled in order to solve specific problems and find solution to questions of interest. A database is designed to serve the need of a group of users. Such needs are called the information needs of the users or the user requirements. The heart of a geographic information system is a well-structured database i.e. spatial database (Kufoniyi, 1998).

The design and implementation of a digital cadastral system which require an approach that enables the integration of cadastral operations with GIS packages and a tool that should be use in a multipurpose system can be achieved through three levels (El Ayachi & Semlali, 2001).

i. In the first level, the existing cadastral applications must be understood and all projects conducted for modernizing cadastral system should be analyzed;
ii. In the second level, it is necessary to outline different methods for linking cadastral data models to GIS software, where the existing methods, their strengths and weaknesses are discussed;
iii. The third level is concerned with the manner by which the conceived system is implemented.

2.7.1. Evolution of Digital Cadastre Data Base

In 1980, the Digital Cadastral Data Base (DCDB) was formed, and cadastral records were computerized. During the 1990s, land administration improved with the development of the internet. Cadastral maps and cadastral data were developed (alongside other technologies in computing) using the internet after 2000 (Enemark, 2009a; I. Williamson et al., 2006). The first period, before 2001, was characterized by the computerization of cadastral maps through computer programs such as geographic information system (GIS). In the second period from 2002 to 2007, the use of digital cameras in papers relating to land registration steadily increased. In 2005, the cadastral maps of keyword network maps were used as a source of information that integrated various projects led by the government, such as land, real estate, and local operations (Zhang et al., 2017). In this period, the capacity was developed to manage land, ownership, limits, and obligations; this formed the foundation of sustainable improvement (R. Bennett et al., 2005). During the third period, which extended from 2008 to 2019, papers related to land administration (based on spatial information) were released (Choi, 2020).

2.7.2. Open Source Software's for Cadastral Data Base Design

Currently, database management systems are quite diverse, but the most popular database management systems are PostgreSQL and MySQL. This database management system is capable of spatial data management thanks to the Spatial Extensions extension which enables the archiving of the analysis of Geographic Functions. PostgreSQL is the database management system used primarily in spatial data-related fields. PostgreSQL has an extension for spatial data management, PostGIS, compared to the spatial extension of MySQL. PostGIS provides functions to analyze and process spatial data in a powerful way (Quang Cuong et al., n.d.) In addition, PostgreSQL and PostGIS are supported by proprietary software, including ArcGIS and become de jure standard software for spatial data management (Ebbeling, 2011).

Map Server is a favorite open source project, which aims to display dynamic spatial maps on the Internet (Steiniger & Hunter, 2013). MapServer includes a number of critical features, including support for presenting hundreds of vector data formats, raster and database formats, and support for a variety of operating systems (Windows, Linux,...), supports programming languages such as (PHP, Python,...) to provide advanced utilities (Steudler, 2009), good quality output, and is used by many open source software (Quang Cuong et al., n.d.). Currently, there are several map server platforms such as GeoServer, MapServer, and Degree. The map server connects to database management systems such as PostgreSQL / PostGIS, ArcSDE, and supported by WebGIS standards such as Web Map Service, Web Feature Service, Transactional WFS (Quang Cuong et al., n.d.).

2.8. Spatial Data Infrastructure (SDI)

The future of spatial data today is focused on global emerging challenges aimed at improving lives. International organization like United Nations (UN), Economic and Social Council (ECOSOC) have established programs 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).

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). National spatial data infrastructure NSDI are being implemented by many nations to better manage and utilize spatial datasets (Rajabifard et al., 2003). 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 & Osanwuta, 2004). And assessment of NSDI are vital for accountability and guide to development of NSDI (Masser, 2005).

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 (Mavima et al., 2001). The development of SDIs involves a wide cross- section of partners from various organizations and institutions each with various perspectives relative to how well an SDI is meeting its needs (Grus et al., 2008). In April 2005, 83 countries develop NSDI clearing houses on the internet. 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 (Grus et al., 2007).

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). 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).

2.8.1. Spatial Data Infrastructure (SDI) Readiness Approach

The SDI-readiness approach integrates factors from various points of view: organizational, national legal agreements, information, access networks, people and financial resources. Each of these factors consists of different indicators that are quantitatively measured (Delgado Fernández 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 Fernández 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.

2.9. Concept of Land Information System

Land Information System (LIS) is a tool for legal, administrative and economic decision making as well as an aid for planning and development. Also LIS is further subdivided into parcel and non-parcel based. Non-parcel based LIS include natural resources information system. Activities within the non-parcel based LIS could include habitat, evaluation, conservation easement procurement, wildlife evaluation, earthquake and landslide prediction, flood hazard abatement, chemical contamination evaluation, forest and range management, and scientific investigation. Parcel-based LIS application is generally focused on land ownership and other cadastral investigations (National Academy of Sciences, 1983). The base of a land information system is a uniform referencing system that could facilitate in linking the different types of data within the system and with other land related datasets. The most important thing in the land information management is the quantity of the data which can be handled, the speed with which these data can be processed and the ways in which the data can be manipulated and analyzed (Dale & McLaughlin, 1988).

2.10. Land

Land is the ultimate resource, without which, life on earth cannot be sustained (Europe et al., 1996). The 2030 Agenda for Sustainable Development puts land at the center of accelerating and achieving the Sustainable Development Goals (SDGs) worldwide. The reason is that land plays a significant role in sustainable development due to its multiple economic, social, political, and cultural dimensions. In terms of the economic aspect, it serves as a basis for livelihood; in terms of the social aspect, land is a space for interaction; in terms of politics, land is a source of power; in terms of culture, land is a symbol of collective identity (Dale & McLaren, 1999).Also Land management encompasses all activities associated with the management of land that are required to achieve sustainable development. Under the umbrella of land management, cadastral system plays major role by ensuring that land is secured (Chekole et al., 2021).

The United Nations Global Geospatial Information Management (UN-GGIM) has affirmed in the Addis Ababa declaration for “Good Land Governance for Agenda 2030” that strong land administration institutions are required to support effective and efficient land administration and management to address the need to secure land and property rights for all (UN-GGIM, 2014). According to UN-GGIM institutional arrangement is defined as the formal and informal structures that support organizations to establish the legal, organizational and productive frameworks. This type of arrangement establishes the sustainable management of geospatial information, inclusive of its creation, updating and dissemination of geospatial data. This in turn provides an authoritative, reliable and sustainable geospatial information base for all users (UN-GGIM, 2014).

2.10.1. Land According to Ethiopia

In Ethiopia, rights to property are stipulated in the constitution of the Federal Democratic Republic of Ethiopia Proclamation No. 1/1995. The rights to ownership of rural and urban land, as well as of all natural resources, are exclusively vested in the State and in the peoples of Ethiopia. Also all land is a common property of the Nations, Nationalities and Peoples of Ethiopia and shall not be subject to sale or to other means of exchange (Federal Democratic Republic of Ethiopia, 1995). Land can be transferred, through inheritance, by a landholder to members of his family. In addition, peasant farmers, semi pastoralists and pastoralists with holding certificates can lease land to other farmers or investors from their holding of a size sufficient for the intended development in such way that shall not displace them. Also a landholder using his land use right may undertake development activity jointly with an investor (Federal Democratic Republic of Ethiopia, 2005). To realize the common interest and development of the people, no person may acquire urban land other than the lease holding system (Federal Democratic Republic of Ethiopia, 2011).

Currently in Ethiopia, urban land is under the responsibility of Ministry of Urban Land Development, Housing and Construction (MULDHC). Within this institution, urban land right provision is undertaken by the Urban Land Development and Management Bureau (ULDMB) while the cadastral system is overseen by the Urban Land Adjudication and Registration Information Agency (ULARIA). As an integral part of the land administration, the Constitution promotes the implementation of cadastral systems. Given this empowerment, the urban land is administered and managed by the legal frameworks of Proc. Nos. 721/211 and 818/2014 (Dale & McLaren, 1999). These proclamations dictate the modality of urban land acquisition and registration, respectively. The institution undertaking these mandates is the Ministry of Urban Development, Housing and Construction (Chekole et al., 2020b).

2.10.2. Land Administration Domain Model (LADM) in Ethiopia

After assessing the strengths and weaknesses of Cadaster 2014, LADM was introduced to establish a shared ontology that enables communication amongst the geospatial community. The growing recognition and influence of LADM are revealed by the multiple country profiles that have been developed based on the standard in various jurisdictions across the world. Accordingly, several countries have contextualized the model into their circumstances and contexts, in which Ethiopia is one of them. Ethiopia Land Administration Domain Model (ELADM) was introduced after the introduction of LADM. Likewise, Turkey, Croatia, Colombia, etc. applied LADM in their land administration system (Kalogianni et al., 2021).

Modern LAS implementations frequently take as a reference the ISO standard Land Administration Domain Model (LADM) (ISO 19152:2012). This standard is the result of wide-ranging consultations between many international experts; thus, its use in developing an LAS ensures access to a common terminology vis-à-vis land administration systems and their computerization (ZEIN et al., 2015).

The ISO LADM has two main goals:

- ✓ Providing an extensible basis for the development and refinement of efficient and effective land administration systems, based on a Model Driven Architecture (MDA), and
- ✓ Enabling the involved parties, both within one country and between different countries, to communicate, on the basis of the shared vocabulary (that is, an ontology) implied by the model.

Therefore the ISO LADM is a conceptual framework for the static part of an information system, and for interfaces. Furthermore it provides ontology as a foundation for information exchange and interoperability. LADM is not a data model; however, a concrete data model can be derived from it (ZEIN et al., 2015).

The ISO LADM defines structures for the following phenomena: (ZEIN et al., 2015)

- ✓ Parties (people and organizations);
- ✓ Basic administrative units, rights, responsibilities, and restrictions (ownership rights);
- ✓ Spatial units (parcels, buildings and networks);
- ✓ Spatial sources (surveying / mapping); and
- ✓ Spatial representations (geometry and topology).

In 2011 the ISO LADM formed the basis for the development of a real property registration system for the tows of Addis Ababa. It was used as the base conceptual model and a two-step development process was followed. First the conceptual model of the land administration domain was developed. This was followed by the development of the database implementation (ZEIN et al., 2015).

CHAPTER III: MATERIAL AND METHODS

3.1. Description of the Study Area

Adama Tows stretches between $8^0$26'15" N to $8^0$37'00" N latitude and $39^0$12'15" E to $39^0$19'45" E longitude (Fig. 3.1) and occupies 134.11 sq. km (Bulti & Sori, 2017). And Adama Town has excellent development potential and is expected to play a significant role in the systematic and integrated development of the nearby urban and rural areas due to its strategic location along the railway line that connects the port of Djibouti with Addis Ababa and at the intersection of major routes to Addis Ababa, Arsi, Harar, and other hinterland areas of high economic importance. And also additional expressway was constructed due to this travel time from Addis Ababa (Tulu-Dimtu) to west Adama 60km which was minimized travel to 45 minutes. Now a day Adama tows is made up of 14 urban and 4 rural kebeles which organized under 6 sub-cities (Terfa et al., 2019).

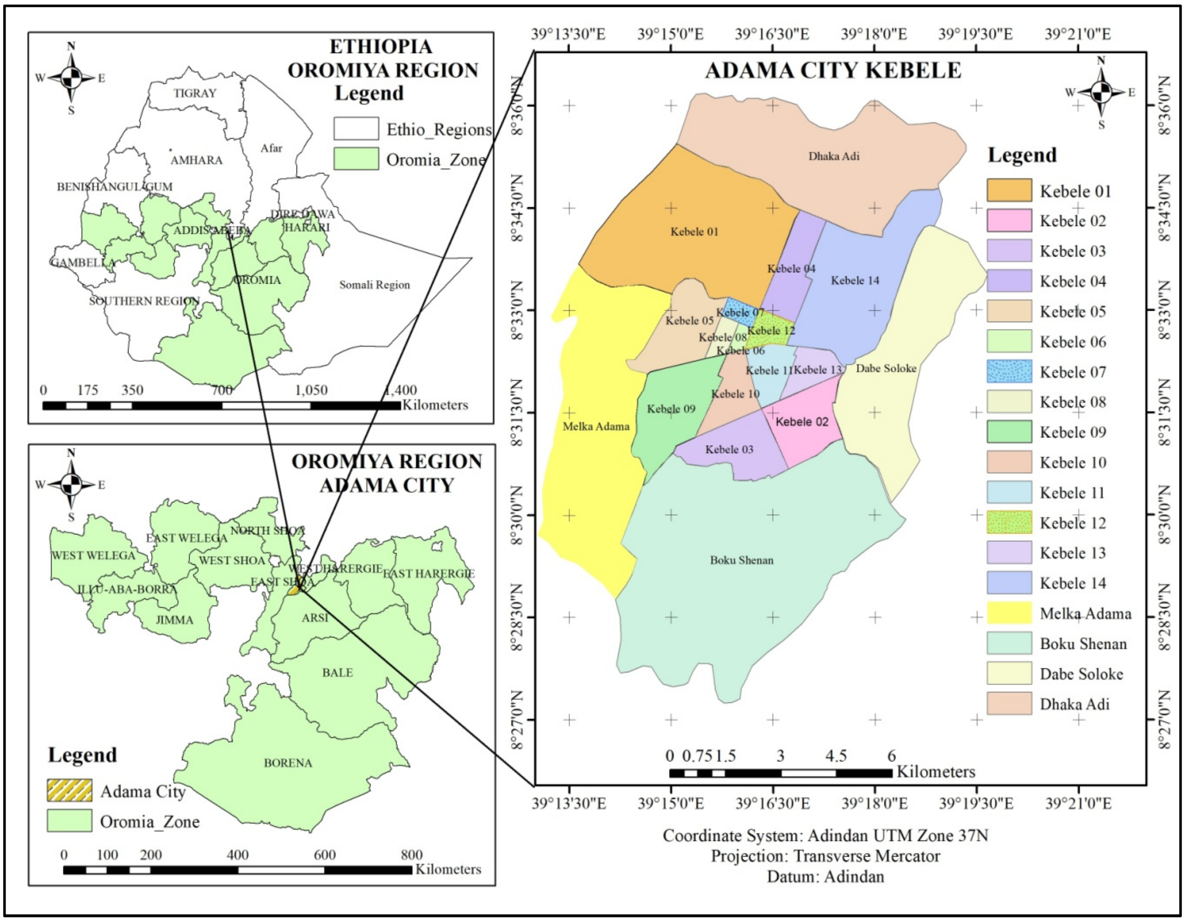

Figure: 3. 1. Location of the Study Area

3.2. Method of Data Collection

As stated in chapter one of the study by the researcher, both primary and secondary data were employed to meet the study's main objectives. And the following are the methods and tactics used to acquire primary and secondary data:

3.3. Primary Data Collection

The SDI-Readiness Approach, developed by Delgado, was used to collect primary data from Adama Tows Urban Land Management office staff with various educational backgrounds, Authorities, and experts. The SDI-readiness approach integrates factors from various points of view: organizational, national legal agreements, information, access networks, people and financial resources. Also Each of these factors consists of different indicators that are quantitatively measured. 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. The SDI-readiness index is calculated based on the value of the 16 indicators of SDI readiness (Table: 3.1).

Table: 3. 1. SDI-Readiness measurable factors adopted from (Delgado *et al*., 2005)

Assessment Global factor	Decomposed Decision Criteria
Organizational	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

Also the following study approach was utilized to collect primary data, which included questionnaires and interviews with Adama Tows Urban Land Management office workers from diverse educational backgrounds, authorities, and experts:

3.3.1. Type of Research Conducted

Mixed research Method is conducted in order to fulfill the objectives of the studies. And mixed research methods include the combination of qualitative and quantitative research work which contains mixture of variables and words are included. Also mixed methods are a research approach that attempts to answer research question through the collection and analysis of both quantitative and qualitative data.

There are three types of mixed methods Research questions:

- Explanatory
- Exploratory and
- Convergent

All three types of questions rely on both quantitative and qualitative data, but the three differ in the order in which data are collected. Also the three types of mixed methods research questions also differ in how the quantitative and qualitative data are used once they have been collected and analyzed. For the current studies question convergent mixed methods, in which quantitative and qualitative data can be collected at about the same time and are then used together to triangulate the findings and answer the research question are selected.

3.3.2. Scale for Research Questions

In order to develop a questionnaire, the researcher performs a number of steps. Step one is to select a suitable scale. Subsequently, the most commonly used scale is Likert scale. Likert scale was invented by a social Psychologist called Renesis Likert ant it is a kind of a scale that is rating scale also it's a psychometric testing to measure for peoples believes, attitudes opinions toward to a particular question or statement. According to designed questions which is close ended in the questionnaires, it have only single choice and no extra explanation for it, just that's why the researcher is utilize Likert scale. Also Likert scale is a continuum Scale from highest to lowest point so it goes into points from two (2) points to ten (10) points. Finally the researcher is choosing three (3) point Likert scales in which the individual can answer a question.

3.3.3. Type of Questions used in the Study

According to the nature of the study close ended questions methods can used because closed ended questions are simple and concise. Many times close ended questions can either be answered in a yes or no, or the respondent has to pick one or multiple options from a set of options. Also in closed ended questions respondents are asked only a set of predefined answers in the form of yes or no, or a set of multiple options or rating scale and the respondents choose from those set of answers.

The difference between open ended and closed ended questions are when open ended questions are the questions that should be answered with long responses where as Close ended questions are the questions that should be answered with short responses. Also in open ended questions, the answers are often descriptive and explanatory while in close ended questions, the answers are short and factual.

Because of the nature of the studies, the following options are in closed ended questions, which is why the researcher used close ended question methods:

- ✓ Close ended questions can be completed in a shorter time frame because they are brief and straight to the point
- ✓ Also data collected through open ended questions are usually reported as an individual or group verbal responses. While the data provided from responses to close ended questions are typically reported as statistical information.

3.3.4. Approach of selecting Respondent

The researcher utilized non-probability sampling to select respondents because selecting respondents by probability method takes too much time, and because identifying and differentiating respondents on this subject wants to do its own research by itself.

Some terms used in Non-Probability sampling are mentioned below to explain why the researcher chose Non-Probability sample:

Basis of Respondent selection: Arbitrary and when probability sampling is random

Methods: Subjective (Related Person in contact with the issues)

Sampling methods: Convenience sampling, voluntary response, Purposive sampling, Snowball sampling and Quota sampling

3.4. Secondary Data Collection

Secondary data was gathered from several organizations to accomplish the study's goal, as shown in Table: 3.2.

Table: 3. 2. Materials used for the Study

Type	Sources	Specifications	Purpose
Ortho Photo	Adama Tows Urban Land Management office	2005 E.c & 2010 E.C	For Comparing Digitized Parcel
GCP Data	Adama Tows Urban Land Management office	Second order	To Identify Ground Control Points
CAD Maps	Adama Tows Urban Land Management office	Base Map of Adama tows	
CAD Maps	Adama Tows Urban Land Management office	Adama Tows Master Plan	For generating spatial data
CAD Maps	Adama Tows Urban Land Management office	Adama Tows Structural Plan	For Generating spatial data
Shape files of Adama tows Administrativ e Boundary	Adama Tows Urban Land Management office		
Sample Parcel Block	Adama Tows Urban Land Management office		For Web Map Development
Socio-Economic Data Contain full Owners (Attribute)	Adama Tows Urban Land Management office	Updated Data	For non-Spatial data extraction

3.5. Software's

In this study, different software was used to achieve the main Objectives of the study as tabulated in Table: 3.3.

Table: 3. 3. Soft Ware's used for the Study

Type	Software`s Characteristics	Specifications	Purpose
Arc GIS	Crack Version	Arc GIS 10.8.1	For data extraction and analysis
QGIS	Crack Version	QGIS Desktop 3.24.3	For data extraction and analysis
Civil 3D	Crack Version	2018	For data extraction and analysis
Global Mapper	Crack Version	2018	For data extraction and analysis
Google Earth	Open Source	Current version	For parcel location and addressing
Microsoft Excel	Crack Version	2016	For analyzing Data

3.6. Web Map Development

After observing the towns Cadastral Information System, the researcher intended to create a Web map to demonstrate modern Cadastral Information System. The data that the researcher working with for this particular task is; Google map (satellite map) as the base map, just under the list of the QGIS quick map services and Mainly Use Shape files of Sample Parcel block and Ortho photo obtained from Adama Tows Land Management office.

3.7. Work flow of the Study

The following work flow will be utilizing the Study Figure: 3.2.

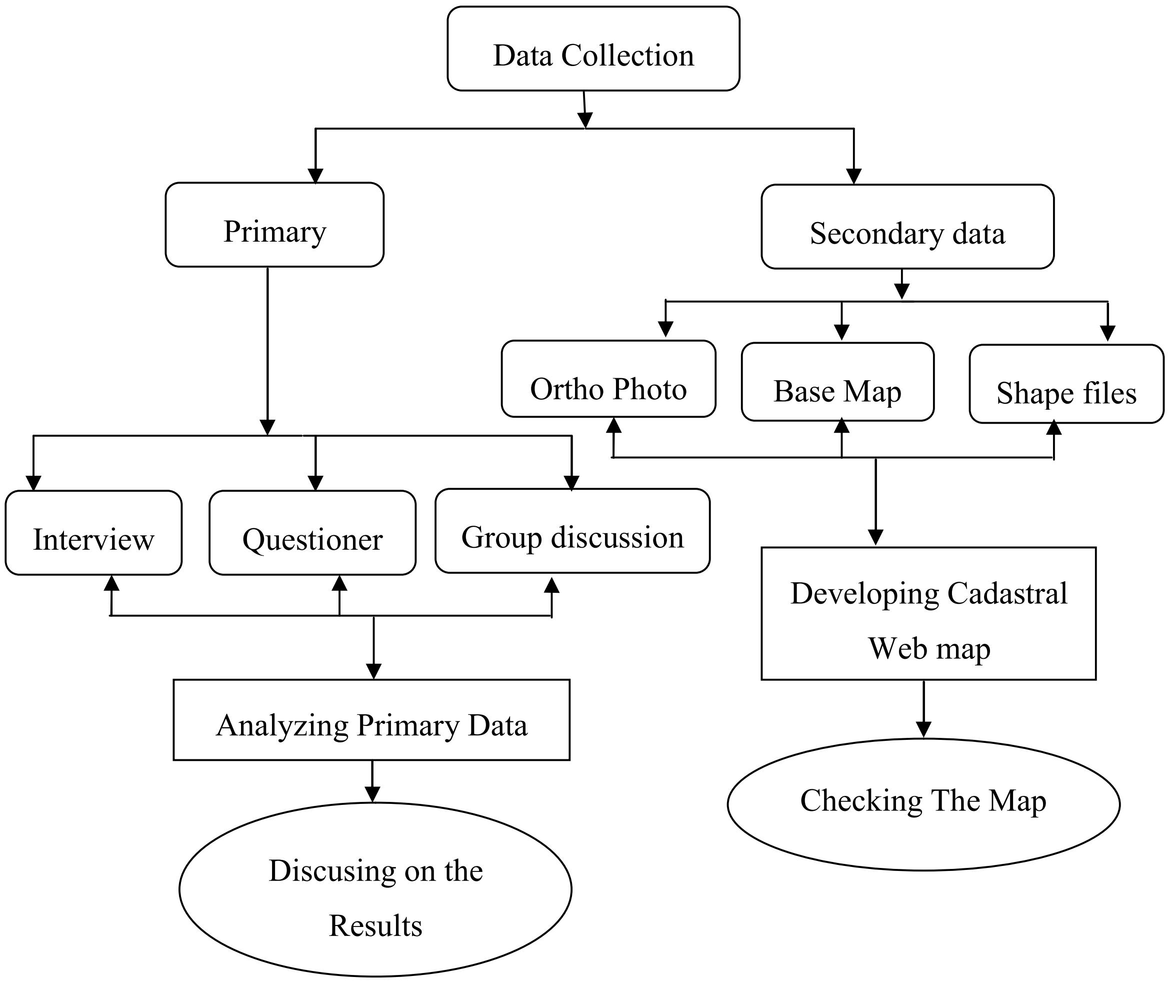

Figure: 3. 2. Work flow of the Study

CHAPTER IV: RESULT AND DISCUSSION

This chapter will describe the findings of the analysis conducted in order to meet the study's main objectives by utilizing primary and secondary data in accordance with the methodology developed. As a result, this chapter covers data analysis and the Discussion on the results obtained from the studies.

4.1. Assessment of Existing Cadastral Information System of the Tows

To assess existing cadastral information system of the Tows the researcher conducted constructed interview with the Adama Tows Urban Land Management office Authorities and experts by using SDI-Readiness Approach Designed by Delgado *et al. (2005).* The SDI-readiness approach integrates factors from various points of view:

- ✓ Organizational
- ✓ Information/Data Availability in Digital form
- ✓ People
- ✓ Access to networks, and
- ✓ Financial resources

Each of these factors consists of different indicators that are quantitatively measured. Based on the results analyzed in the study the result is presented as follows accordingly;

4.2. Organizational

4.2.1. Politician will regarding to geospatial Data

As shown in Table 4.1, 6.67 percent of respondents believe that politicians' intentions to geospatial data are highly implemented in the tows, whereas 60.00 percent say that politician intentions regarding geospatial data are on the Middle level. In addition, 33.33 percent of respondents are unsure about the topic. This reveals that even within the tows administration, respondent perceptions of politician's intentions regarding geospatial data is different from each others.

Table: 4. 1. Respondents views on the Politician will regarding to geospatial Data

Indicator	Frequency	Percent
High	2	6.67
Medium	18	60.00
Not sure	10	33.33
Total	**30**	**100.00**

4.2.2. Institutional leadership

During the study, respondents were asked about their thoughts toward institutional leadership awareness. As a result, Table 4.2 shows that approximately 9 experts (30.00 percent) confirm that institutional leadership awareness is Medium, 3 experts (10.00 percent) confirm that they are unsure whether institutional leadership awareness exists, and 18 experts (60.00 percent) believe that institutional leadership awareness is highly implemented in the tows. This shows that institutional leadership in the local government is well-communicated on the subject.

Table: 4. 2. Respondents views on the Institutional leadership

Indicator	Frequency	Percent
High	18	60.00
Medium	9	30.00
Not sure	3	10.00
Total	**30**	**100.00**

4.2.3. Umbrella legal agreement

As indicated in Table 4.3, 27 respondents (90.00%) believe that umbrella legal agreement awareness is widely implemented in the tows, whereas 6.67% believe that umbrella legal agreement are on the Middle level. Furthermore, 3.33 percent of respondents are unsure about the subject. The result is shows that the local governments are well-communicated on the subject.

Table: 4. 3. Respondents views on the Umbrella legal agreement

Indicator	Frequency	Percent
High	27	90.00
Medium	2	6.67
Not sure	1	3.33
Total	**30**	**100.00**

Summary of SDI-readiness approach integrates factors from various points of View according to Organizational factors.

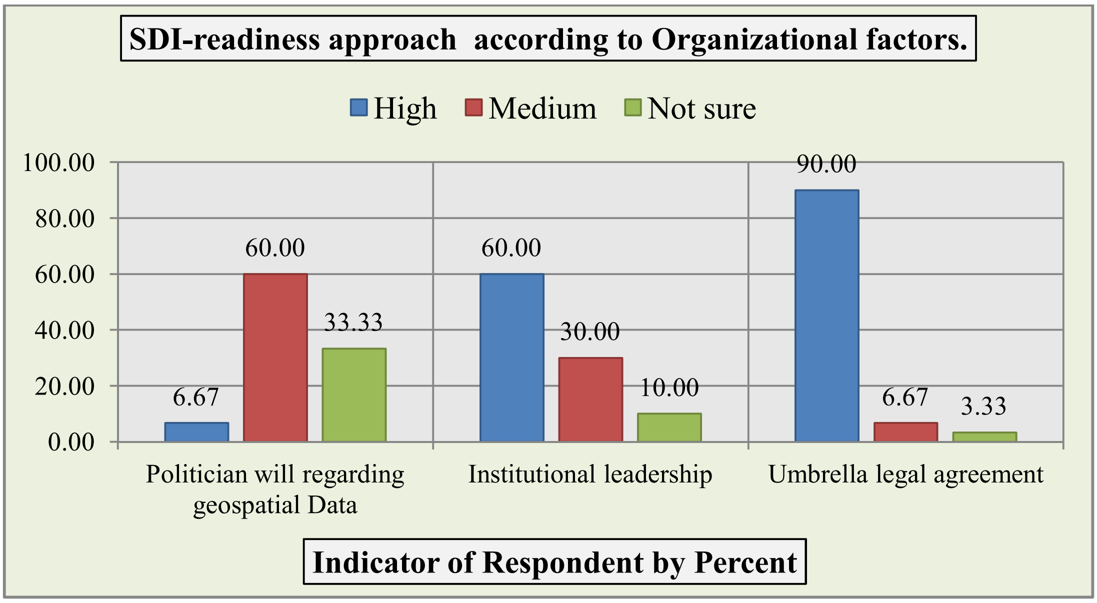

Figure: 4. 1. Respondents Organizational Point of View Summary Chart

4.3. Information/Data Availability in Digital form

4.3.1. Spatial Data Availability

Respondents were asked what they thought about the availability of information/data in digital form - spatial. As a result, Table 4.4 shows that 22 respondents (73.33 percent) confirm that information/data in digital form - spatial is available, 3 respondents (10.00 percent) confirm that they are unsure whether the information/data in digital form - spatial exists, and 5 respondents (16.67 percent) respond that information/data in digital form - spatial was not available. This result shows while spatial information/data in digital form was available in most tows administration offices, it was not useful in many application areas, and tows experts did not use it properly to carry out their responsibilities.

Table: 4. 4. Respondents views on the Spatial Data Availability

Indicator	Frequency	Percent
Available	22	73.33
Not available	5	16.67
I have no Information	3	10.00
Total	**30**	**100.00**

4.3.2. Meta Data availability

During the poll, respondents were asked about their opinions on the availability of information/data in digital form - metadata. As shown in Table 4.5, approximately 1 expert

(3.33 percent) confirms that metadata information/data in digital form was available; 3 experts (10.00 percent) are unsure whether or not metadata information/data in digital form was available; and 26 experts (86.67 percent) respond that metadata information/data in digital form was not available this reveal that many of the respondent have no idea about the availability of Meta data.

Table: 4. 5. Respondents views on the Meta Data availability

Indicator	Frequency	Percent
Available	1	3.33
Not available	26	86.67
I have no Information	3	10.00
Total	**30**	**100.00**

Summary of SDI-readiness approach integrates factors from various points of View according to Information/Data Availability in Digital form factors.

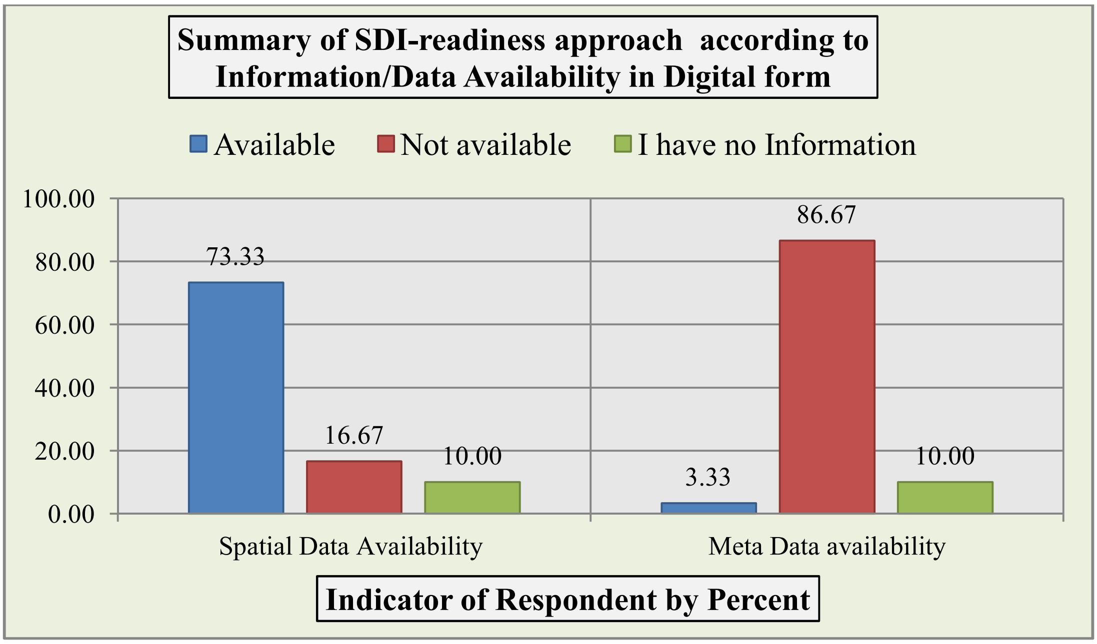

Figure: 4. 2. Respondents Information/Data Availability in Digital form Point of View Summary Chart4.4. People

4.4. People

4.4.1. Human capital

Respondents' attitudes regarding human capital According to Table 4.6, approximately 3 experts (10.00 percent) respond that human capital is not available, 1 expert (3.33 percent) responds that they are doubtful, and 26 experts (86.67 percent) respond that they have a high level of knowledge of human capital according to this tows administration's human capital is in good working order.

Table: 4. 6. Respondents views on the Human capital

Indicator	Frequency	Percent
Available	26	86.67
Not available	3	10.00
I have no Information	1	3.33
Total	**30**	**100.00**

4.4.2. Expert in all Area

Respondent opinions were solicited during the study to examine respondents' attitudes regarding Expert in all Areas. According to Table 4.7, 18 Respondent (66.67%) agree that an expert in all areas is available, 6 Respondent (20%) are unsure, and 4 Respondent (13.33%) respond that an expert in all areas is not available. According to respondent views on experts in all Areas shows that experts in all areas are in the progressive stage to carry out geospatial and associated activities in tows.

Table: 4. 7. Respondents views on the Expert in all Area

Indicator	Frequency	Percent
Available	20	66.67
Not available	4	13.33
I have no Information	6	20.00
Total	**30**	**100.00**

4.4.3. Individual leadership

Respondents' viewpoints were collected in order to investigate their attitudes toward individual leadership. Individual leadership is not available for 5 respondents (16.67 percent), they have no information for 5 respondents (16.67 percent), and they have a high level of knowledge about Individual leadership for 20 respondents (67.67 percent), according to Table 4.8. This implies that the local administration's Individual leadership is seeking for some form of arrangement or change to improve Individual leadership.

Table: 4. 8. Respondents views on the Individual leadership

Indicator	Frequency	Percent
Available	20	66.67
Not available	5	16.67
I have no Information	5	16.67
Total	**30**	**100.00**

Summary of SDI-readiness approach integrates factors from various points of View according to People factors.

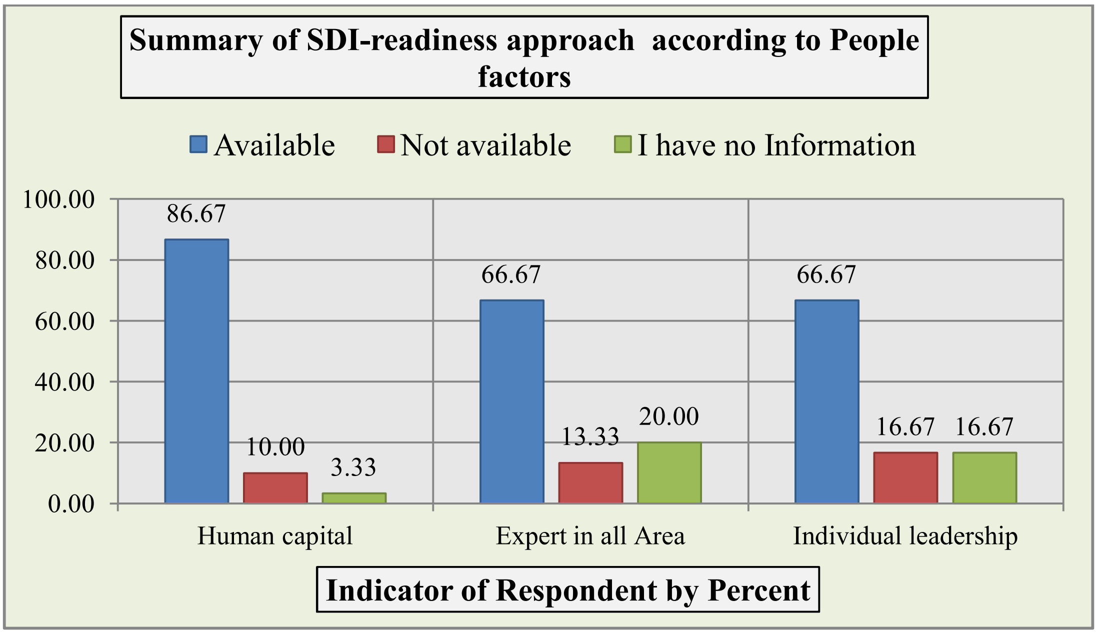

Figure: 4. 3. Respondents People Point of View Summary Chart

4.5. Access to Network

4.5.1. Web connectivity

Respondents were asked about their thoughts on the tows's Web connectivity during the poll. According to Table 4.9, approximately 21 Respondent (70.00%) confirm that Web connectivity was available; 5 experts (16.67%) are unsure; and 4 respondents (13.33%) indicate that Web connectivity was not available.

Table: 4. 9. Respondents views on the Web connectivity

Indicator	Frequency	Percent
Available	21	70.00
Not available	4	13.33
I have no Information	5	16.67
Total	**30**	**100.00**

4.5.2. Telecommunication infrastructure

During the poll, Respondents were asked about the tows's telecommunication infrastructure. According to Table 4.10, 26 respondents (86.67 percent) confirm that telecommunication infrastructure was available, 3 Respondent (10.00 percent) have no information, and 1 Respondents (3.33 percent) imply that telecommunication infrastructure was not available. Telecommunication infrastructure was available in the tows, but many

Respondents were unaware that telecommunication infrastructure has a high level of interaction with geospatial data.

Table: 4. 10. Respondents views on the Telecommunication infrastructure

Indicator	Frequency	Percent
Available	26	86.67
Not available	1	3.33
I have no Information	3	10.00
Total	**30**	**100.00**

4.5.3. Own geo-information development

Participants were asked their thoughts on the tows's own geo-information development during the survey. According to Table 4.11, 1 respondent (3.33%) confirms that Own geo-information development was available, 3 respondents (10.00%) are unsure, and 26 respondents (86.67%) imply that Own geo-information development was not available. This show that own geo-information development was not available in the tows.

Table: 4. 11. Respondents views on the Own geo-information development

Indicator	Frequency	Percent
Available	1	3.33
Not available	26	86.67
I have no Information	3	10.00
Total	**30**	**100.00**

4.5.4. Geospatial software availability

According to the availability of geospatial software for the improvement of the tows' cadastral information system; Table 4.12 reveals that about 3 Respondents (10.00%) response they have no information regarding geospatial software availability, 2 Respondents (6.67%) confirm that it is not available, and 25 Respondents (83.33%) answer yes.

Table: 4. 12. Respondent view on the Geospatial software availability

Indicator	Frequency	Percent
Available	25	83.33
Not available	2	6.67
I have no Information	3	10.00
Total	**30**	**100.00**

4.5.5. Open source culture

Respondents were asked what they thought of the tows's open source culture. Accordingly, Table 4.13 shows that 23 respondents (76.67%) confirm that there is no open source culture in the tows, 3 people (10.00%) confirm that they do not know the tows uses open source software or not and respondents (13.33%) answered that the tows is currently using open source software. Despite the fact that there was no Open Source culture in the tows.

Table: 4. 13. Respondents views on the Open source culture

Indicator	Frequency	Percent
Available	4	13.33
Not available	23	76.67
I have no Information	3	10.00
Total	**30**	**100.00**

Summary of SDI-readiness approach integrates factors from various points of View according to Access to Network factors.

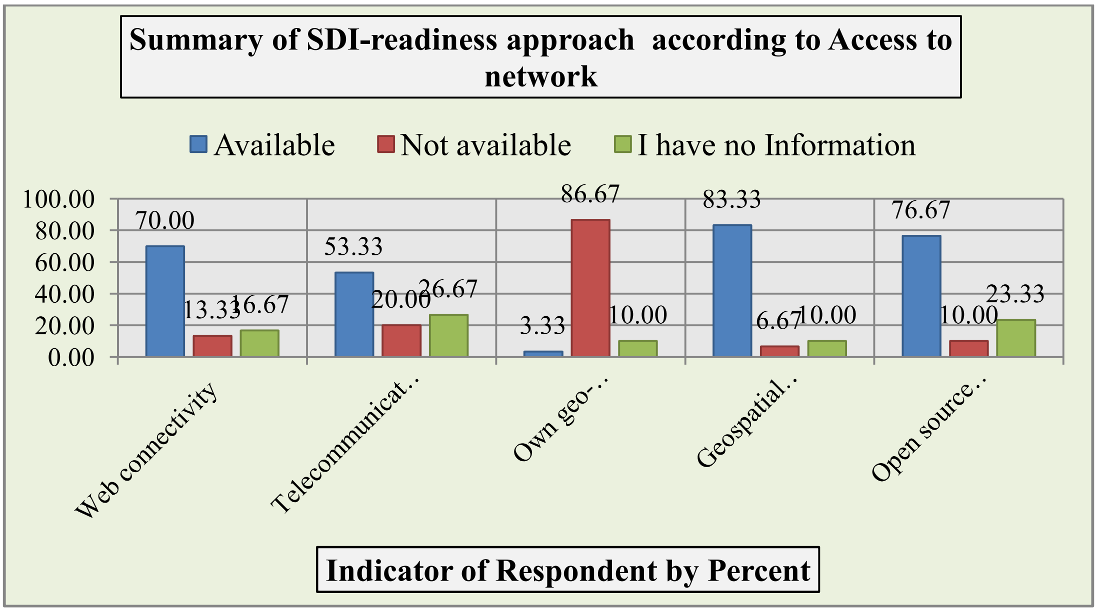

Figure: 4. 4. Respondents Access to Network Point of View Summary Chart

4.6. Financial Resources

4.6.1. Sufficient Government central funding

Respondents' views on the provision of sufficient funds by the central government to improve the cadastral information systems of tows; According to Table 4.14 shows that about 6 respondents (20.00%) confirmed that they do not have information about sufficient central government funding to improve the tows's cadastral information system, 2 respondents (6.67%) confirmed that there no is enough central government funding to improve cadastral information. and 22 respondents (73.33%) said yes. This show that sufficient government central funding to improve the tows' cadastral information system is however, at a decent state of development.

Table: 4. 14. Respondents views on the Sufficient Government central funding

Indicator	Frequency	Percent
Available	22	73.33
Not available	2	6.67
I have no Information	6	20.00
Total	**30**	**100.00**

4.6.2. Data policy aimed to return on investments

During the study, respondents were asked about their opinions on data policy targeted at maximizing returns on investments. Table 4.15 shows that 18 Respondents (60.00%) indicate that Data policy targeted at return on investments was available, 7 Respondents (23.33%) are unclear, and 5 Respondents (16.67%) imply that Data policy aimed at return on investments was not available.

Table: 4. 15. Respondents' views on the Data policy aimed to return on investments

Indicator	Frequency	Percent
Available	18	60.00
Not available	5	16.67
I have no Information	7	23.33
Total	**30**	**100.00**

4.6.3. Enterprise and private sector funding

Table 4.16 shows that about 10 Respondents (33.33 percent) confirm they have no information about Enterprise and private sector funding for the improvement of tows' cadastral information system whereas, 6 Respondents (20.00 percent) confirm that Sufficient Government central funding to improve tows cadastral information system is not available, and 14 Respondents (46.67 percent) say yes. This response demonstrates that Enterprise and private sector funding for improving cadastral information systems of the tows need special attention.

Table: 4. 16. Respondents views on the Enterprise and private sector funding

Indicator	Frequency	Percent
Available	14	46.67
Not available	6	20.00
I have no Information	10	33.33
Total	**30**	**100.00**

Summary of SDI-readiness approach integrates factors from various points of View according to Financial Resources factors.

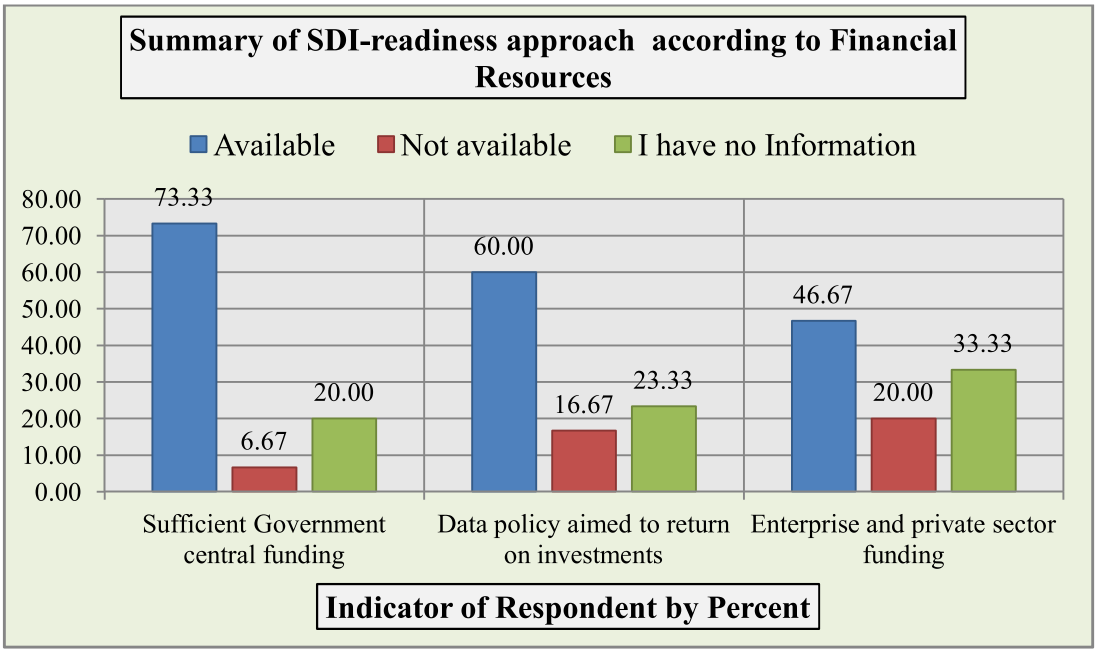

Figure: 4. 5. Respondents Financial Resources Point of View Summary Chart

4.7. Summary of Respondent View on Adama Tows SDI-readiness Approach

4.7.1. Summary of Respondents views on the indicator of Organizational View

Respondent's views on Adama tows SDI-readiness approach data were gathered during primary data collection which included interviews and questioners. Consequently, the summary of the respondent's response to the indicators of the ***Organization*** view is presented in the table and chart as follows.

Table: 4. 17. Summary of Respondents views on the indicator of Organizational View

S.N	Geospatial Data Readiness Aspect	Indicator	Measurement Level		
			High	Medium	Not sure
1	Organizational	Politician will regarding geospatial data	6.67	60.00	33.33
		Institutional leadership awareness	60.00	30.00	10.00
		Umbrella legal agreement	90.00	6.67	3.33

The summary of respondent views on ***Organizational*** view and each measurable factors under organizational view such as *Politician will regarding to geospatial Data,* *Institutional leadership*, and *Umbrella legal agreement* that are quantitatively measured result analysis shows that; According to Table 4.1, 6.67 percent of respondents believe that politicians' intentions toward geospatial data are strongly implemented in the tows, whereas 60.00 percent believe that politicians' intentions toward geospatial data are on the Middle level. Furthermore, 33.33 percent of respondents are unsure about the topic. This demonstrates that, even within the tows administration, respondent opinions of politicians' intentions using geospatial data varied from one another.

In contrast, institutional leadership awareness As a result, Table 4.2 shows that approximately 9 experts (30.00%) confirm that institutional leadership awareness is Medium, 3 experts (10.00%) confirm that they are unsure whether institutional leadership awareness exists, and 18 experts (60.00%) believe that institutional leadership awareness is highly implemented in the tows. This demonstrates that institutional leadership in local government is well-informed on the subject. Finally, according to Table 4.3, 27 respondents (90.00 percent) believe that umbrella legal agreement awareness is widely adopted in the tows; whereas 6.67 percent consider that umbrella legal agreement awareness is on the Middle level. In addition, 3.33 percent of respondents are unclear about the topic. The outcome demonstrates that the tows administrations are well-communicated on the matter.

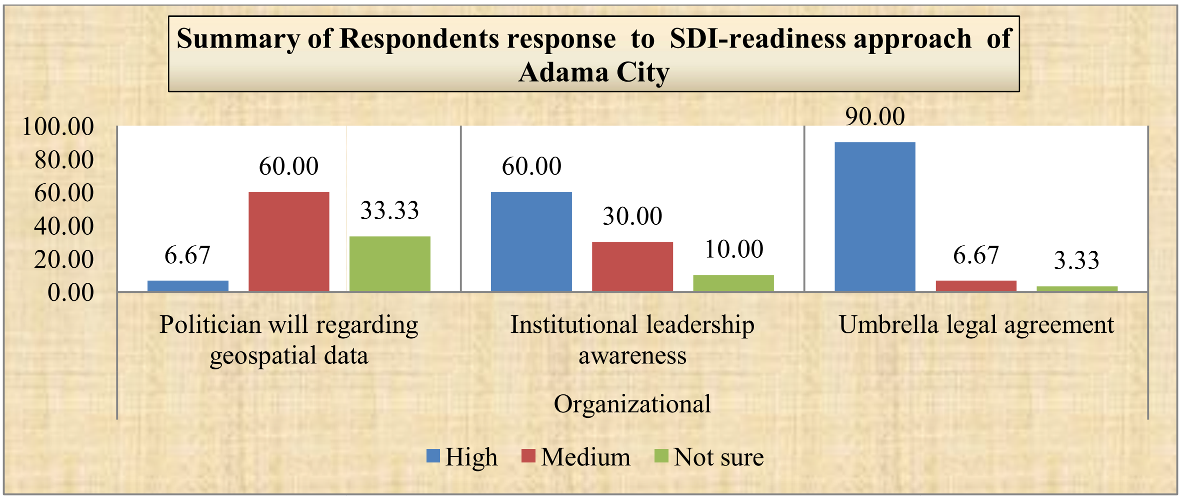

Figure: 4. 6. Summary of Respondents views on the indicator of Organizational View Chart

4.7.2. Summary of Respondents views on the indicator of national legal agreements, information data availability, access to networks, people and financial resources view

Respondent's views on Adama tows SDI-readiness approach data were gathered during primary data collection which included interviews and questioners. Consequently, the summary of the respondent's response to the indicators of the ***information data availability***, ***access to networks***, ***people*** and ***financial resources view*** is presented in the table and chart as follows.

Table: 4. 18. Summary of Respondents views on the indicator of national legal agreements, information data availability, access to networks, people and financial resources view

S.N	Geospatial Data Readiness Aspect	Indicator	Measurement Level		
			Available	Not Available	I have no Information
2	**Information/data availability in digital form**	Spatial data	73.33	16.67	10.00
		Metadata	3.33	86.67	10.00
3	**People**	Human capital	86.67	10.00	3.33
		Expert in all Area	66.67	13.33	20.00
		Individual leadership	66.67	16.67	16.67
4	**Access to network**	Web connectivity	70.00	13.33	16.67
		Telecommunication infrastructure	86.67	3.33	10.00
		Own geo-information development	3.33	86.67	10.00
		Geospatial software	6.67	83.33	10.00
		Open source culture	13.33	76.67	10.00
5	**Financial resources**	Sufficient government central funding	73.33	6.67	20.00
		Data policy aimed to return on investment	60.00	16.67	23.33
		Enterprise/NGO and private sector funding	46.67	20.00	33.33

The summary of respondent perspectives on information data availability and each measurable aspect under ***information data availability*** that is objectively measured, such as Spatial Data Availability and Meta Data Availability, demonstrates that; According to Table 4.4, 22 respondents (73.33 percent) indicate that information/data in digital form - spatial is available, 3 respondents (10.00 percent) are unclear, and 5 respondents (16.67 percent) respond that information/data in digital form - spatial is not available. This finding demonstrates that, while digital geographic information/data was available in most tows administration offices, it was ineffective in many application areas, and tows experts did not use it correctly to carry out their tasks. In contrast to the availability of metadata As shown in Table 4.5, approximately one expert (3.33 percent) agrees that metadata information/data in digital form was available; three experts (10.00 percent) are unclear;

and 26 experts (86.67 percent) respond that metadata information/data in digital form was not available.

The summary of respondent perspectives on Peoples view and each measurable element under Peoples view such as; Human capital, Expert in all Areas, and Individual leadership that are quantitatively quantified result analysis demonstrates that; Human capital perspectives of respondents According to Table 4.6, approximately 3 experts (10.00 percent) say that human capital is not available, 1 expert (3.33 percent) responds that they are skeptical, and 26 experts (86.67 percent) respond that they have a high level of knowledge of human capital. This shows that human capital in the tows is on progressive stage. Also According to Table 4.7, 18 respondents (66.67 percent) agree that an expert in all areas is available, 6 respondents (20 percent) are unsure, and 4 respondents (13.33 percent) indicate that an expert in all areas is not available. According to respondent perspectives on experts in all fields, it is on the progressive stage of carrying out geospatial and related activities in tows. Finally the responses of respondents were gathered in order to evaluate their perspectives toward individual leadership. Individual leadership is not available for 5 respondents (16.67 percent), they have no information for 5 respondents (16.67 percent), and they have a high level of knowledge about Individual leadership for 20 respondents (67.67 percent), according to Table 4.8. This means that the local administration's Individual leadership is looking for some sort of arrangement or modification to boost Individual leadership.

Respondents perspectives on Access to Network view and each quantifiable component under Access to Network view, such as; Web connectivity, Telecommunication infrastructure, Own geo-information development, Geospatial software availability and Open source culture that are quantitatively measured result analysis shows that; According to Table 4.9, nearly 21 experts (70.00%) agree that Web connectivity was available; 5 respondents (16.67%) are unclear; and 4 respondents (13.33%) indicate that Web connectivity was not available. As Table 4.10 shows, 26 respondents (86.67 percent) indicate that telecommunication infrastructure was available, 3 respondents (10.00 percent) had no information, and 1 respondent (3.33 percent) imply that telecommunication infrastructure was not available. Telecommunication infrastructure was accessible in the tows, but many respondents were unaware that it interacts heavily with geospatial data.

As shown in Table 4.11, during the survey, participants were asked about the towns own geo-information development, and 1 respondent (3.33 percent) indicates that it was available, 3 respondents (10.00 percent) are doubtful, and 26 respondents (86.67 percent) imply that it was not available. This demonstrates that the tows did not have its own geo-information development. According to the availability of geospatial software for the improvement of tows' cadastral information systems, Table 4.12 shows that approximately 3 Respondents (10.00 percent) respond that they have no information regarding geospatial software availability, 2 Respondents (6.67 percent) confirm that it is not available, and 25 Respondents (83.33 percent) respond yes. Finally, respondents' perspectives on the tows's open source culture. According to Table 4.13, 23 respondents (76.67 percent) confirm that there is no open source culture in the tows, 3 people (10.00 percent) confirm that they do not know whether the tows uses open source software or not, and respondents (13.33 percent) respond that the tows is currently using open source software. Despite the fact that there was no Open Source culture in the tows.

Perspectives on Financial Resources view and each quantifiable aspect inside Financial Resources view, such as; Sufficient Government central funding, Data policy aimed to return on investments and Enterprise and private sector funding that are quantitatively measured result analysis shows that; According to Table 4.14 shows that approximately 6 respondents (20.00 percent) confirmed that they do not have information about sufficient central government funding to improve the tows's cadastral information system, while 2 respondents (6.67 percent) confirmed that there is insufficient central government funding to improve cadastral information. And 22 people (73.33 percent) voted yes. This show that sufficient government central funding to improve the tows' cadastral information system is however, at a decent state of development.

Respondents were asked about their thoughts on data policy aimed at optimizing returns on investment during the study. According to Table 4.15, 18 respondents (60.00 percent) believe that data policy aimed at return on investment was available, 7 respondents (23.33 percent) are unsure, and 5 respondents (16.67 percent) respond that data policy aimed at return on investment was not available. Finally, Table 4.16 shows that approximately 10 respondents (33.33 percent) confirm they have no information about Enterprise and private sector funding for the improvement of tows' cadastral information system, 6 respondents (20.00 percent) confirm that sufficient Government central funding to improve tows' cadastral information system is not available, and 14 respondents (46.67 percent) say yes. This response shows that enterprise and private sector financing for enhancing the tows's cadastral information systems need special attentions.

Chart Shows Summary of Respondent's views on Adama tows SDI-readiness approach on the indicators of the ***information data availability***, ***access to networks***, ***people*** and ***financial resources view***.

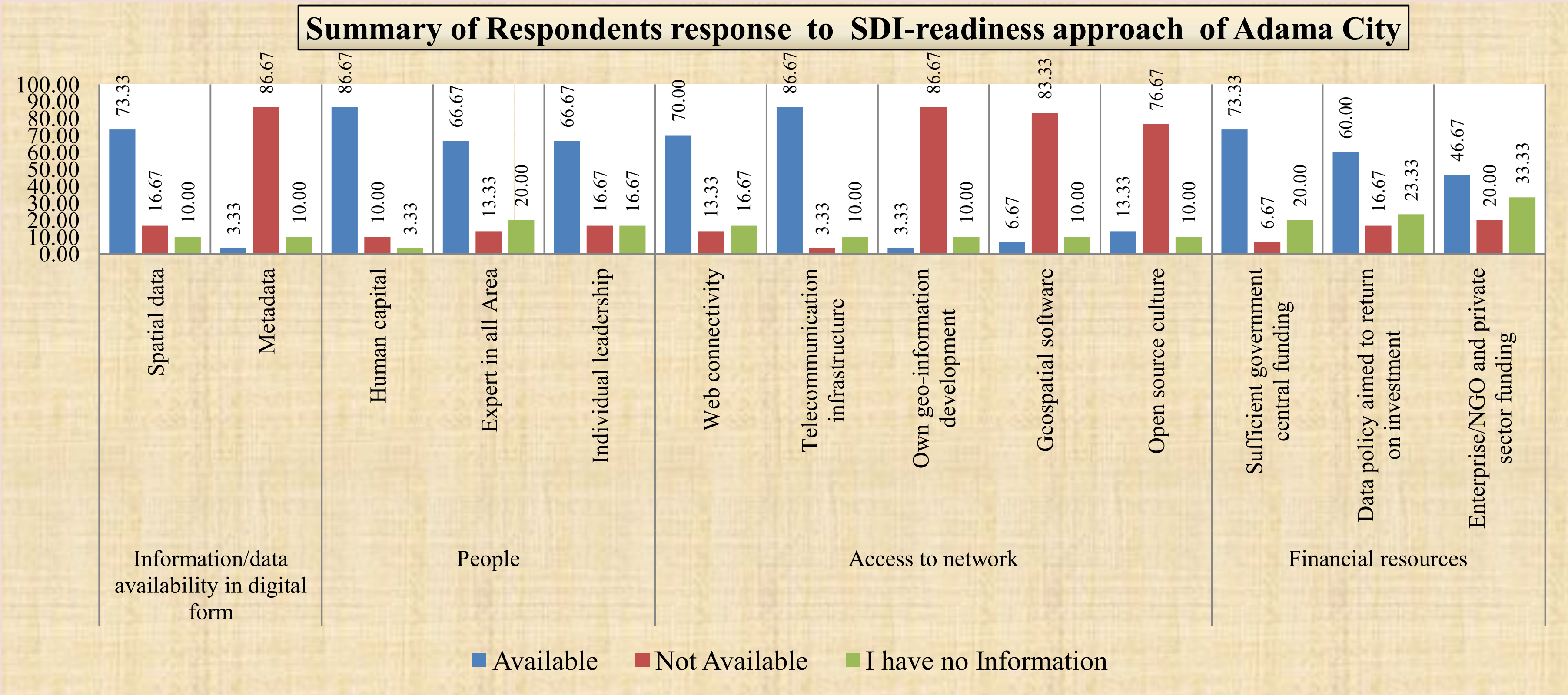

Figure: 4. 7. Summary of Respondents views on the indicator of national legal agreements, information data availability, access to networks, people and financial resources view Chart.

4.8. Establishing Cadastral Web Map

During developing the Cadastral Web Map the researcher use a spatial and non spatial data created by ArcGIS software; and all data were used as obtained from Land Management office of the tows. Figure: 4.8 below shows the Map of Sample Selected Parcel Block for the Study.

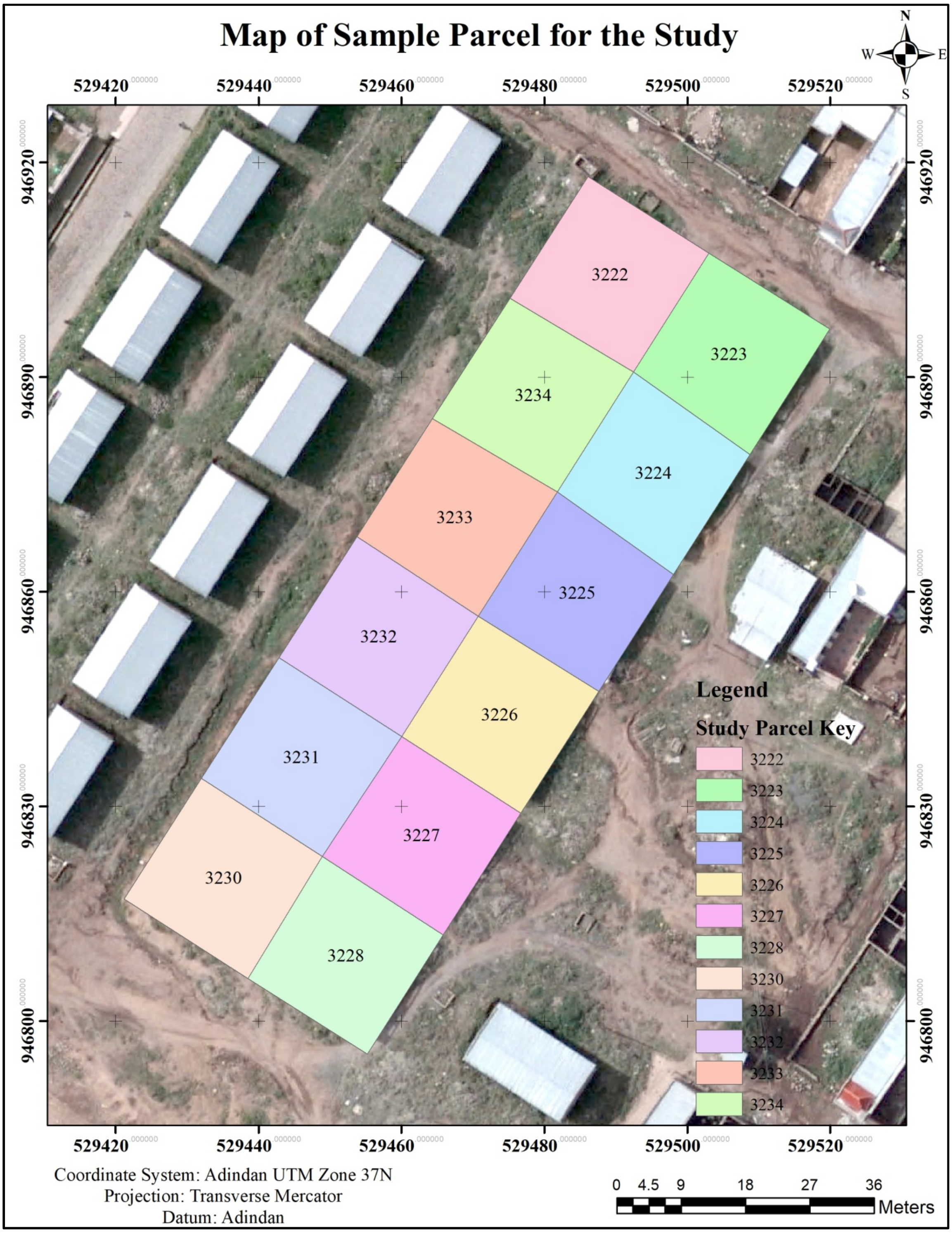

Figure: 4. 8. Map of Sample Parcel Block for the Study

4.9. Establishment of Cadastral Web Map Involves

This map will be running on our web browser and there's absolutely no need for us to have a Java Script software package. Once we manage to create this web map and if we want to share our maps with somebody else, not as an exported PDF or JPEG image but as a dynamic and interactive map, we can just pass the generated web-map to them and they would be able to open the map in their own web browser and all the settings that we intended to have would be preserved.

4.9.1. Plug in QGIS

So the plug-in that connects QGIS to Web is called qgis2web, and if we haven't gotten that Plug-in install yet, we can simply go to Plug-in and manage and install and we can simply search for qgis2web Figure 4:9.

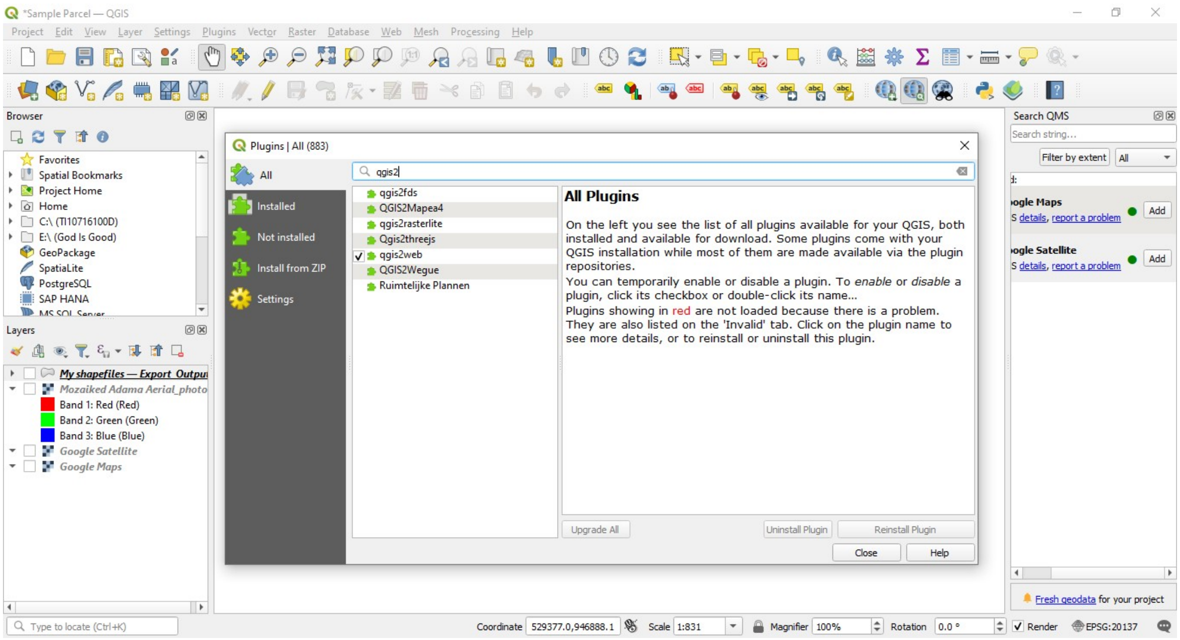

Figure: 4. 9. Plug-in Dialog Box when connecting QGIS to Web

4.9.2. The Data Used when Creating Web Map

To give a quick overview to the data that I'm working with for this particular Task, that I'm used Google map (satellite map) as the base map, just under the list of the Plug-in we will be searching quick map services and we can install that Also Mainly I Use Sample Parcel Block Shape files and Aerial photograph obtained from Adama Tows Land Management office. This Sample Parcel Block contains 12 (Twelve) single parcel which have their own non spatial data such as owner name, parcel block, parcel number and so on, and I'm pretty much going to use just these data to create my web map. And if I open up the attributes table over here in these parcel the Attribute is the same with original and these are the Attributes that I'm going to pass to my web map.

Now before I get started with the preparing the web map, first of all, I'm going to create a project title because that title would appear in the web map that I am going to create.

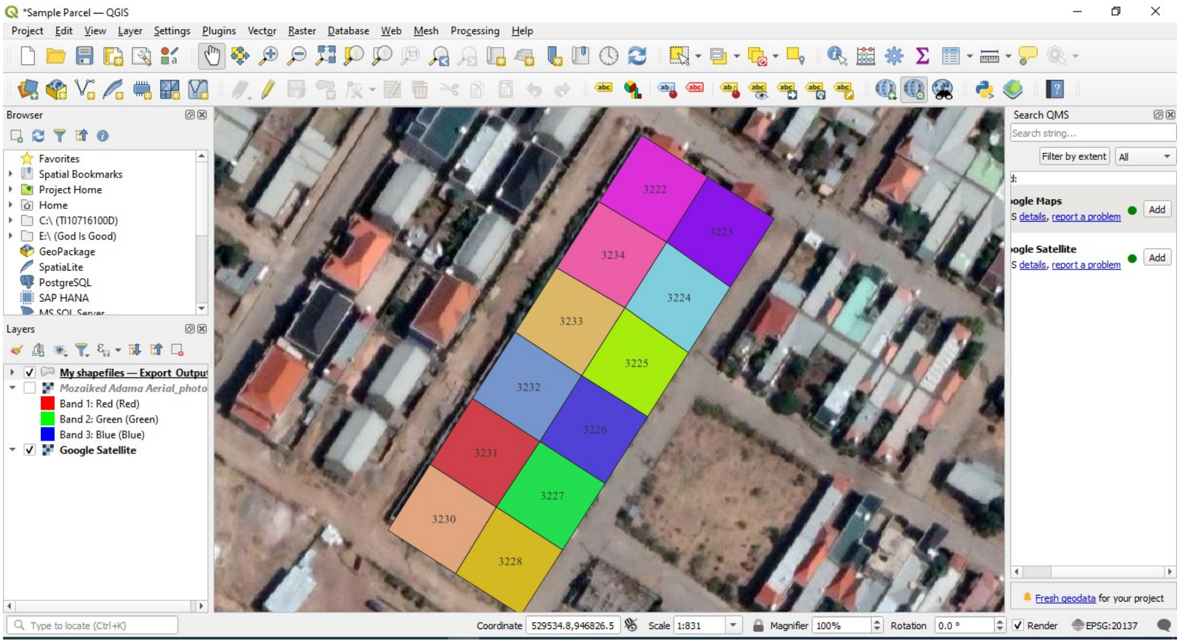

Figure: 4. 10. Sample Parcel Block and Over layed Satellite image

And one of the cool things that we can actually change the attribute if necessary

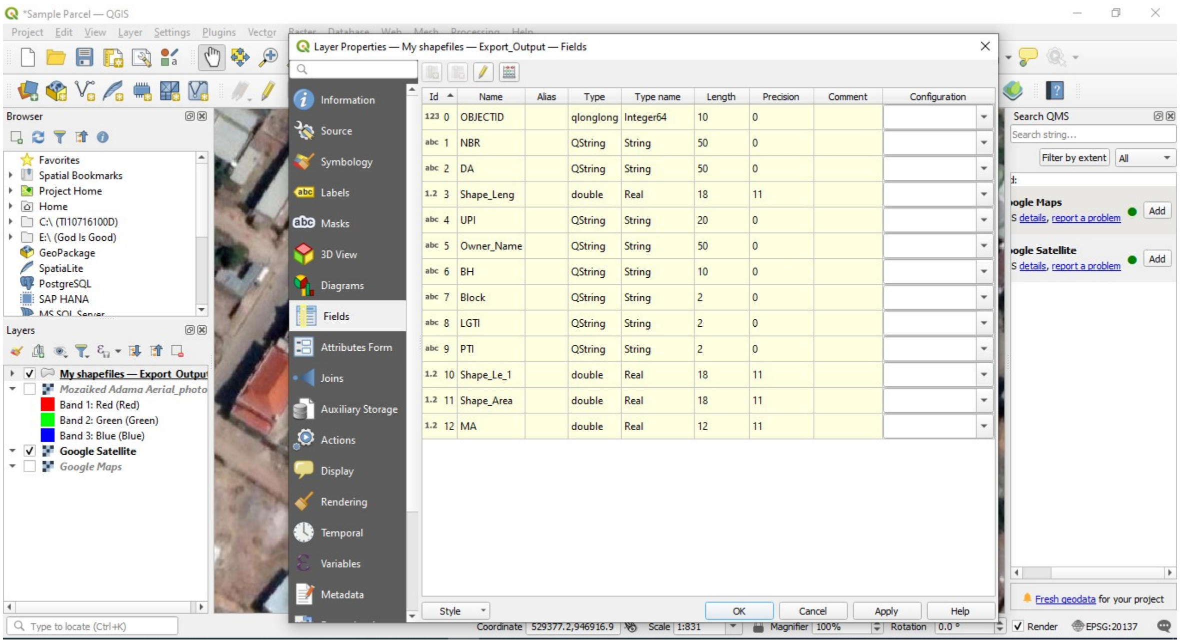

Figure: 4. 11. Layer property of QGIS

4.9.3. Connect QGIS to Web

Right now here we have a couple of things that we need to take care of now and we need to specify whether to include all labels on attribute table or not. And right over here we can pick either we want to go with open layers, leaflet or Map box GL JavaScript, but I'm going to go with leaflet.

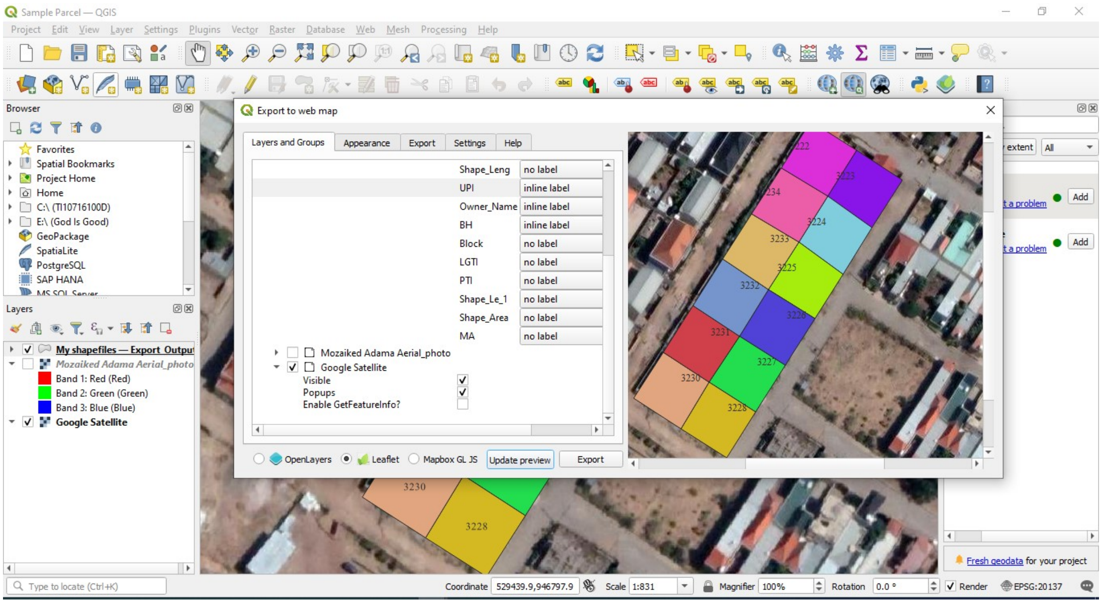

Figure: 4. 12. Map Export from QGIS to Web

And right over here we can make some appearance as well. Now, for example, if we would like to add address search bar basically for searching a places as long as we have an Internet connection we can easily search the places we wants. And we can even change our maximum and minimum zoom levels over here.

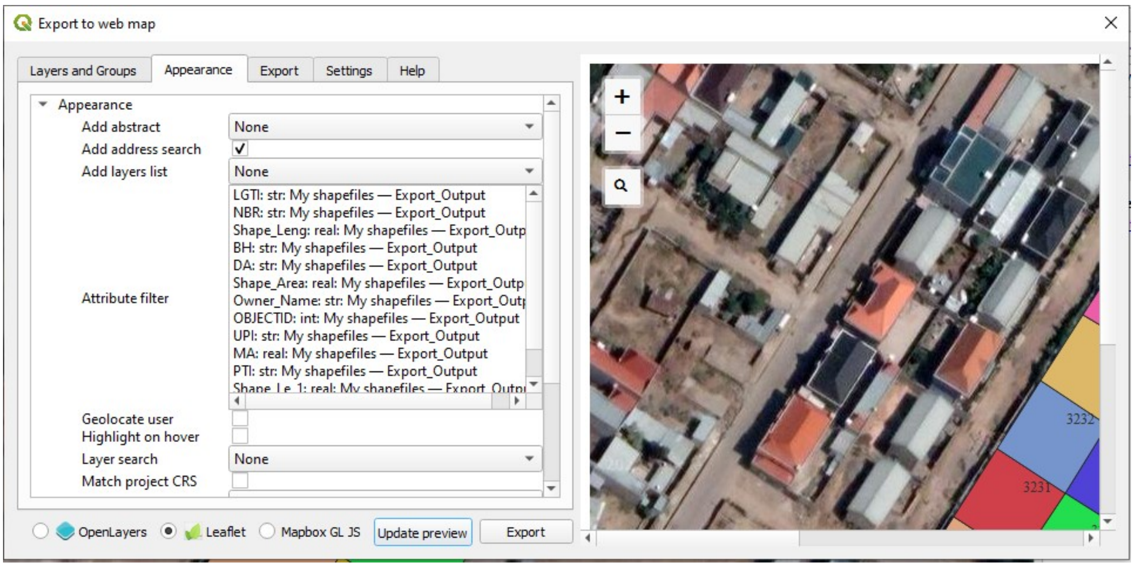

Figure: 4. 13. Appearance Setting in QGIS

So finally, to get a final view of my web map, I'm going to export my project files into a separate folder. And just in a matter of few seconds I will have my web map running completely in a web browser.

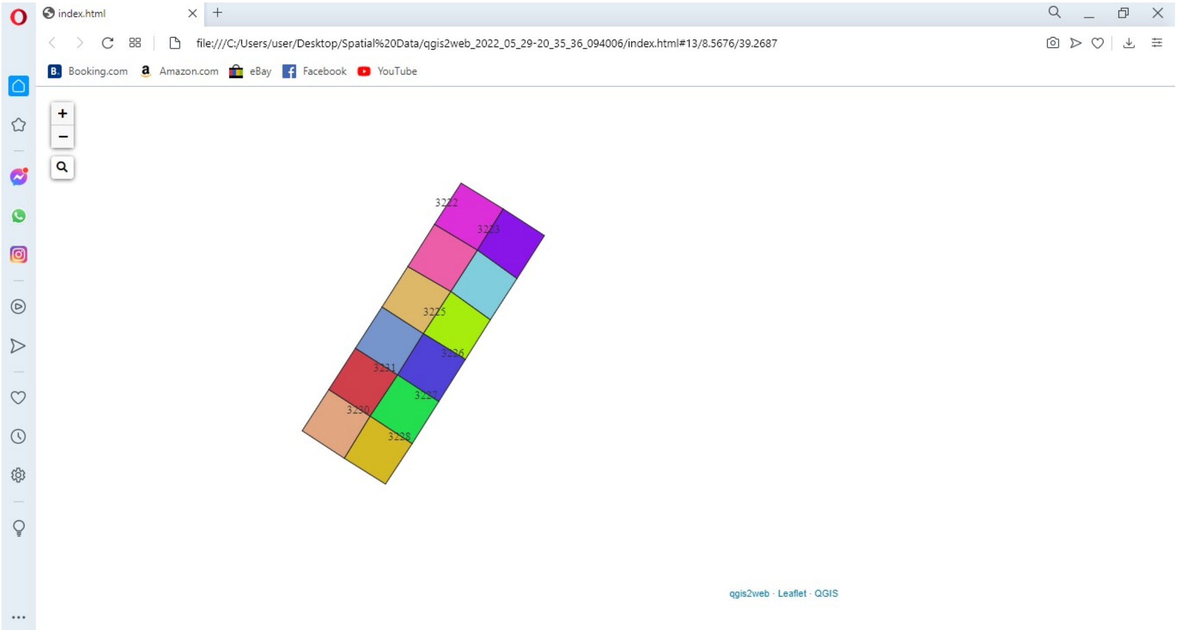

Figure: 4. 14. Cadastral Web Map on the internet Browser

But right now the Map is running completely in my web browser and if I were click on one of this Parcel I can easily get original information about the parcel.

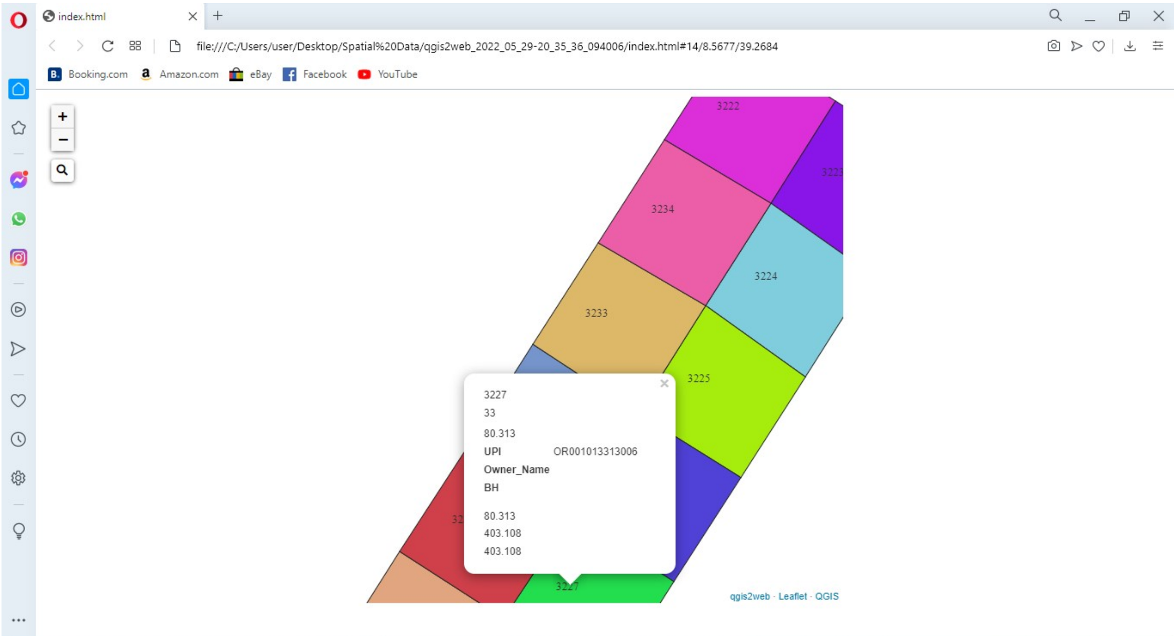

Figure: 4. 15. Po-Up menu from Attribute

4.10. Discussion

As described in the methodology chapter of this study, two major tasks are being undertaken to complete this study; the first task is the evaluation of the current status of Adama tows Cadastral information system; and the second task is the development of cadastral web maps using secondary data obtained from Adama tows land management office; to complete the first task, the researcher used the SDI-Readiness Approach designed by Delgado et al (2005).

SDI-readiness approach integrates factors from various points of view which are listed as follows;

- ✓ Organizational
- ✓ Information/data Availability in digital form
- ✓ People
- ✓ Access to Networks and
- ✓ Financial resources

Each of above listed factors consists of different indicators that are quantitatively measured and consists of sub indicators. Finally According to the result obtained from Evaluation of Adama Tows Existing Cadastral Information System the result is discussed in this section.

Organizational

Politician will regarding to geospatial Data: The researcher sought respondent attitudes concerning politician’s intents regarding geospatial data during the study and the result obtained shows reveals that even within the tows administration, respondent perceptions of politician’s intentions regarding geospatial data different from each others.

Institutional leadership: The findings from respondents’ perspectives on institutional leadership in local government show that; the institutional leadership in the tows is on the progressive way.

Information/Data Availability in Digital form

Spatial Data Availability: According to respondents, while spatial information/data in digital form was available in most tows administration offices, it was not effective in many application areas, and tows experts did not use it correctly to carry out their tasks.

Meta Data availability: During the poll, many respondents' attitudes toward the availability of Meta data indicate that they have no understanding what Meta data is.

People

Human capital: According to human capital the respondent response shows that tows administration's human capital is in good working order.

Individual leadership: The outcome implies that Individual leadership is looking for some sort of arrangement or modification to boost Individual leadership.

Access to Network

Telecommunication infrastructure: Telecommunication infrastructure was available in the tows, but many Respondents were unaware that telecommunication infrastructure has a high level of interaction with geospatial data.

Own geo-information development: The result reveals that; own geo-information development was not available in the tows.

Open source culture: During the poll, respondents were asked about the tows's open source software's culture; despite the fact that the tows has no Open Source culture.

Financial Resources

Sufficient Government central funding: Respondent views on Sufficient Government Central Financing indicate that the government central funding to improve tows cadastral information system is however, at a decent state of development.

Enterprise and private sector funding: Demonstrates that funding for improving tows' cadastral information systems by private sector need special attentions.

CHAPTER V: CONCLUSIONS AND RECOMMENDATION

5.1. Conclusions

The most difficult problem in building a Cadastral Information System is a lack of political leadership knowledge, as well as insufficient expert and financial allocation. However, as proven by observations, written material, and interviews, the current situation of the Tows clearly reveals an immense discrepancy between existing resources and demand for constructing the Geospatial Based Cadastral Information System. On the other hand, there is a lack of awareness and understanding of the appropriate regulations for making data available for Geospatial Based Cadastral Information Systems. The tows needed both skilled employees and efficient financial resources to build a modern cadastral information system.

The summary of the study's findings imply that there is a knowledge gap related to the implementation of cadastral information systems of tows, which is now being implemented in other countries, for example, own geo-information development process and employing Open source culture in order to share cadastral map among various stake holders. Even the work environment in which they serve the customer is particularly not attractive.

5.2. Recommendation

Based on the results obtained from the study the researcher would like to forward the following recommendations;

- **Own geo-information development**: Many developed and developing countries are now developing their own geo-information applications in order to share and convey spatial data with various stakeholders inside their respective countries. However, according to the Adama tows administration, the development of own geo-information applications requires special attention; hence, own geo-information development is critical in order to improve spatial data sharing of tows among various stakeholders.
- **Open source culture:** However, according to the Adama tows administration, the use of OSS culture require special attention; consequently, Open source culture is critical in order to improve geographic data sharing of tows among diverse stakeholders.

- **Enterprise and private sector funding:** Administrative authorities should concentrate on encouraging enterprise and non-governmental organizations to invest in improving cadastral information systems of the tows.
- Having up-to-date attribute data on each parcel should also help to enhance and assist the establishment of a geospatial-based cadastre for effective land management. The attribute information (such as ownership, rights, area etc.) in the land registers is linked with the graphical information (such as boundary, shape, location etc.) But, unfortunately one can easily see that the Tows Cadastral database have no well-developed by full attribute information so accordingly the expert must have give more attentions to it.
- The advent of web mapping can be regarded as a major new trend recently. Accordingly the tows geospatial expert must have give attentions to develop web map to share the cadastral map with various stake holders in the tows.

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APPENDICES

Appendix I: Questionnaire Part-I

Adama Science and Technology University

School of Civil Engineering and Architecture

Geomatics Engineering Department

(Only for the purpose of Research and Education)

The following questionnaire is prepared to collect the part of data required for the research project entitled: **"Evaluation and Development of Cadastral Information System by Using Web GIS Techniques: a case of Adama Tows, Ethiopia"**. Since Land information system project is going on in your Tows and you are one of the professionals working on it; you are selected to fill the questionnaire because of your expertise and experiences as a professional in the area. Your responses will have significant contributions for the study. All responses of the respondents shall not be identified by name and the responses shall be analyzed and summarized as a group.

Thanks for your cooperation!!!

Name (optional): ____________________________

Your educational background: ________________________________

Show your answer by putting "√ " sign

1- Since when the awareness of computerized Land information system introduced in your Tows? _______________ E.C.
2- Your experience in the Tows municipality? _____________
3- From which staffs are you? Technical and professional staff☐ Administrative staff☐ management/position holder☐
4- In which year the modern Land information system project of the Tows started? _________ E.C.
5- Do you know Land information system rules and regulations or frameworks, policy exists? Yes☐ No☐
6- If your answer for question number 5 is yes, to what extent these rules and regulations or the policy being implemented? Very high ☐ Medium ☐ Low ☐ very low ☐

7- Do you think there are challenges/problems in implementing the rules, regulations, and the policy? Yes ☐ No ☐

8- If your answer for question number 7 is yes, where do you think the challenges/problems emerge from? From the policy☐ From implementation process☐

9- During formulating the rules, regulations, and the policy related to Land information system, where there discussions/ awareness creation programs conducted with the local governments, the society, and the sector professionals? Yes☐ No☐ I have no information☐

10- Currently, evaluations of the policy implementation going on? Yes☐ No☐ I don't know☐

11- If your answer for question number 10 is yes, by whom? ________________________

12- If your answer for question 10 is no, why______________________________________

13- For which one of the following purposes your town is using Land information system more?

For demarcating land/property boundaries and for land conflict resolutions ☐

For land valuation and levying right amount of tax and increase revenue of the town ☐

For the security of land tenure ☐

For land use control and development ☐

For controlling illegal construction ☐

To create digital land Database in order enable digital land data sharing among different stake holders and for data dissemination using internet or open consortium☐

To build the town land Database ☐

To build regional and National Land Bank ☐

14- Do you think sufficient amount of budget is being allocated for the Land information system project of the town? Yes ☐ No ☐

15- If your answer for question no. 14 is no, what is/are your recommendation/s to get additional budget? From which source/s? And how?

____

____

____

____

16- From your experiences, would please forward additional comments, suggestions, observed problems/challenges, etc. relevant to Land information system project of the town?

Appendix II: Questionnaire Part-II

Adama Science and Technology University

School of Civil Engineering and Architecture

Geomatics Engineering Department

Questionnaire Part-II

(Only for the purpose of Research and Education)

The following questionnaire is prepared to collect the part of data required for the research project entitled: **"Evaluation and Development of Cadastral Information System by Using Web GIS Techniques: a case of Adama Tows, Ethiopia"**. Since Land information system project is going on in your Tows and you are one of the professionals working on it; you are selected to fill the questionnaire because of your expertise and experiences as a professional in the area. Your responses will have significant contributions for the study. All responses of the respondents shall not be identified by name and the responses shall be analyzed and summarized as a group.

Thanks for your cooperation!!!

Name (optional): ___________________________

Your educational background: _______________________________

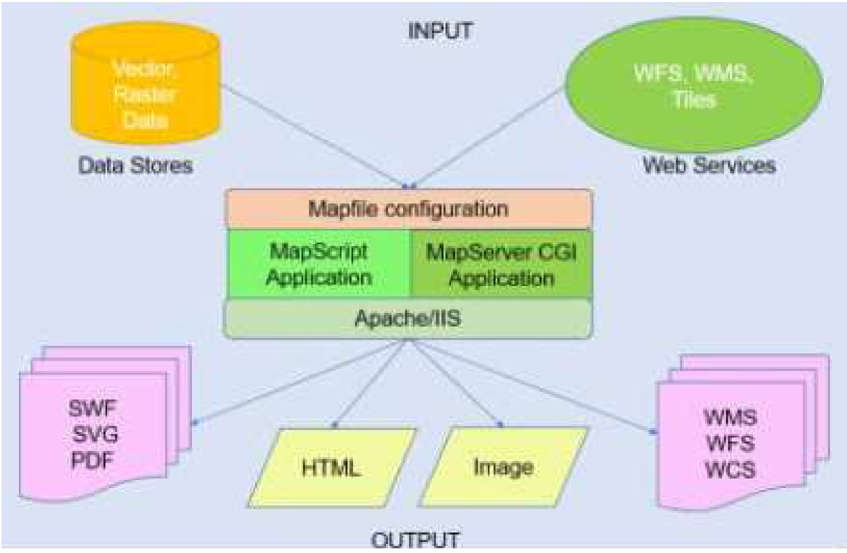
Show your answer by putting "√ " sign

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

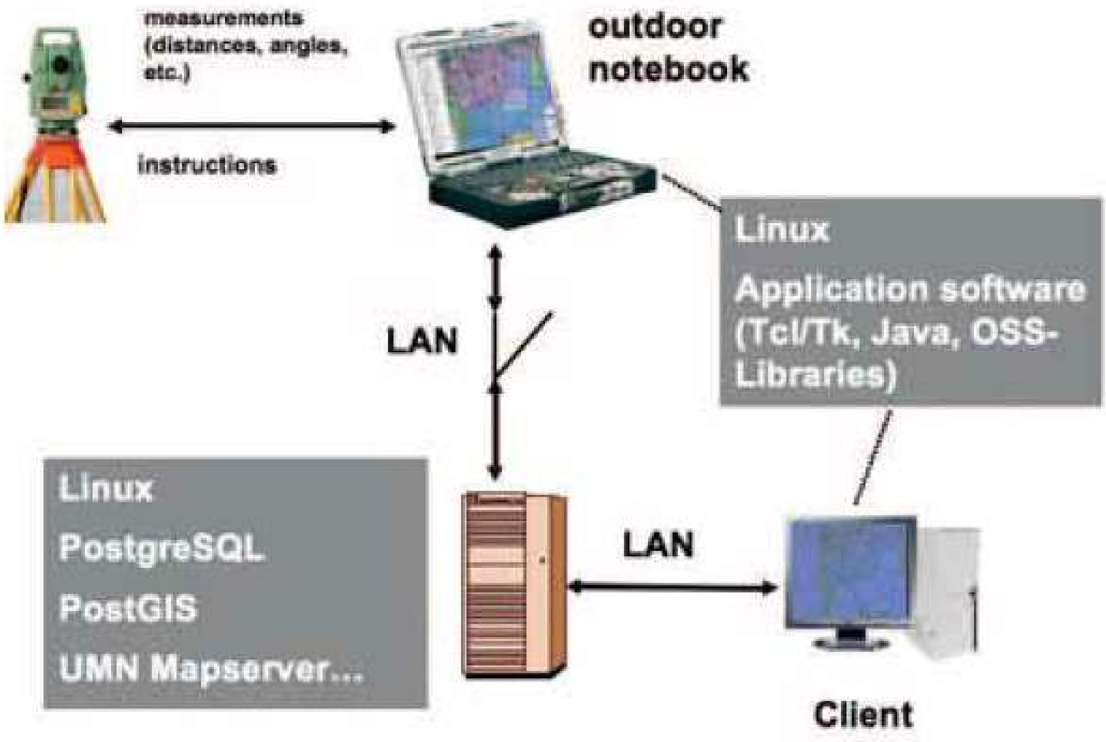
S.N	Geospatial Data Readiness Aspect	Indicator	Measurement Level		
			High	Medium	Not sure
1	Organizational	Politician will regarding geospatial data			
		Institutional leadership awareness			
		Umbrella legal agreement			
			Available	Not Available	I have no Information
2	Information/data availability in digital form	Spatial data			
		Metadata			

3	People	Human capital			
		Expert in all Area			
		Individual leadership			
4	Access network	Web connectivity			
		Telecommunication infrastructure			
		Own geo-information development			
		Geospatial software			
		Open source culture			
5	Financial resources	Sufficient government central funding			
		Data policy aimed to return on investment			
		Enterprise/NGO and private sector funding			

Appendix III: The basic structure of Map-Server



Appendix IV: Elements of the Bavarian surveying and geo-data management system



Appendix V: Bonn geo data management system infrastructure